



El futuro
es de todos

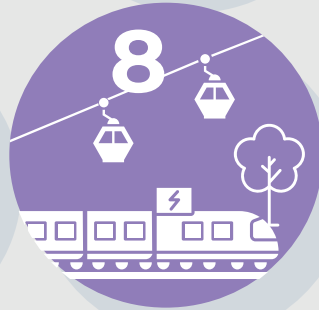
Gobierno
de Colombia



E2050

COLOMBIA

E2050 Colombia's long-term climate strategy
to meet the Paris Agreement



EXECUTIVE SUMMARY





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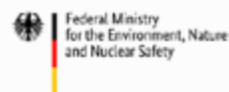
E2050

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Socios del proceso:



E2050 Colombia's long-term
climate strategy to meet
the Paris Agreement

E2050 Colombia's long-term climate strategy to meet the Paris Agreement

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Introduction

Today, humanity suffers consequences of climate change. In accordance with the mandate of the Paris Agreement, it is necessary to work together to reduce and capture CO₂ emissions and, by doing so, limit the increase in global temperature.

During my government, in accordance with our National Development Plan, Pact for Colombia, pact for equity, we have articulated climate commitments with national planning in such a way that Colombia will become a benchmark in Latin America in the search for alternatives and solutions to the problem of climate change that challenges our economies and our society.

Since Colombia is one of the countries most exposed to climate change, this Government has determinedly assumed leadership for a true revolution in our development model, spreading a new social ethic and strengthening a true sustainability agenda. By doing so, we have designed the policy called Producing While Conserving, Conserving While Producing, on which we build the circular economy strategy, the first of its kind in Latin America. Thus, this agenda is represented with the unrestricted commitment to protect the Amazon, forests and moorland, giving a great boost to energy transition and expansion of non-conventional renewable energies, the creation of opportunities based on bioeconomy and green

businesses, promoting clean mobility, implementing policies that will have Colombia being a carbon neutral country by 2050.

Although our country only represents 0.6% of CO₂ emissions, we are acting like a large polluter should. We do so with the conviction that our ethics must be to embrace the protection of the environment with determination and without hesitation. Colombia wants to lead by example, this great clean growth agenda in Latin America, and we want to take strong steps to make it happen. And we will achieve it with your support.

Setting long-term strategies is essential in this process since all of our actions in the National Development Plan, as well as of other national policies, must respond to greater objectives that lead to transform territorial realities and thus build a country less vulnerable to climate change.

Faced with climate challenges, Colombia's position is clear: it is imperative to increase our ambition not only to reduce greenhouse gas emissions, but also to increase our capacity to adapt and to reduce our risks to safeguard lives and assets of the country's inhabitants. Our commitment is to build a low-carbon future consistent with global climate goals. For this reason, we have updated the country's

national determined contribution (NDC), with the commitment to reduce our greenhouse gas emissions in 51% by 2030.

In this process, I am grateful for the support given by the French Government, which, through its financial and technical cooperation agencies AFD and Expertise France, are helping us to advance in the preparation of our strategy. The fight against climate change and moving towards sustainable development are priority objectives at national and global level.

Starting today, we take a look towards 2050, as the port of arrival to a modern, competitive, socially and environmentally equitable and climate-resilient country, in general terms, a country consistent with the commitment to have a great structural transformation the humanity towards sustainability.

This is why I am proud to present the document E2050 Long-term Climate Strategy of Colombia to comply with the Paris Agreement. A strategy that identifies, guides and leads deep changes and transformations, at the sectorial and territorial level, that Colombia will take as an action framework to build long-term climate resilience.

Iván Duque Márquez

President of the Republic of Colombia

With the signing and ratification of the Paris Agreement, Colombia began its path towards building a new society. The common struggle to change our models and forms of production and consumption has led us to build low-carbon social and economic paths with fewer territorial risks to the impacts of climate change. For this, we must ensure that all public, private, and civil society actors act with the same logic of not increasing its causes and vulnerabilities.

Colombia's position has been clear, to significantly increase climate ambition to build technological, institutional, and territorial paths to support carbon-neutrality development and with high adaptation capacities, in other words, to become a climate-resilient society. A commitment endorsed on multiple occasions by the President of the Republic, Iván Duque Márquez, who, during the United Nations Climate Summit in 2019, announced that Colombia would be a carbon neutral country in 2050.

On this path of transformation and building a country resilient to climate by 2050, we updated our Nationally Determined Contribution (NDC), with which we committed to reduce 51% of our greenhouse gas emissions by 2030, through 196 mitigation, adaptation measures and means of implementation in every sector.

This effort should be complemented with actions such as the Climate Action Law, the conservation of 30% of

the maritime and terrestrial protected areas, zero deforestation, the development plans of the next governments and *E2050 Long-term Strategy*.

I am proud to present to the world this document that we lead from the Ministry of Environment and Sustainable Development, which is the result of almost two years of work; 2,100 people from around 500 institutions contributed with its creation. This is the result of a collaborative and participatory process. We listened to the voices of representatives of public and private institutions, civil society, and indigenous and Afro-Colombian communities, who had the opportunity to debate and define the priority issues and actions that constitute the 9 efforts and its 48 transformation options that mark the key issues for Colombia to be a climate-resilient country.

The formulation of our E2050 has been possible thanks to the valuable and determined support of important national and international actors and of the French Government, which through its financial and technical cooperation agencies French Development Agency (AFD for its acronym in Spanish) and Expertise France,

has worked hand in hand with technical teams of the Ministry of Environment and Sustainable Development, the National Planning Department and the Ministry of Foreign Affairs, as well as with other national institutions in charge of leading this transformation towards climate resilience.

This is the roadmap towards a new economic, social, and environmental model that will bring equity and opportunities to every sector and that will be key for the post-COVID-19 economic reactivation.

From now on, the challenge of implementing E2050 begins by articulating its vision, fundamental principles and efforts on public policy instruments that will contribute to create the path for a new carbon-neutral Colombia, with broad capacities to adapt to climate change.

Carlos Eduardo Correa Escaf
Minister of Environment and Sustainable Development

1. Strategic messages of E2050

For the general action

01

By 2050, Colombia aspires to transform itself into a climate-resilient society and economy, that is, carbon neutral and with high adaptive capacity in its territories and sectors.

02

To achieve carbon neutrality in 2050, it is necessary to reach the emissions goal presented in the most recent NDC for Colombia. For this, it is essential that before 2030 national emissions reach their highest level (peak) and begin a decreasing path.

03

Compared with the economic rehabilitation plan of the National Government in the face of the crisis presented by COVID-19 pandemic, figures for 2021 and 2022 are very similar to the expected annual loss (EAL) in the face of prioritized climate threats.

04

Early action (5 years from now) is key to achieving carbon neutrality targets by mid-century. Early action is required both to initiate greenhouse gas mitigation and to signal the changes that must be achieved in the medium and long term. This signaling and early action are necessary for proper planning to avoid getting trapped in the emission of carbon *lock in* and reducing the chances of having sunken assets. Anticipation is also key to identify the sectors that will see their activity reduced and to ensure a fair transition of the workforce to the new green jobs.

05

It is a priority to attend and generate options for the private sector to anticipate and prevent climate transition risks (linking them with social and environmental risks), related to the possible depreciation of assets, access, and management of resources (time and money), the needs of personnel with new qualifications, access or technological transformation and the potential loss of markets.

06

In general, for Colombia, the expected annual loss due to climate change (in a scenario of RCP 4.5) is of 4.03 trillion pesos. Comparing EAL with the general budget of the nation for 2021, it turns out that EAL corresponds to 21.46% of the budgeted spending in the areas for housing, agriculture, environment, and transportation.

07

To achieve climate resilience, it is essential to take the necessary actions to reduce inequalities and socio-economic and educational gaps, at the aggregate national level and between regions, which significantly increase the vulnerability to climate change.

08

Colombia cannot achieve climate resilience working alone. Technical and financial support from the international community will be essential to achieve this effort. Collaborative work with neighboring countries and the region will also make it possible to advance in joint actions that translate into greater climate ambition.

09

Non-traditional exports should be encouraged to seek compensation for the trade balance. The strengthening of the bioeconomy can be presented as an excellent opportunity for this purpose.

10

To advance towards gender equality, all dimensions of the climate action must integrate a gender perspective. Each territory is different and for this reason, the needs, impacts and actions to close gender gaps depend on the variations and territorial contexts. Women and men are important agents of change: their knowledge is essential for adaptation and mitigation measures and policies; their full and effective participation is essential in the long-term strategies.

To achieve carbon neutrality

11

To comply with what is required by science (1.5% to 2%), by 2050, Colombia needs to reduce GHGs emissions in about 90% compared to 2015 emissions and balance the remaining 10% with proportional national removals (10%), to achieve a net zero balance between emissions and removals of greenhouse gas (carbon equivalents) as of year 2050.

12

Carbon neutrality is an effort needed to be carried out by every sector and territory.

13

Electricity should play a very important role in a future carbon neutrality. Final energy demand must migrate to power, in all cases where this energy is appropriate, and technology allows. The scenarios of the national energy plan indicate that under cost effective conditions the electrification of the matrix is between 18% and 26%. However, in E2050 projections, it is anticipated, that the theoretical range should be between 40% and 70% of the final use satisfied with electricity, to the extent that more efficient equipment and processes are incorporated in every sector. Natural gas remains in the long-term energy matrix.

14

The electricity sector must be modernized and streamlined to be in line with the future diversification of the basket and take on the challenge of carbon neutrality, while guaranteeing the sustainability of the assets in operation. The new expansion must be based mainly on renewable energy (sun, wind, sea, among others), however, due to reliability conditions, traditional fossil generation must guarantee its carbon neutrality. The challenge for the electricity sector, which will see the activity levels of the industry grow rapidly, has three components (in addition to the tariff): clean, reliable, and affordable generation must be guaranteed, transport and distribution must be ensured, and more robust and flexible system operating mechanisms are needed, as well as regulatory modernization.

15

New generations of fuels need to be explored for sectors that are difficult to electrify. For uses that cannot be electrified with the technologies available today (2021) such as aviation and long-distance heavy cargo transport, those must be satisfied with a combination of fossil fuels, synthetic fuels from hydrogen, syngas and sustainable biofuels of second and third generation. In the carbon neutrality scenarios explored, fossil liquid fuels decrease their share.

