UN environment programme

GREEN ECONOMIC RECOVERY

Mobilizing investments towards a low-emission, climate-resilient economy in Latin America and the Caribbean

ISBN: 978-92-807-4140-7
Job Number: ROLAC/2630/PA
https://doi.org/10.59117/20.500.11822/45331

Published by the United Nations Environment Programme (UNEP), March 2024.

Disclaimer

Suggested citation

United Nations Environment Programme (2024). Green economic recovery: Mobilizing investments towards a low-emission, climate-resilient economy in Latin America and the Caribbean. Panama City.

Production

United Nations Environment Programme (UNEP)

Acknowledgments

The United Nations Environment Programme (UNEP) would like to thank the lead authors, technical modelling team and country contributors (authorities and technical team) for their contribution to the preparation of this assessment report.

Coordinator

Jorge A. Macías Programa de las Naciones Unidas para el Medio Ambiente (PNUMA), Oficina para América Latina y el Caribe

Modeling Expert

Dr. Andrea M. Bassi.

Peer Review

Gustavo Máñez, Climate Change Coordinator of the Regional Office of the United Nations Programme for Latin America and the Caribbean.
María de las Mercedes Garcia Fariña, Economics Division, United Nations Environment Programme (UNEP), Latin America and the Caribbean Office
Himanshu Sharma, Economics Division, United Nations Environment Programme (UNEP)

Technical Team Countries

Argentina: Evelin Goldstein, María Sol Aliano, Mariela Beljansky, Gisele Battaiotto, Alejandro Gottig, Salvador Gil and Carina Guzowski. United Nations Environment Programme (UNEP), Latin America and the Caribbean Office.
Costa Rica: Mónica Rodríguez, Economics Researcher for the Energy Power and Energy Research Laboratory (EPERLab) of the University of Costa Rica.
Honduras: Leonardo Matute Valladares and Roberto Enrique Chang, United Nations Environment Programme (UNEP), Latin America and the Caribbean Office
Panamá: Dr. Christian Navntoft (UNEP), Latin America and the Caribbean Office

Design

Luis Gómez Theriot, La Colaboración

Karla Delgado Olguín, United Nations Environment Programme (UNEP), Office for Latin America and the Caribbean

Special thanks

This series of technical documents has been developed with the financial support of the European Union, within the framework of the EUROCLIMA+Programme

Euroclima+

Funded by the European Union

Glossary

A

ATE: Energy Transition Agenda,

B

BAU: Trend scenario,
IDB: Inter-American Development Bank,

C

CBA: Cost-Benefit Analysis,
CO2eq: Carbon dioxide equivalent emissions,

E

EA: Early Action,
ENDRCH: Honduras Decarbonization and Climate Resilience Strategy,
EPI: Environmental Performance Index,
EA 2045: Net Zero Early Action Scenario, Target 2045: (LA 2045),
EA 2050: Net zero early action scenario, 2050 target: (LA 2050),
Baseline scenario: (BAU),

G

GHG: Greenhouse Gases,
GEM: Green Economy Model,

H

HDI: Human Development Index,

I

IFC: International Finance Corporation,
ILO: International Labour Organization,
INEC: National Census Bureau,

L

LAC: Latin America and the Caribbean,
LA: Late Actio,
LA 2045: Net zero late action scenario, target 2045,
LA 2050: Net zero late action scenario, 2050 target:,
LCD: Low Carbon Development,
LTS: Long-Term Strategies,

M

Mt: metric tons.,

N

NDC: Nationally Determined Commitments,
NDP: National Decarbonization Plan,

O

OSeMOSYS: Open Source Energy Modelling System,

P

GDP: Gross Domestic Product,
UNEP: United Nations Environment Programme,
United Nations Environment Programme: (UNEP)„ III

S

SD: System Dynamics,
SERNA: Secretariat of Natural Resources and Environment of Honduras,

U

USD: United States Dollars,

Index

Executive Summary

The project "Green Economic Recovery: Mobilizing investments towards a low-emission and climate-resilient economy in Latin America and the Caribbean" aimed to support selected LAC countries (Argentina, Costa Rica, Grenada, Honduras and Panama) to address the main barriers faced by countries when designing, planning and financing post-COVID-19 recovery plans aligned with the Paris Agreement.

Throughout the technical accompaniment, a series of evaluations were carried out that analyze the opportunities to integrate low-emission climate-resilient development strategies into economic recovery packages. These analyses demonstrate that economic recovery plans aligned with the Paris Agreement are forward-looking and cost-efficient investments for LAC governments. In this spirit, the "Green Economic Recovery" project worked closely with authorities and experts in 5 countries to support the planning process with science-based assessments. For this purpose, the Green Economy Model (GEM) was used; a System Dynamics (SD) modeling tool that facilitates a comprehensive approach to environmental planning.