16

To achieve carbon neutrality, it is expected that it will be necessary that by 2050, to guarantee almost seven times the electricity consumed in 2015. For this, it is necessary for Colombia to work on promoting energy efficiency (changes in habits, adoption of good practices, technological spare parts), smart cities, circular economy, electrification of the countryside, among others.

17

Sustainable mobility should play a central role in carbon neutrality. To do this, land transport modes must be electrified, while the construction of charging infrastructure is accelerated and regulations for the adoption of various types of electric vehicles are updated.

18

In the case of the AFOLU sector, it is necessary to prevent deforestation and degradation of ecosystems, as well as to increase removals under different mechanisms such as the increase in commercial forest plantations, the restoration of ecosystems and the implementation of agroforestry and silvopastoral systems, among others.

19

The sustainable intensification of the agricultural sector is essential to guarantee both the satisfaction of the demand for food and the generation of net removals.

20

In the livestock sector, a productive reconversion and the release of areas is required to increase the removals associated with the AFOLU sector.

21

The mining sector is a relevant actor for energy transition, as well as being an ally to achieve carbon neutrality goals in a competitive manner. Energy transition will require a greater use of minerals that contribute to the construction of new infrastructure and clean technologies.

22

Emerging technologies can play a very important role in carbon neutrality scenarios, but its technical and economic availability is not yet confirmed. Therefore, the country will advance in the exploration of these alternatives without diminishing the effort on developing the most mature options.

23

Non-emission-intensive sectors, such as the services sector, should be strengthened. In this sense, the circular economy through the replacement of products by services and the creation of new products represents an opportunity.

24

All actions aimed at achieving carbon neutrality and climate resilience in Colombia must include transformations in climate change management models «Making visible the differentiated impact that climate change has on women and men, is a central element for incorporating the approach of gender in mitigation and adaptation actions»¹.

1. IDEAM et al. 2018⁹.

To strengthen the capacity for adaptation and risk reduction due to climate change

25

Colombia should reduce the vulnerability of its municipalities and departments to low or very low categories (≤ 0.4), in relation to the current classification of high (0.88)²; and it should reduce damages and losses caused by climate change, with a comprehensive and multisectoral territorial approach.

26

To achieve climate resilience by 2050 it is essential to stop deforestation as soon as possible, each year that the problem continues has very severe impacts on the territorial stability of the areas where it occurs and the country in general. Natural ecosystems are irreplaceable and provide many key ecosystemic services for human welfare and adaptation to climate change.

2. According to the results of the Third Communication on Climate Change (IDEAM et al. 2017).

27

It is urgent and necessary to accelerate ecological restoration actions in areas of degraded native ecosystems that are terrestrial, marine, coastal, and insular. Restoration is essential to increase the removals required for carbon neutrality and increase the adaptive capacity of socio-ecosystems.

28

The adaptation strategy for the country is the combination of achieving a benefit of 50% of the maximum possible (in terms of reducing the EAL). Thus, the combination of measures to reduce risks from floods, hurricanes, storm surges, landslides, forest fires and droughts are adaptation strategies that achieve a benefit of 50% of the maximum expected annual loss. This has an approximate and indicative present value cost of \$ 7,800,000 million pesos / year.

29

Without considering production for export, agricultural production should roughly double by 2050. This requires, on average, an increase of around 70% in agricultural productivity, but that the increase in demand for land does not exceed 30%. This would allow accommodating new land uses without exceeding the limit of the agricultural frontier established by the country and preserving sufficient areas for the development of ecological restoration.

30

The use of agricultural technologies aimed at preserving soil health is essential for increasing productivity, increasing carbon sequestration in the sector, and for sustainability. The intensification of the agricultural sector cannot follow the imprint of the use of technologies that negatively impact the health of soils and encourage the emissions of carbon deposited in them.

2. Mandate and importance

of having a long-term strategy

2.1 National and international context and justification for action

- 01 The Paris Agreement (Law 1844 of 2017) establishes in article 4, numeral 19 that “All Parties should endeavor to formulate and communicate long-term strategies to have a development with low greenhouse gas emissions, bearing in mind article 2 and taking into consideration its common but differentiated responsibilities and its corresponding capacities, in regards to different national circumstances”.
- 02 Long-term strategies, although they are voluntary, set the horizon towards which nationally determined contributions and other related policies, at the national and sub-national level, must evolve to lead the country to comply with the necessary transformations.
- 03 These long-term strategies should be considered as policy instruments that guide the action of the

State at the national, regional, and local level in relation to climate change, beyond the effort of a particular government, maintaining coherence, avoiding duplication and specifying its follow-up and measurement, in full accordance with other national development actions.

- 04 Colombia cannot achieve climate resilience working alone. Technical and financial support from the international community will be essential to achieve this effort. Collaborative work with neighboring countries and the with the whole region will also allow to advance in joint actions that translate into greater climate ambition.
- 05 In 2019, the Intersectorial Commission on Climate Change (ICCC) approved the roadmap for the formulation of Colombia’s E2050.
- 06 Under the leadership of the Ministry of Environment and Sustainable Development, the National Planning Department (DNP) and the Ministry of Foreign Affairs, with the support of the French Government, through its financial and technical cooperation agencies, AFD and Expertise France, through the funds of Facilité 2050, E2050 Colombia’s Long-term Strategy was formulated. In addition, the process had the support of the World Resources Institute (WRI), the Inter-American Development Bank (IDB) and the United Nations Development Program (UNDP).
- 07 The implementation of E2050 must be carried out in a comprehensive manner, not fragmenting its action between sectors, or actors with particular interests.

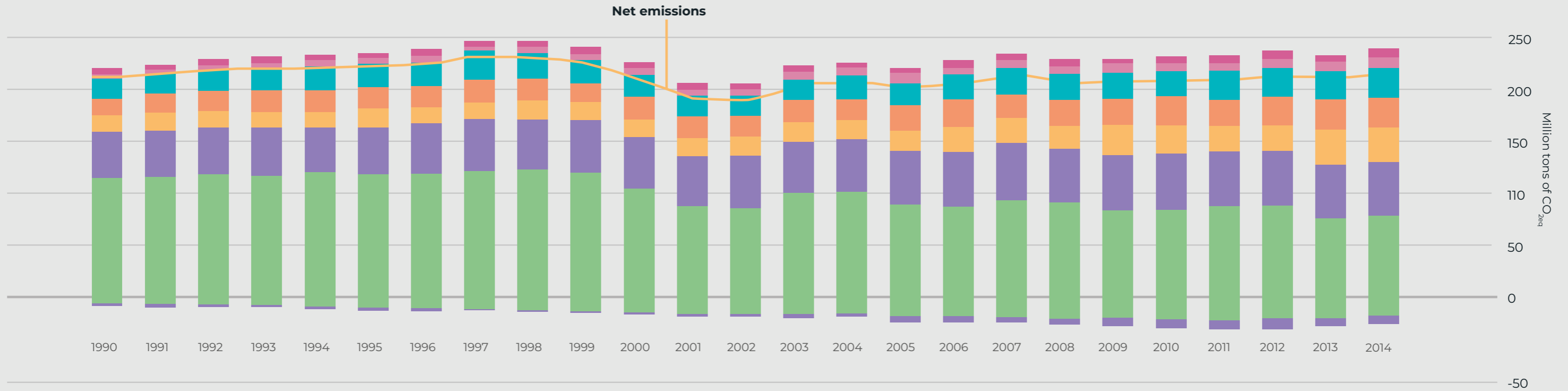
It is essential to articulate the path to have carbon neutrality and to strengthen adaptation capacities with the development of other national strategic actions to combat climate change, such as the Colombian Strategy for Low Carbon Development (ECDBC for its acronym in Spanish), the National Adaptation Plan (PNACC for its acronym in Spanish), the Comprehensive Strategy to Control Deforestation and Forest Management (EICDGB for its acronym in Spanish) and the Territorial and Sectoral Plans for Climate Change Management (PIGCC for its acronym in Spanish), the Nationally Appropriate Mitigation Actions (NAMA for its acronym in Spanish) and other instruments aligned for the pursuit of sustainability such as the Green Growth Policy, ODS and the goals of the Post 2020 Agenda of the CDB, among others.

- 08 Although the numerical references contained in E2050 do not constitute binding goals either for the sectors or for the territories, given the broad thematic, its long-time horizon and its aspirational and non-binding nature, it is important to understand that precisely, these indicative guides of the minimum changes necessary to achieve climate resilience, are the opportunity to guide all these sectorial and territorial actions and ambitions towards a common vision. For this reason, E2050 must be understood as a «living document», which with the passing of the years and the development of scientific information and climate governance, can be updated, supplemented, adjusted and adapted so as not to lose validity and to be able to support the fulfillment of the country’s commitments.

2.2 Profile of greenhouse gas (GHGs) emissions by sector in Colombia



Figure 1.
Profile of greenhouse gas (GHGs) emissions of Colombia between 1990-2014





	Million tons of CO _{2eq}			Growth (%) 1990 - 2014	Growth (%) 2010 - 2014	Compound annual growth rate from 1990 to 2014
	1990	2010	2014			
Emissions generated by Forest Land Management	113,93	84,21	79,23	-30%	-6%	-1,5%
Emissions from agricultural activity	45,24	54,7	52	15%	-5%	0,6%
Emissions generated in the mining and energy industries	14,06	26,66	32,32	130%	21 %	3,5%
Emissions generated in manufacturing industries	15,40	25,10	27,63	79%	10%	2,5%
Emissions generated by transport	18,95	24,52	28,96	53%	18%	1,8%
Emissions generated by sanitation activities	4,17	9,22	9,82	135%	7%	3,6%
Emissions generated in commercial and institutional facilities and residences	4,55	5,94	7,01	54%	18%	1,8%
Total Emissions	216,29	230,36	236,97	10%	3%	0,40%
Forest land removals	-3,22	-17,15	-15,6	385%	-9%	6,80%
Agricultural activities removals	-3,68	-6,13	-7,06	92%	15%	2,70%
Total removals	-6,90	-23,28	-22,66	228%	-3%	5,10%
Net emissions (Balance of emissions - removals)	209,1	207,08	214,31	2%	3%	0,10%

2.3 Colombia, a country with high risk due to climate change (period 2040-2070)

To quantify the risk, incorporating climate change in Colombia, the estimated annual loss (EAL) was calculated for the following threats and exposure portfolios: flood and hurricane in buildings (housing, commerce, industry, government, education and health) and infrastructure (transport, water, energy, hydrocarbons and communications), landslides in the main road network, drought in the national portfolios of corn (white and yellow, traditional and technified) and rainfed rice (manual and mechanized) and ecosystem services of native forest of the country. These threats and exposure portfolios, although not exhaustive, illustrate the levels of risk that the country faces as a consequence of development processes that have historically led to the construction of the existing vulnerability and that may be exacerbated by the effect of climate change in the modification of patterns of occurrence of hydrometeorological threats (INGENIAR 2021).

The EAL represents the multi-year average of disaster losses, calculated by simulating thousands of possible hydro-meteorological hazard events determined, based on climatic conditions resulting from considering multiple global trajectories of greenhouse gas emissions by 2050. The EAL can be interpreted as the annual value that should be paid if it was possible to be covered in a yearly bases, first order direct costs of the disasters of the future. To calculate the EAL, the risk curve was evaluated, which is nothing more than the probable maximum loss curve (PML), or the loss curve as a function of the return period (INGENIAR 2021).

Table 1 presents the results of the disaster risk assessment, indicating the EAL for the threats and portfolios indicated above. The risk was calculated considering a current unmodified climate (indicated as base climate), on which climate change was incorporated considering five possible future climates,

and the global circulation model HadGEM2-AO was selected (Collins et al., 2008), with which the future climate was projected to 2050 in the national territory, using the four greenhouse gas concentration trajectories indicated in the IPCC Assessment Report 5 (IPCC, 2014). In this way, four climate futures directly associated with greenhouse gas emissions were incorporated in the future: RCP2.6, RCP4.5, RCP6.0 and RCP8.5. Finally, the projections given by IDEAM were incorporated into the Third National Communication on Climate Change (IDEAM et al. 2017), obtained through an assembly of global circulation models, which provides change values in meteorological variables for different periods in the future, at department level. The latter is indicated in the table as CCIDEAM.

In general, the total EAL for the country with climate change and for all portfolios, ranges between 3.55 and 4.33 trillion pesos, depending on the different emission trajectories scenarios considered. If the effect of climate change is isolated in the EAL values obtained, it is observed that, with the current climate (that is, not altered by climate change), the EAL is 3.28 trillion pesos, which means that currently the country presents a level of risk already configured, not associated with climate change, which is not negligible and the reduction of which represents a challenge of great proportions. However, the increase in risk that can be attributed to climate change is evident, increasing the EAL between 8% and 39%, depending on the emissions scenario considered (INGENIAR 2021).

If the RCP 4.5 emissions scenario is considered, which represents an intermediate level of increase in the average global air temperature, the EAL for Colombia is estimated at 4.03 billion pesos. From the macroeconomic point of view, taking into account the general budget of the Nation for 2021 in housing, agriculture, environment and transportation, estimated at 18.8 billion pesos, this level of loss corresponds to 21.46%. If the projected expenditures in health and education are additionally included, said level of loss or EAL corresponds to 3.98% of the total expenditure in these six items of 101.4 billion (INGENIAR 2021).



Table 1.

EAL calculated by threat and sector³ (figures in millions of pesos)

Threat	Flood	Hurricane ⁴	Landslides	Drought	Fires	Total EAL ⁵
Sector	Constructions + infrastructure	Constructions + infrastructure	Infrastructure (main roads)	Corn - rice production	Forest - agricultural frontier	
Portfolio value	\$2.365.319.220	\$2.365.319.220	\$138.923.291	\$3.564.798	\$3.065.960.374	
Base climate	\$356.740	\$5.375	\$136.274	\$22.177	\$2.764.957	\$3.285.523
	0.15 ‰	0.002 ‰	0.98 ‰	6.22 ‰	0.90 ‰	
RCP2.6	\$321.098		\$146.018	\$22.864	\$3.057.112	\$3.552.821
	0.14 ‰		1.05 ‰	6.41 ‰	0.99 ‰	
RCP4.5	\$392.809	\$5.729	\$187.365	\$19.619	\$3.428.349	\$4.033.871
	0.17 ‰	0.002 ‰	1.35 ‰	5.50 ‰	1.12 ‰	
RCP6.0	\$302.902		\$117.135	\$22.572	\$3.174.211	\$3.622.549
	0.13 ‰		0.84 ‰	6.33 ‰	1.04 ‰	
RCP8.5	\$28,777		\$67.469	\$22.889	\$3.953.161	\$4.335.025
	0.12 ‰		0.49 ‰	6.42 ‰	1.29 ‰	
CC IDEAM	\$374.614		\$153.088	\$21.949	\$3.147.874	\$3.703.254
	0.16 ‰		1.10 ‰	6.16 ‰	1.03 ‰	

3. The relative values presented in this table are calculated as the absolute monetary value of the EAL divided by the portfolio value. They are expressed to the thousand with the symbol ‰.

4. The hurricane threat was calculated only incorporating the A1B emissions scenario defined in the IPCC Assessment Report 4 (IPCC, 2007). This emissions scenario is equivalent to RCP 4.5.

5. The total EAL is presented in this report in order to obtain a total risk indicator. However, the reader is cautioned that the nature of the modeled losses may mean that they are not added in the strict sense.

Additionally, it is possible to state that:

◇ The value of EAL due to flooding and hurricane is equivalent to 7.54% compared to the projected housing expenditure in the general budget for 2021 (4.8 billion pesos).

◇ The EAL value for the main road network due to landslides is equivalent to 1.18% compared to the projected expenditure on transportation (11.6 billion). It is important to highlight that it does not take into account the losses due to landslides at urban level or of other infrastructures.

◇ The EAL for drought in the crops considered (corn and rice) is equivalent to 1.30% of the expenditure on agriculture and rural development (1.7 trillion). Note that, although the crops considered are fundamental components of the country's agricultural portfolio, the risk assessment developed in this consultancy is not exhaustive, therefore it is to be expected that the EAL for the total agricultural portfolio is higher than the value indicated here.

◇ The EAL for bush fires is of 3.4 trillion pesos, which if compared with the environmental expenditure (0.7 trillion) turns out to be a much higher value (486%). In this case, it was decided to additionally compare it with respect to gross capital formation (236.4 trillion) of the last reported period, which is a macroeconomic variable that expresses

public and private investments in assets. The EAL value for bush fires is equivalent to 1.17% compared to gross capital formation. This comparison shows environmental losses cost, versus what accumulates in regard to built assets, illustrating the tension between the advancement of infrastructure, construction and agricultural activity, with the environmental losses resulting from this process.



3. Bases for building

a climate-resilient future in Colombia

3.1 Socio-ecological resilience as basis for climate action

Colombia's climate resilience towards 2050 will be built through the comprehensive development of ambitious and disruptive actions to allow the economy to be significantly decarbonized. It seeks to reach levels that are congruent with those required by science to effectively contribute with the fulfillment of the global goal, established by the Paris Agreement, of keeping the global temperature below 2 °C (ideally 1.5 °C). The socio-ecological transitions (TSE for its acronym in Spanish) necessary to make Colombia

go from being a carbon intensive country and highly vulnerable to climate change (IDEAM, et al., 2017), to being, as of 2050, a carbon neutral country with high capacities of adaptation, are materialized through national and regional planning with a systemic vision and with a territorial, differential and gender focus, so that, through the development of the phases of these transitions, the different efforts and their transformation options materialize in transformations of concrete realities.

Table 2.

General description of the three phases of the socio-ecological transition (TSE for its acronym in Spanish) for long-term climate resilience (2050) in Colombia

Source: E2050

Phase of significant increase in ambition (2020-2030)
<p>It is characterized by a significant intersectoral effort allowing reaching national goals contained in various policy instruments, such as the NDC (2015 with a horizon of 2025 and 2020 with a horizon of 2030 —148 goals—), the National Development Plans, the SDGs, other CONPES and sectoral policy instruments that contribute advancing with the foundations for building long-term climate resilience (2050). The development of climate change actions and projects (mitigation⁶, adaptation⁷ and risk management), at the local and regional levels, that should advance towards the articulation and coordination between initiatives, so that it is easier to scale the results, good practices and lessons learned, allowing to increase the ambition and drive the TSE towards carbon neutrality and increased adaptive capacity, while increasing participation, gender equality and equity. It is a phase for a significant strengthening of capacities and technical and financial support for public, private and civil society actors, on the recognition of the differentiated impacts and the technological, institutional needs and implications, and means of implementation necessary for a long-term climate resilience.</p> <p>This support will be key in managing climate transition risk (CTR for its acronym in Spanish), which is key in the required business transformation. In addition, the necessary restructuring in the institutional arrangements and policy instruments (economic and non-economic) must be advanced and accelerated to support and provide initial assurance to investors, producers and industries in the changes and adjustments that will be necessary, as well as the fair transition of the workforce. At this stage, it will also be crucial to unite all efforts to stop deforestation as soon as possible, since the conservation of the biodiversity is a fundamental pillar for the creation of climate resilience due to the offer of key ecosystemic services to guarantee human welfare, and at the same time that deforestation is one of the main sources of GHGs emissions in the country. This phase will also be crucial to start fuel transition, promoting renewable and clean energies, privileging natural gas over other fossil fuels and initiating the transition from first generation biofuels towards second and third generation biofuels⁸.</p>

6. Greenhouse gas mitigation; is the management that seeks to reduce the levels of greenhouse gas emissions in the atmosphere by limiting or reducing the sources of GHGs emissions and increasing or improving sinks and reserves of GHGs. For the purposes of this law, climate change mitigation includes policies, programs, projects, incentives or disincentives and activities related to the Colombian Strategy for Low Carbon Development and the National REDD + Strategy (ENREDD +) (Law 1931 of 2018) (Congress of Colombia, 2018).

7. Adaptation to climate change: it is the process of adjustment to the present and expected effects of climate change. In social decision-making areas, it corresponds to the adjustment process that seek to mitigate the harmful effects or take advantage of the beneficial opportunities present or expected from climate and its effects. In socio-ecosystems, the process of adjusting biodiversity to the current climate and its effects can be intervened by society in order to facilitate the adjustment to the expected climate (Law 1931 of 2018) (Congress of Colombia, 2018).

Multidimensional transformation phase (2030-2040)
<p>In this phase, the main actions that should give continuity to the policies initiated in the previous decade are proposed, in addition to others that contribute to making significant progress in the desired transformation towards carbon neutrality and increasing the capacity for adaptation. New post-2030 NDCs should continue to increase in ambition and consistent with projected decarbonization pathways and new adaptation goals. It will be a priority to build local action processes that transform realities, articulated and oriented from a regional planning, based on new agreements and logics for territorial management, which enable joint responsibility, inclusion, and empowerment of sectorial and community actors to face climate change.</p> <p>In this phase, institutional and financial support, as well as climate transition risk management (CTR) continue to be key to reiterate new processes, some of which started in the previous phase, and significantly reducing GHGs emissions, increase carbon stocks and contributing to increase the adaptive capacity of the population, sectors, and territories, leveraging and driving significant increases in productivity, competitiveness, inclusion, social equity and sustainability. It is important to note that, in this phase, the changes leveraged up to 2030 are the ones that will allow the driving of deeper transformations in the Colombian social and inter-sectoral system, closing gaps on the path to achieve / consolidate carbon neutrality.</p>
Phase of consolidation of a climate-resilient future (2040-2050)
<p>This phase identifies the actions to complete the macrostructural changes that should guide the maintenance of the system as carbon neutral and with high capacity to adapt to the territorial challenges of climate change. Through national actions, the desired ambition is met according to the decarbonization routes or the minimum level of change necessary for the climate resilience vision set forth in this strategy to be fulfilled. The means of implementation support, underpin and provide legal security to national and sub-national processes of territorial and sectoral transformation, as well as for investment. Risk management, both climate and climate transition, added to the mainstreaming of differential approaches, will continue to open the way to new and permanent adaptation needs, since risk will never disappear and adaptation is not an objective to be achieved, but, on the contrary, it is an evolutionary path of permanent construction and transit.</p>

8. Conventional or first generation biofuels are those created from food crops grown on farmland. On the other hand, the second generation are those that are manufactured from biomass derived from plant materials (woody crops, agricultural residues or waste plant material from food crops that have already fulfilled their food purpose) or animal fat. Finally, third generation biofuels are extracted from algae with a natural oil content of at least 50%. The production of the third generation has not yet been carried out on a commercial scale (GAVE, 2021).

Given the enormous uncertainty and complexity that the long-term projection (≥ 30 years) of complex systems implies, E2050 is structured through efforts, which together seek to develop the large TSE towards a climate-resilient country. The transformation towards carbon neutrality is initially guided by the national GHGs inventories (INGEI for its acronym in Spanish) (IDEAM, et al., 2016) and the nationally determined contribution (NDC) (Ministry of Environment, 2021), which present the strategic activities and sectors that concentrate the largest GHGs emissions in the country and the greatest mitigation opportunities. On the other hand, the transformation to increase the adaptation capacity is guided in the Third National Communication (IDEAM, et al., 2017), the Risk Atlas (UNGRD 2018) and the evaluation of the risk due to climate change (RCC for its acronym in Spanish) (Ingeniar, 2021). TSE is described in three main phases (Herrfahrtd-Pähle et al., 2020; Folke, 2020), which are developed over periods of decades (Loorbach, 2017)

The systemic approach to guide the creation of socio-ecological climate resilience, defines the need to consider all the effort as related to each other, forming a system, where although within each effort there are sectorial and more specific processes; wealth and success of the process will be in the relationship and activation of each one in function of the others. The means of implementation, the gender approach and actions for disaster risk management and climate transition will play a fundamental role in activating, coordinating, and enhancing the results to be obtained so that, in the long run, carbon neutrality and capacity of adaptation strengthened for the long

term, emerge as emergent properties of the system thanks to the virtuous cycles created.

The management of the TSE for the construction of climate resilience in Colombia will also require the strengthening of the participation and governance processes that recognize the importance of the different knowledge systems and ancestral use of the territory to optimize the management capacity from local scales to higher regional and national scales. Likewise, these participation and governance schemes recognize that men, women, boys, girls and adolescents are members of society, with different needs, roles, abilities and interests and with a different impact on the territory.



3.2 Participatory construction of E2050 Long-term Climate Strategy

E2050 was formulated in a widely participatory process where more than 2,100 people, from around 500 institutions, contributed with the more than 300 different meeting and workspaces

that were implemented for its creation. This work opened the participation of representatives of public and private institutions, civil society, and indigenous and Afro-Colombian communities.



Figure 2.
General diagram of the participation process
for the construction of E2050 in Colombia
Source: E2050.



3.3 The Colombian pathway towards Carbon Neutrality

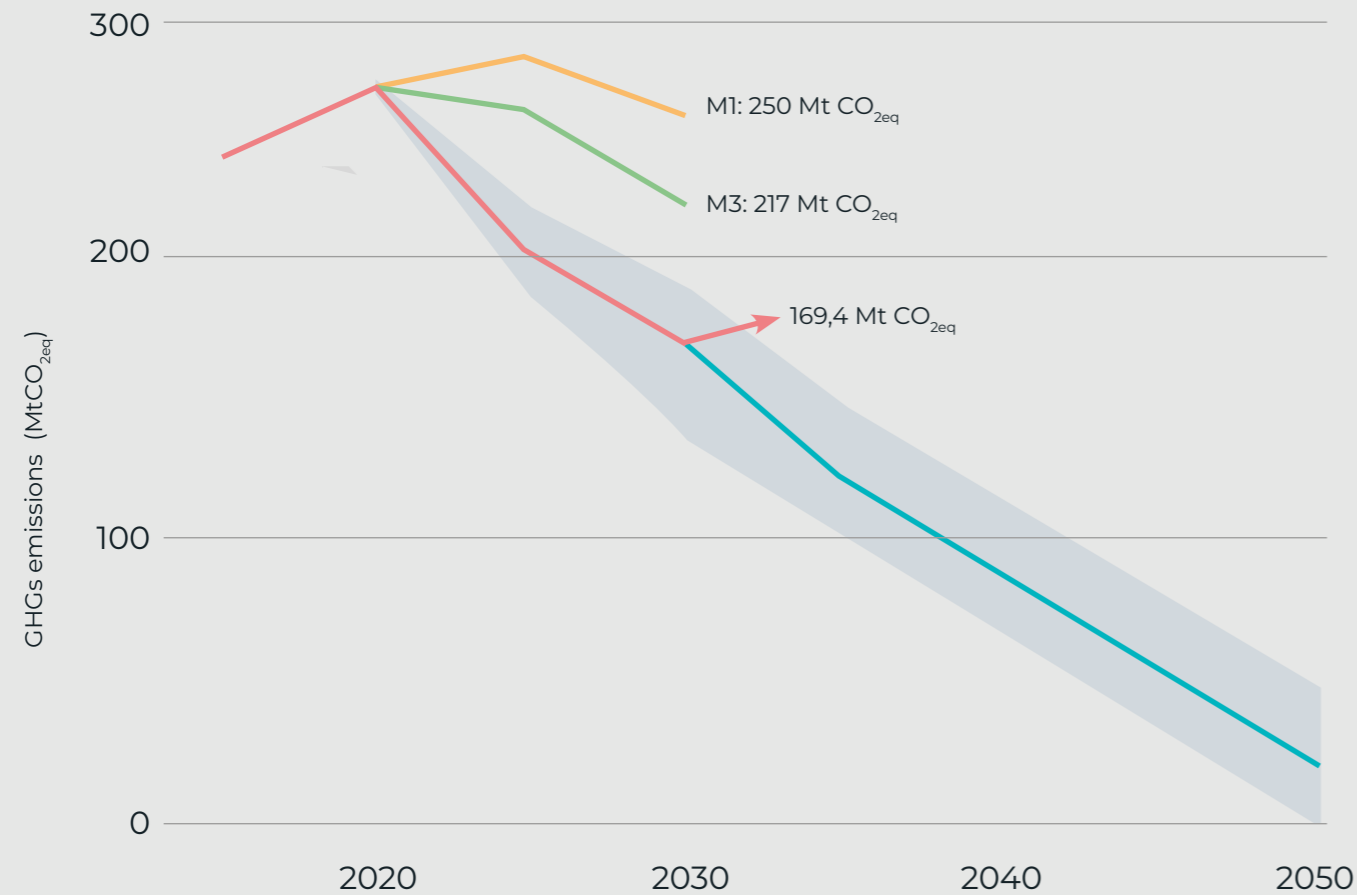
Deep decarbonization trajectories towards 2050

Regarding the emission trajectories of the modeled scenarios, the gray area corresponds to an emissions space that would allow Colombia to achieve carbon neutrality, since for multiple scenarios it is necessary to achieve additional compensations to those already considered in 2050 (figure 13). In particular, the scenarios lead to a decarbonization of 90% compared to 2015 levels and a substantial reduction in GHGs other than CO₂. These residual emissions must be offset by additional captures. It is important to highlight that the emissions presented, include scenarios where there is carbon capture and storage, with capture by reforestation and afforestation, and the use of carbon for the production of zero-emission fuels or for the production of materials. (Andes University et al., 2021).



Figure 3. Emission trajectories under uncertainty, the exploration includes requirements for emission levels in changes in land use, the emission level of the Colombian NDC towards 2030 (M1, M3 and red line) is located within the scenarios regarding carbon neutrality presented in the strategy (blue line)

Source: E2050 Andes University et al. 2021; IDB 2021.



Options to increase greenhouse gas removals by 2050

Long-term carbon neutrality involves striking a balance between GHGs emissions and removals by carbon sinks to offset eventual emissions that occur. For Colombia, viable removal alternatives are identified framed in two categories: i) no AFOLU for those technological alternatives that allow CO₂ to be captured from the atmosphere, stored, or used to re-enter production processes and ii) AFOLU for those alternatives that come from natural sources or inspired by them and that prevent the degradation and loss of ecosystems (CAIA Engineering 2021).

The capture potential of the non-AFOLU category options is approximately 6 M t / year of CO₂ from specific emission sources, which could be expanded to the total available (17.8 M t / year of CO₂), if EOR is implemented

and intersectoral capture clusters are developed. Additionally, there is a potential of approximately 4.7 M t / year of CO₂ from the main landfills if *oxyfuel* combustion is implemented for the generation of energy from waste (WtE), reaching a CO₂ capture potential of more than 10 M t / year for the three prioritized non-AFOLU options. However, the integral management of solid waste contemplated in the NDC by 2030, estimates a reduction goal of 3.26 M t / year CO₂ that must be discounted from the combustion of *oxyfuel*, adjusting then, the available capture potential of the non-AFOLU options, a value of 7.3 Mt of CO₂ / year in 2050 is obtained. The tables below show the storage potential of the prioritized options, as well as its development status and costs (CAIA Ingeniería 2021).

Tabla 3. Non-AFOLU capture potential

Source: E2050: CAIA Ingeniería, 2021.

Option	Available emissions t CO ₂ /year	Capture potential t CO ₂ /year	Additional to the NDC t CO ₂ /year	To 205 t CO ₂ /year	Storage potential t CO ₂
CCS after combustion or EOR	17.810.435	5.900.000	5.900.000	5.900.000	247.000.000
CCS combustion <i>oxyfuel</i>	6.096.000	4.695.197	1.435.197	1.435.197	

In the AFOLU category, the NBSs⁹ are the pathways for the sector to become a major sink for GHGs emissions. There are 3 types of actions related to NBSs that provide the benefits of atmospheric CO₂ removal, its difference is the level of engineering applied to biodiversity and ecosystems, and the delivery of ecosystem services (Eisenberg and Polcher, 2019). Type 1: these are solutions that involve a better use of existing or protected ecosystems, Type 2: are solutions based on the development of sustainable management protocols and procedures for managed or restored ecosystems, and Type 3: solutions that involve the creation of new ecosystems or its management in a very intrusive way. Given that 30% of the national territory is owned by indigenous and black ethnic peoples and 53.4% of the natural

9. Umbrella concept that builds and develops concepts such as ecosystem-based adaptation (EbA), green and blue infrastructure, ecosystem services, among others (Eisenberg and Polcher, 2019).

forests of Colombia (IDEAM 2017) are found in these territories, the alternatives identified in the AFOLU category will be transcendental in the removal of GHG by 2050.

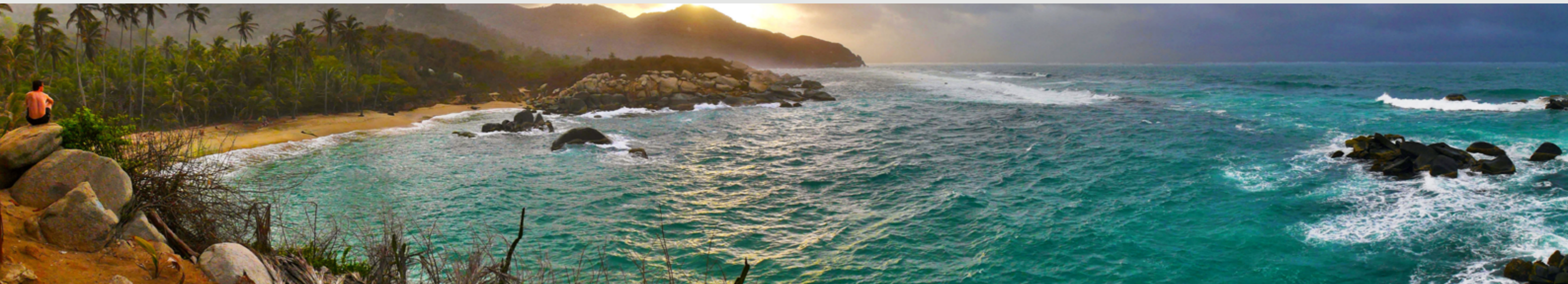
Within each of the types of NBSs, nine alternatives were identified, these options were analyzed and validated through consultation with experts and were subsequently prioritized using the analytical hierarchy process (AHP), with which, the three actions regarding protection and conservation of natural ecosystems were prioritized (moorland, mangroves, and forests) followed by silvopastoral systems and forest plantations. Additionally, a special mention is made to the ecological restoration, including the inter-sectorial control strategy of deforestation, degradation, conservation, carbon increase and sustainable forest management, carbon storage in moorland ecosystems due to slow decomposition and humification of the organic matter, and in mangrove ecosystems both in aerial

biomass and in accumulated sediments around roots and soils (CAIA Ingeniería 2021).

According to the results of 2050 decarbonization scenarios, it would be necessary to capture 14.4 to 31.5 M t of CO_{2eq}, depending on the levels of GHGs emission reduction achieved at national level. However, each of the options have associated challenges and barriers that could limit its implementation. For example, for the non-AFOLU options, one of the direct causes that limits its development is the high costs and low level of technological maturity, while for the AFOLU options, the degradation and loss of ecosystems permanently due to changes in the use of the soil (CAIA Ingeniería 2021).

In order for the country to move towards a real implementation of these options, it is necessary to develop a series of actions during the 2030-2050 period and combat the direct and indirect causes that limit its implementation. For the non-AFOLU

category, these actions should be geared towards achieving three specific objectives: i) achieving social acceptance for the implementation of new removal technologies, ii) increasing technological maturity and reducing the total costs of its implementation, and iii) facilitating the financial closing for the implementation of removal technologies in the different sectors. On the other hand, for the AFOLU category focused on four specific objectives: i) promoting the conservation and sustainable use of ecosystems at national level, ii) increasing the generation of primary information on ecosystems and its variations over time, iii) leveraging and managing financial incentives for the development of initiatives focused on sustainable management of ecosystems and iv) increasing administrative and legislative instruments to guarantee the protection and sustainable management of the ecosystems (CAIA Ingeniería 2021).



4. The vision of Colombia towards 2050

01

Colombia must have a net zero balance between its emissions and removals of greenhouse gases (carbon equivalents) from year 2050, with respect to the emissions reported in 2015.

In 2050, Colombia will be a climate-resilient country that prioritizes human welfare, biodiversity conservation, and water security. It will have a competitive, circular and carbon neutral economy. Also, regions, sectors, and institutions with broad capacities for adaptation to climate change, achieved from sustainable transformations promoted through ethical action, knowledge, innovation, multicultural social inclusion, food security and the strengthening of the territorial governance.

To achieve this vision, two main goals are proposed to guide the trajectories that Colombia should follow to consolidate itself in 2050 as a climate-resilient country:

02

Colombia should reduce the vulnerability of its municipalities and departments to low or very low categories (≤ 0.4), in relation to the current classification of high (0.88)¹⁰ (IDEAM, et al., 2017) and should reduce the damages and losses caused due to climate change, with a comprehensive and multisectoral territorial approach.

¹⁰ According to the Third National Communication on Climate Change (IDEAM, et al., 2017), the Climate Change Risk Index (Rcc for its acronym in Spanish) ranges from 0 to 1, with 1 being the maximum risk.

4.1 Fundamental principles



1. Equity



2. Vital priority of socio-ecological climate resilience



3. Consistency



4. Orientation 1.5 ° C



5. Knowledge-based approach



6. Co-responsibility



7. Articulatory approach



8. Transparency



9. Welfare of the population and improvement of its quality of life



10. Caution



11. Recognition, appreciation, and inclusion of cultural difference



12. Gender equality



13. Territorial dimension



14. Decentralization



15. Solidarity



16. Programs adaptable to uncertain scenarios



17. Measurable and quantifiable

5. Areas of action for

the transition to a resilient Colombia:
benchmarks of ambition and instruments

5.1 Commitments to achieve socio-ecological climate resilience in Colombia by 2050



Some of the 195 ambition references contained in the 48 transformation options that make up the 9 efforts of E2050 were selected:



Effort 1

Climate knowledge and governance

- 01 Climate monitoring and digital transformation of national data for decision making.
- 02 Disruptive innovation for equitable and productive territorial, business, and institutional transition.
- 03 Education, training, and awareness on climate change, promoting social inclusion, reconciliation, and gender equality.
- 04 Increased knowledge to support climate change risk management and reduce damage and losses.
- 05 Empowerment and participatory social governance for the comprehensive management of climate change, with a gender perspective.



Effort 2

Comprehensive management of biodiversity and its ecosystemic services

- 06 Socio-ecological transition towards multifunctional cultural landscapes, reducing ecosystem degradation and increasing ecological connectivity.
- 07 Sustainable management of marine, coastal and ocean ecosystems.
- 08 Comprehensive water management for water security.
- 09 Strengthened National *ex situ* Conservation System.



Effort 3

Sustainable Consumption and Production

- 10 Circular economy that generates new opportunities.
- 11 Bioeconomy and green business.
- 12 Sustainability criteria in consumer decisions.
- 13 Sustainable lifestyles integrated into consumer goods and decisions.



Effort 4

Fair Transition of Workforce

- 14 Follow-up to the national strategy for fair transition of the workforce.
- 15 Adapt the educational offer and training for employment.
- 16 Conditions for the fair transition of the workforce and green jobs.
- 17 Investments and incentives for green jobs.



Effort 5

Sustainable rural development differentiated by regions

- 18 Agricultural landscapes with multi-functional territorial planning.
- 19 Sustainable agri-food systems with high adaptability.
- 20 Comprehensive conservation in agroecosystems that stops soil degradation and increases ecological integrity.
- 21 Sustainable and low-carbon livestock systems.
- 22 Fisheries management based on ecosystem services.
- 23 Sustainable and low carbon growing aquaculture.
- 24 Competitive, vigorous, and sustainable forest economy.



Effort 6

Cities-regions with comprehensive urban development

- 25 Orderly urban growth and effective local and regional planning.
- 26 Comprehensive management of resources and waste to activate a circular economy.
- 27 Mobility systems focused on quality, accessibility, and reduction of negative externalities.
- 28 Highly efficient and adapted buildings.
- 29 Nature-based solutions in cities and regions.
- 30 Self-generation with renewable energy sources.
- 31 Governance of human mobility.





Effort 7

Diversification of the energy matrix

- 32 Electrification of the economy, efficiency in energy transformation processes and end use.
- 33 Distributed and decentralized electricity generation through smart grids.
- 34 Renewable energies distributed according to the regions with the greatest potential and connected to the national grid.
- 35 Digitization to incorporate new equipment for end use and automated network management.
- 36 Adoption of CCUS technologies and compensation in coal and gas thermo-electric plants.
- 37 Multifunctional landscape management to favor ecosystemic services and risk reduction in the generation and transmission of energy and the sustainable exploitation of minerals.



Effort 8

Sustainable mobility and infrastructure

- 38 Transportation system not dependent on fossil fuels.
- 39 Promotion and adoption of heavy load transport technologies based on clean energies.
- 40 Air transport and airports with technologies that reduce the risk of climate change, noise and GHG emissions.
- 41 Petrol and diesel peak for year 2040.
- 42 Disintegration of vehicles to reduce the circulation of machines with polluting technologies.
- 43 Primary and secondary road network updated as smart roads (*Smart Roads*).
- 44 Intelligent maritime and river transport (*Smart Rivers*) integrated into the inter-modal supply chain.
- 45 Climate-resilient road infrastructure and multifunctional landscape management to reduce risk.



Effort 9

Increase the adaptive capacity of the population and of the health system

- 46 Integrated public health surveillance and control system (SIVCSP for its acronym in Spanish) and early warning systems (EWS).
- 47 Health promotion through governance to enhance health co-benefits.
- 48 Public health programs and health system infrastructure adapted to climate change.



Figure 4. Socio-ecological transition (TSE for its acronym in Spanish) suggested for some of the 195 ambition referents contained in E2050.



Suggested socio-ecological transition (TSE for its acronym in Spanish) for some of the 195 ambition benchmarks contained in E2050.

1 Coverage of hydrometeorological networks

2 Technology trends in business

3 Knowledge within the scope of territorial actors

1 Zero deforestation and ecosystem degradation

2 Forests with sustainable management

3 Ecological restoration for connectivity and SS. EE

4 Conservation *ex situ*

1 Bioeconomy and GDP

2 Increase in circular economy companies

1 Sustainably forest

1 Increase in agricultural productivity

2 Sustainable livestock

2020-2030

Phase of significant increase in ambition

35% of the country

30-40% of enterprises

20-50% of the country's municipalities

2,550,000 ha

More than **20%**

1,000,000 hectares approx.

At least **30%** of threatened species

8-10% of GDP

20-40%

15-20%

10-20%

40-60%

2030-2040

Phase of multidimensional transformation

70% of the country

60-80% of enterprises

50-80% of the country's municipalities

3,400,000 ha

More than **35%**

Minimum **1,130,000** hectares

At least **60%** of threatened species

10% - 15% of GDP

40-60%

20-45%

40-60%

60-70%

2040-2050

Phase of consolidation of a climate-resilient future

100% of the country

80-100% of the country's municipalities

80-100% of large companies
at least **60-80%** of MSMEs

Minimum **4,250,000** ha

More than **50%**

Minimum **1,300,000** hectares

At least **90%** of threatened species

20% of GDP

80-90%

More than **45%**

30-50%

70-100%

Suggested socio-ecological transition (TSE for its acronym in Spanish) for some of the 195 ambition benchmarks contained in E2050.

- 3** Wood with traceability
- 1** Cities optimizing land use
- 2** Reused building materials in new buildings
- 3** Thermal districts
- 1** Electricity generation with renewables
- 2** Reduction of energy demand per BAT
- 3** Access to electric power
- 1** Reduction of energy intensity in passenger transport
- 2** Reduction of energy intensity in cargo transport
- 1** Events contemplated in the SIVCSP and SAT
- 2** Adaptation in health in municipalities

2020-2030

Phase of significant increase in ambition

50-60%

50-70%

60%

16 cities

10 - 47%. 90 and 50 g CO₂ per kWh.

9.9 - 30%

50-70%

20-40%

10-16%

50%

100% of indigenous territories and **100%** of Afro-Colombian communities and **30%** of category 4, 5 and 6 municipalities

2030-2040

Phase of multidimensional transformation

60-80%

70-90%

65%

70-90%

22 - 70%. 57 and 25 g CO₂ per kWh.

30 - 40%

70-90%

34-50%

21-32%

80%

100% of category 4, 5 and 6 municipalities and **35%** of category 1, 2 and 3 municipalities

2040-2050

Phase of consolidation of a climate-resilient future

80-100%

100%

75%

100%

34 - 84%. 26 and 1 g CO₂ per kWh.

40 - 60%

100%

50%

30-45%

100%

100% of municipalities

5.2 Means of implementation to sustain and boost climate resilience

5.2.1 Prospective analysis of public policy instruments and the role of key actors

In this way, the country should concentrate its normative and policy efforts by 2050 on strengthening governance and territorial management processes associated with the variables of highest influence (land use and multifunctional landscapes), for, and through the articulation, coordination and coherence between the specific territorial expressions of the intersectoral processes, promote the most influential and dependent variables so that the most dependent and least influential variables are also positively impacted, thus accelerating the transformations towards a carbon-neutral and climate-resilient economy and society .

The main mission of E2050 should be to promote the creation and protection of multifunctional landscapes, as well as the environmental planning of the territory and the proper use of the land. There are six strategic variables that will drive the strategy and the fulfillment of its mission: economic growth, conservation of biodiversity,

reduction of climate risk, reduction of deforestation, land use planning and reduction of greenhouse gas emissions.

The most influential actors for E2050 are: the National Planning Department, the National Trade Union Council and the Ministry of Finance. These actors have a power role facing others that respond to their ability to influence processes, projects, missions and even the existence of other actors. Their role is important insofar as they can promote projects and processes of the coordinating actor of the strategy.

The actors that most respond to the stimuli of the identified influential actors are: civil society organizations, ethnic and peasant communities, and mayors and governorships.

5.2.2 Planning and organization instruments

The integration of mitigation and adaptation to climate change is proposed in the development of the PIGCCS and PIGCCT, seeking intersectoral integration

and the definition of guidelines for the integrated incorporation into the instruments at regional and local level, as well as the reconciliation between the sustainability model and economic development model.

The inclusive vision of adaptation and mitigation, and the incorporation of co-benefits would accelerate the incorporation of climate change in the management of the ministries and institutions of the national government and would induce the strengthening of the institutions and their work teams.

Facing territorialization of national policies, it is proposed:

- i) **To deepen the integration of national climate change guidelines into territorial, environmental and development planning instruments.**
- ii) **Materialize the incorporation of the risk management component in the instruments of territorial organization and development planning in conjunction with those of environmental planning and optimize its technical scope and scales.**
- iii) **Strengthen planning from a regional perspective to respond to challenges that go beyond political-administrative limits.**
- iv) **Deepen the capacity for implementation of the instruments, management and financing, as well as monitoring and evaluation.**

v) **The prioritization of institutional strengthening and technical assistance processes, improving the information available for the entire territory.**

vi) **Taking advantage of the implementation of the Peace Agreement as an opportunity to reduce territorial gaps.**

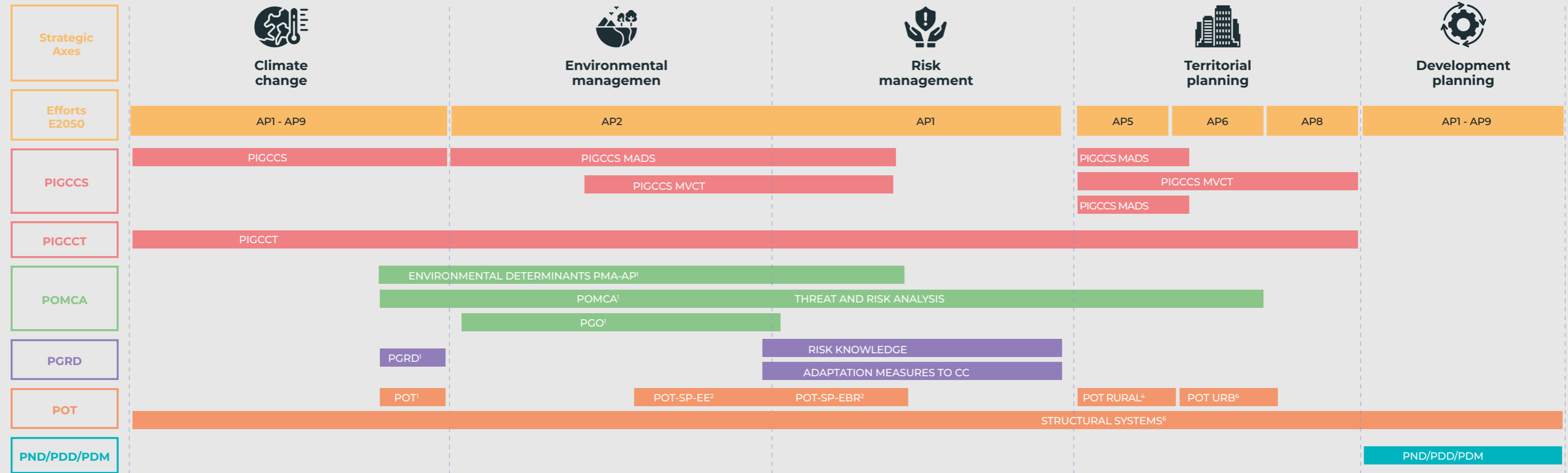
vii) **Consolidate differential approaches and governance models in development planning, territorial organization, environmental organization and climate change in accordance with the territorial and particular dynamics of occupation and use of the territories and developing models of gradualness and diversity in the instruments of planning, in accordance with institutional capacities and the needs to incorporate climate change.**

In the long term, it is necessary to ensure that the different instruments for managing climate change, environmental planning, risk management, land use planning and development planning have a sequence, guaranteeing a logical and harmonious framework between the instruments. The foregoing, taking into account the integration, prospective and gradual principles established in the LOOT.

Facing the incorporation of risk management, the need to unify the methodologies of risk studies stands out, being essential to unify basic criteria or standardize methodologies, without closing the door to new methods considered more appropriate that arise over time.

Figura 5.
Relations between E2050 efforts and the components of planning and environmental instruments and territorial organization

Source: E2050 CIDER Andes University, 2021.



Notas

1. If it has climate change built-in. 2. SP - EE: Protective soil - Ecological structure. 3. EBR: Basic Risk Study - Protective soil - threat / risk condition. 4. Protective soil: Agricultural production / rural component - CDR restricted development categories. 5. Protective soil - public services - public services - Cultural heritage / urban component. 6. Structural Systems: Mobility - Public services - Public space - Equipment. 7. Environmental Management Plans and Protected Areas

Efforts

AP1 Climate Knowledge and Risk Management
 AP2 Biodiversity and ecosystemic services
 AP3 Sustainable production and consumption
 AP4 Fair Transition of the Workforce
 AP5 Resilient Rural, Marine and Coastal Development

AP6 Comprehensive urban development
 AP7 Diversified strategic matrix
 AP8 Sustainable mobility and infrastructure
 AP9: Adaptation, population, and health system



5.2.3 Education, science, technology, and innovation

The creation of a holistic vision around the understanding of nature based on scientific, multicultural, and traditional knowledge will be promoted throughout the educational community, as a result of the recognition of the differentiated knowledge, needs, roles, abilities and interests of all communities and social groups in the territories of the country. Access to material related to climate change in different languages of indigenous, Afro-descendant and Raizal communities will be contemplated, so that they are subject (not only object) of knowledge. Likewise, a special emphasis will be placed on enhancing roles, skills and attitudes of men and women in climate change management, so that knowledge, from education and CTI, advances towards gender equality.

Research, led by teachers and other experienced people, will be vital in the dynamics of meaningful knowledge and learning.

Education and CTI (understanding and appreciation of the interdependent and complex relationship between human and nature) will be the great drivers of change in mentality, development of individual capacities (mindset) and collective (mainstream) and transformation (cultural, social, political, and economic) of the country.

Planetary challenges require the flexibility of education and STI systems and the transformation of systems, institutions, and the ways in which the production and management of knowledge is measured. This adaptability will be an opportunity to develop a relevant education for the local and regional context, which fosters the integral formation of a global citizenship prepared to take on these challenges. Sustainable

lifestyles and consumption habits will be developed, stimulating the demand for new products and services and promoting the generation of green business models and jobs. This will accelerate the fair transition of the workforce, with human rights, differential, gender, and intergenerational approaches.

A large National System for the Social Appropriation of Knowledge will be formed that will allow the identification, visibility and monitoring of the emerging actions of civil society in each territory to allocate resources for the stimulation and advancement of informal education and CTI with a focus on climate change.

The society will become the subject and object of empowerment of multidisciplinary and diverse knowledge; It will also contribute to a socio-technological and bioethical transformation in all territories. Thus, the goal will be to develop in Colombian citizens the neces-

sary skills to take on this planetary challenge: empathy, adaptability, curiosity (imagination), reflective (critical) thinking, creativity, entrepreneurship (leadership) and survival capacity (resilience).

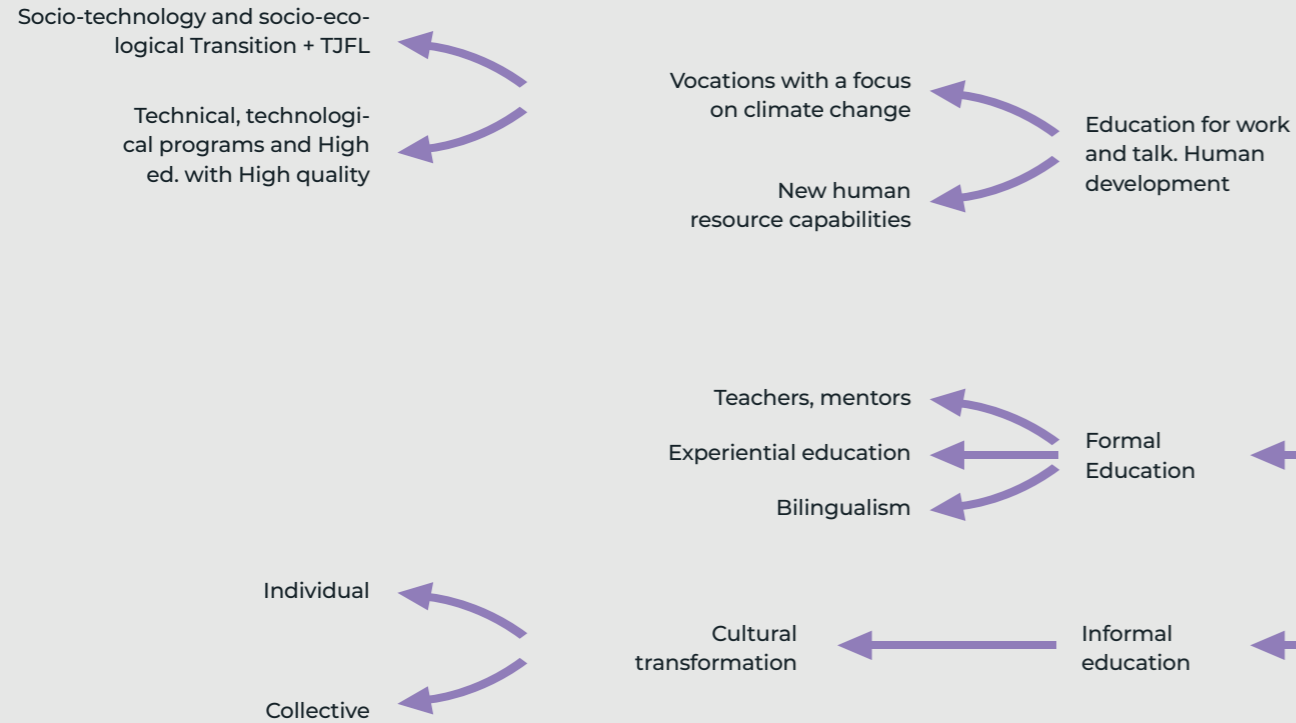
Education, training, awareness-raising, and capacity building is, and will continue to be, fundamental way for the empowerment of different social actors and the mobilization of joint climate action.

Colombia, in 2050, will be a carbon neutral country with a knowledge society for climate change management, capable of implementing and developing science, technology and innovation resilient to extreme hydro-meteorological conditions by itself. A nation with public awareness based on ethics, where the preservation of life, respect, and recognition of all kinds of knowledge, in addition to the common good of the ecosystem, it will take priority over any particular interest.

Figure 6.
CTI Vision and education to achieve climate resilience

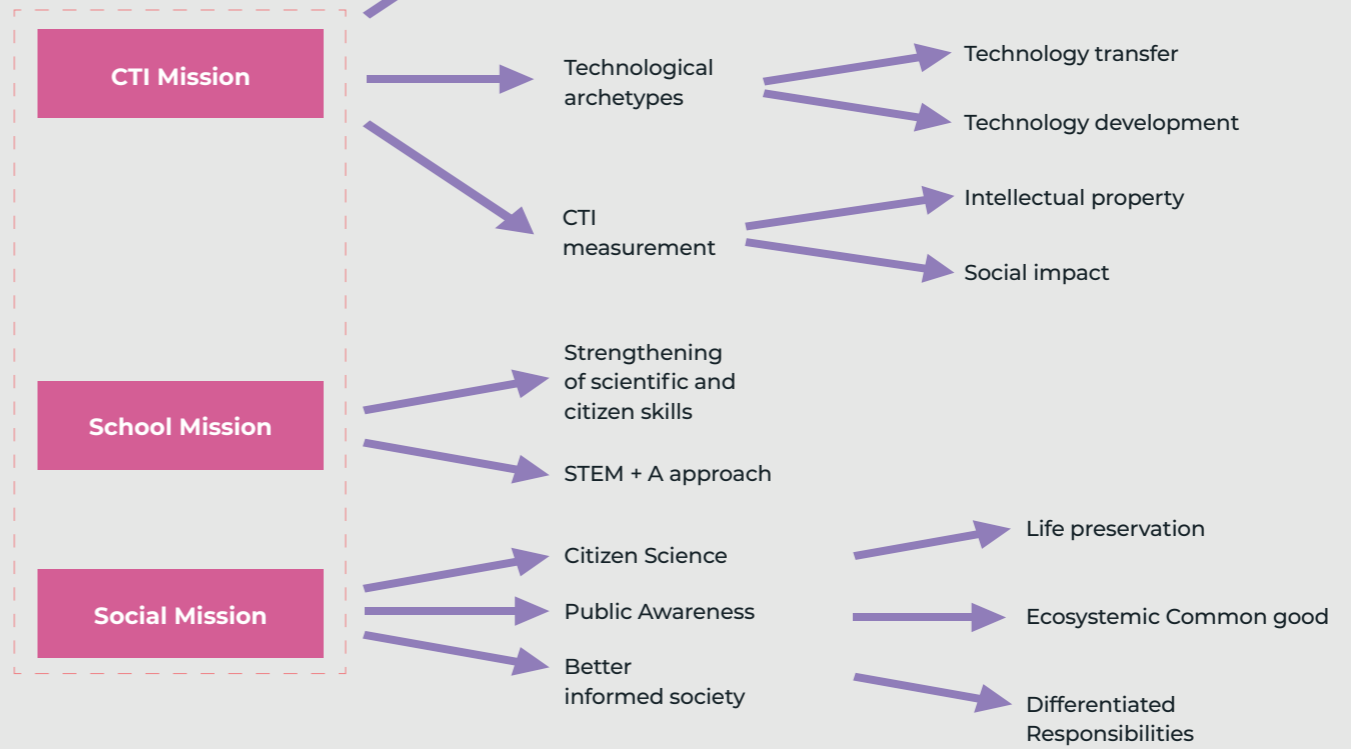
Source: E2050 Explora Park, 2021.

Education, training, and awareness
 (environmental education)



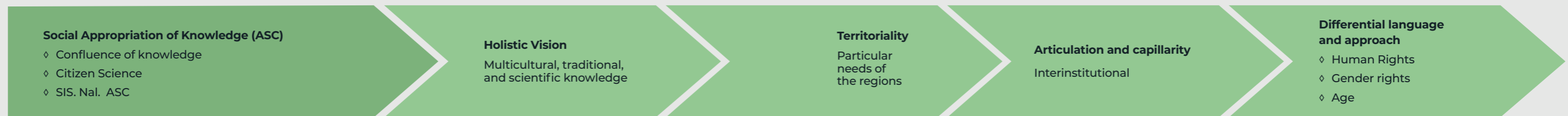
Society that makes decisions based on knowledge

Research



Information, Science, Technology, and Innovation

Principles



5.2.4 Economic and financial instruments

Currently, Colombia has a solid legal base of economic and financial instruments that support environmental and sustainable development policies, in particular, climate change and green growth policies. Most of them have been working for a long time and there is not only experiences regarding its operational viability but also about its legal security. There are also instruments that fulfill the dual purpose of i) encouraging private agents to develop actions and investments that collaborate with climate goals and ii) collecting fiscal resources that can be used to finance actions and public investments that do not have that same collection capacity (Econometrics 2021).

The most important instruments available at the time of E2050 formulation have mostly the ability to be sustained over time and empowered to achieve the goals set in most of efforts from now until at least year 2050. However, some aspects have been identified in which new specific economic instruments will be required for topics such as the incentive for bio-economy, circular economy, the coverage of climate risks and the generation of green jobs with a gender approach to adapt to climate change, in addition to new environmental taxes.

In a prospective vision towards 2050, the main economic and financial instruments that can leverage

the transformations towards climate resilience are grouped as follows (Econometrics 2021):

1. Instruments for internalizing externalities and carbon pricing:

those that seek to determine a price for an externality within the production or consumption process (such as carbon emissions) and seek to internalize the social cost of these negative externalities, as part of the price of goods and services in the economy.

- ◊ Emissions trading system.

- ◊ Carbon tax.

- ◊ Other environmental taxes.

2. Other market instruments:

it is the creation of market conditions to stimulate the free participation of private agents in the financing of initiatives compatible with climate policy.

- ◊ Renewable energy auctions.

- ◊ Investment funds for bioeconomy and sustainable products (new).

3. Burden balance instruments and benefits:

corresponds to State interventions to establish mechanisms to attract payments from those who receive benefits from a public action and transfer them appropriately to those who incur the costs of such actions.

- ◊ Fee for water use.

- ◊ Environmental services payments

- ◊ Remuneration rate.

- ◊ Deposit-refund mechanisms for circular economy (new).

- ◊ Catastrophic insurance for public infrastructure (new).

4. Instrumentos de subsidio y transferencia:

son ayudas directas del Estado a los agentes particulares, para cambiar su comportamiento en concordancia con las políticas climáticas.

- ◊ Financial incentives for mitigation and adaptation such as rediscount and compensated rates, terms and grace periods (current to be transformed).

- ◊ Incentive for rural capitalization for silvopastoral and agroforestry systems (current to be transformed).

- ◊ Incentives for alternative energy and energy efficiency.

- ◊ Tax exemption in science, technology and innovation projects (CT + I).

- ◊ Targeted grants with a gender approach for agricultural and climate extension (new).

- ◊ Incentive for private climate insurance (new).

- ◊ Incentive for community employment in adaptation to climate change with a gender perspective (new).

5. Adverse incentives:

these are measures that negatively affect, delay, or reduce the effectiveness of climate policies and are expected to be modified or dismantled.

- ◊ Distortion in the taxable base of the rural property tax.

- ◊ Distortion in the tax base and in the vehicle tax rate.

- ◊ Implicit subsidies for fuels and design of the price stabilization fund.

- ◊ Benefits to the price of fuels in border areas.

- ◊ Tax benefits given to extractive industries.

Table 4.

Relationship between economic and financial instruments and strategy efforts

Source: E2050, Econometrics 2021

Instruments in order of prioritization		Effort 1	Effort 2	Effort 3	Effort 4	Effort 5	Effort 6	Effort 7	Effort 8	Effort 9
		Knowledge and Climate governance	Comprehensive management of biodiversity	Sustainable production and consumption	Fair Transition of the Workforce	Resilient Rural, Marine and Coastal Development	Resilient and smart regional cities	Diversified energy matrix	Sustainable mobility and infrastructure	Adaptation of the population and of the health system
Emissions trading system	Source of resources	Source of resources	Source of resources	Benefit	Source of resources	Source of resources	Source of resources	Source of resources	Indirect Incentive	Source of resources
	Benefit	Direct Incentive	Direct Incentive							
Carbon tax		Source of resources	Indirect Incentive	Benefit	Source of resources	Indirect Incentive	Source of resources	Source of resources	Indirect Incentive	Benefit
		Indirect Incentive								
Incentives to alternative energy and EE			Direct Incentive	Benefit			Direct Incentive	Direct Incentive	Direct Incentive	Direct Incentive
Financial Incentives (rates, terms, etc.)	Direct Incentive	Direct Incentive	Direct Incentive	Benefit			Direct Incentive	Direct Incentive	Direct Incentive	Direct Incentive
Tax exemption in TC + I projects	Direct Incentive	Direct Incentive	Direct Incentive	Benefit			Direct Incentive	Direct Incentive	Direct Incentive	Direct Incentive
Financial instruments of Law 388				Benefit			Direct Incentive	Direct Incentive	Direct Incentive	Direct Incentive
Renewable energy auctions				Benefit			Direct Incentive	Direct Incentive	Direct Incentive	Direct Incentive
Incentive for rural capitalization		Benefit	Benefit	Benefit	Source of resources	Source of resources	Direct Incentive	Benefit	Benefit	Benefit
		Direct Incentive	Direct Incentive							
Water Use Rate	Benefit	Source of resources	Direct Incentive	Benefit	Source of resources	Source of resources	Direct Incentive	Benefit	Benefit	Benefit
		Indirect Incentive								
Payment for environmental services		Source of resources		Direct Incentive			Benefit	Source of resources		
Pay rate	Benefit	Source of resources	Direct Incentive	Benefit	Source of resources	Source of resources	Benefit	Beneficio	Beneficio	Beneficio
		Direct Incentive								

Instruments in order of prioritization		Effort 1	Effort 2	Effort 3	Effort 4	Effort 5	Effort 6	Effort 7	Effort 8	Effort 9	
	Investment funds for bioeconomy and sustainable production	Source of resources	Source of resources	Source of resources	Benefit	Benefit					
			Direct Incentive	Direct Incentive							
	Deposit-refund mechanism for circular economy		Benefit	Source of resources		Benefit	Direct Incentive	Benefit			Benefit
				Direct Incentive							
	Catastrophic insurance for public infrastructure	Benefit		Direct Incentive			Benefit	Benefit	Benefit	Benefit	Benefit
	Incentive for private climate insurance	Benefit		Direct Incentive			Direct Incentive	Direct Incentive			Benefit
Incentive for community employment in adaptation to CC with a gender focus					Direct Incentive					Benefit	
Other environmental taxes	Source of resources	Source of resources	Source of resources		Benefit	Source of resources	Source of resources	Source of resources	Source of resources	Source of resources	
			Direct Incentive			Direct Incentive					

In creating new instruments, the following considerations will be taken (Econometrics 2021):

◇ Incentives such as subsidies and transfers should be provided only when the desirable investments, from the social point of view, are not enough to generate sufficient revenues to stimulate private agents to make them 100% on their own. As far as possible, these should have diversified sources of financing, be conditioned to results

and be decreasing until they disappear, to stimulate the search for their own sustainability and reduce the fiscal cost.

◇ When it comes to internalizing environmental costs, the instruments that channel the resources from the agents that generate the externality and directly place them in the agents that are affected or make efforts to eliminate them, without the

need for State intermediation, should be privileged. These can be, for example, market instruments, funds for parafiscal contributions or others that balance burdens and benefits.

◇ Very long-term investments in public goods with very long useful lives must have financing schemes that balance the efforts of current generations with those of future generations.

◇ The new taxes that are established, in addition to discouraging activities adverse to E2050, should have a specific destination of their collections, to be directed towards environmental issues compatible with it, including information systems, administration and monitoring, as well as evaluation mechanisms of their impacts.

6. The way forward for

E2050 implementation and update

Thus, E2050 will not have a specific action plan, since it is not strategic to create a new planning instrument, which ends up becoming a budgetary and administrative burden, carrying new potentially uncoordinated tasks from the other instruments with which the Nation and the regional and local governments build their strategies to respond to the challenges that climate change will continue to bring. On the contrary, given its broad thematic, its long-time horizon and its aspirational and non-binding nature, the implementation of E2050 will seek to permeate multiple intersectoral and territorial plans, policies and instruments and actions so that they can capture the long-term vision in its designs. and actions, as well as transformation options. In this way, ambitious progress will be made in achieving the changes required to achieve carbon neutrality and build socio-ecological climate resilience by 2050, without deviating in directions that move the

country away from these objectives that have become essential for the survival of humanity in the face of the climate crisis that the planet is experiencing. In other words, the aspirations raised in E2050 must be taken as transformation options, to official goals in planning instruments, policies and the existing or new regulations in Colombia, at the central, sectoral and territorial levels.

For this, a roadmap for the operation of 2050 Strategy has been developed, the objective of which is to **Generate the enabling conditions to materialize the efforts of the 2050 Strategy**. Once operational, the 2050 Strategy must gain institutional anchoring, public positioning, the support of the necessary capacities and information, and a management and monitoring structure so that E2050 has the highest possible impact and remains current and relevant for the country for the next three decades.

Table 5.

Work blocks that configure the E2050 operational roadmap

Work block	Specific objective
Institutional, monitoring, follow-up, and evaluation anchoring	Have E2050 formalized in the Colombian institutional landscape through a clear legal mandate and an institutional structure that allows carrying out cross-sectional advocacy stage, and having information generation, monitoring, follow-up and evaluation and updating processes of the E2050.
Inclusion of long-term considerations in planning, policies and instruments	Permeate planning instruments, policies and national instruments with long-term planning considerations for socio-ecological resilience, making the necessary regulatory adjustments to direct the efforts approved by E2050.
Information, capacities and technology for climate resilience	Generate enabling conditions so that the implementation of the E2050 efforts have in the long term, the necessary information, the required capacities and the appropriate technologies for its development.
Pioneering implementation of the efforts and transformation options of E2050	Demonstrate with real implementation examples that the efforts of E2050 are viable and beneficial, gathering lessons learned for its scaling up.
Communication and management of the transition	Position and keep E2050 in force as a long-term plan that must commit the Colombian State and all its citizens, effectively addressing the natural resistance that will be faced to many of the transformations necessary for carbon neutrality and resilience.

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E2050

COLOMBIA

E2050 Colombia's long-term climate strategy
to meet the Paris Agreement