The model was adapted to the needs of each country and designed to assess policy outcomes in all relevant sectors, considering a multiplicity of economic actors, dimensions of development and different time periods. The evaluation exercises were aligned to national contexts and priorities. The contextualization was carried out to analyze in more detail the main challenges or strategies of the various participating countries in terms of climate mitigation and risks and identify possible synergies in investment strategies to enhance a green and resilient recovery package.

The analyses were useful to complement national efforts in the development of various public policy instruments. The following is a summary of the requests for technical assistance that received feedback from the project:

- **Argentina:** The Ministry of Environment and Sustainable Development requested technical assistance to prioritize the energy and transport sectors in the development of the green recovery plan. This plan favored a special focus on promoting local production through national manufacturing value chains. This technical assistance was led by an inter-ministerial committee that included the Ministry of Productive Development, together with the Ministry of Transport, the Ministry of Energy and the Ministry of Agriculture. This evaluation supported the definition of Argentina's National Electric Mobility Strategy, as well as the country's Energy Transition Agenda and the design of a green recovery economic package aligned with environmental planning processes.

- **Costa Rica:** technical assistance was requested by the Ministry of Environment and Energy. This analysis assessed the socio-economic impacts of the implementation of the National Decarbonization Plan integrated into a future National Green Recovery Plan. The project provided data and numbers on how to integrate the National Decarbonization Plan (long-term objective) and the National Adaptation Plan (NAP) with future recovery objectives (long-term objective).

- **Granada:** The Ministry of Climate Resilience, Environment and Renewable Energy requested support to incorporate the National Decarbonization Plan into its economic recovery plan.

- **Honduras:** The Ministry of Natural Resources and Environment (SERNA), together with the Special Cabinet for Reconstruction and Recovery, requested support to develop the national reconstruction and recovery strategy. After the impacts of hurricanes ETA and IOTA, the cost-benefit analysis laid the groundwork for a resilient recovery in Honduras.

- **Panamá:** The technical assistance for Panama was the first to be completed. Alongside with the National Secretariat of Energy (SNE) and the Ministry of Environment (MiAmbiente), the report "The Energy Transition as a Key Driver of the Economic Recovery of COVID-19 in Panama" was developed. This assessment demonstrated that investments in clean energy transition stimulate the economy and create employment opportunities. An achievement of this evaluation was the allocation of public funds from the Ministry of Economy and Finance to the SNE for complementary activities in carrying out the implementation of the Energy Transition Agenda, as part of the fiscal year 2021 budget.

From the feedback to the planning process of the participating countries, results and various policy scenarios were generated that informed decision-making and investment prioritization. The estimation of the environmental impact was accompanied by evaluations that allowed us to understand the effect that these instruments have both in the economic and labor spheres.

It was shown that policies and investments that foster the energy transition, decarbonization and resilience to the climate crisis have the potential to, in parallel, foster economic growth, higher employment and reduce poverty conditions. This report presents a summary of the technical support, as well as the main conclusions that may be relevant for decision makers in Latin America and the Caribbean.

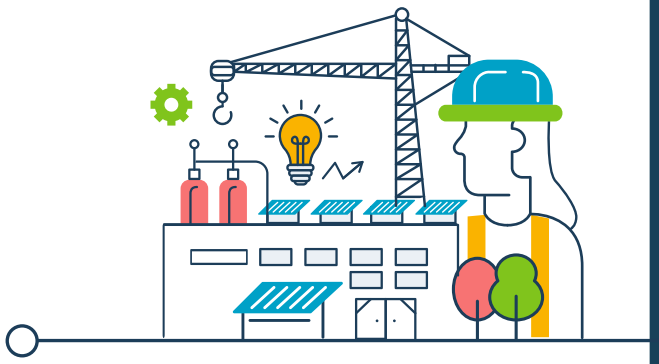
Context

The recent pandemic derived from COVID 19 highlighted various economic, environmental and social challenges of the current development model in Latin America and the Caribbean (LAC).

The dominant development model has affected numerous imbalances driven by growing inequality, the serious consequences of environmental deterioration and climate change at the global level. (CEPAL 2016). At the same time, green investment policies and projects are receiving increasing interest as strategic elements for recovery, as well as for the protection of public health and the implementation of a more responsible and sustainable development system.

Latin America faced the worst social and economic consequences of the COVID-19 crisis. The region has suffered 32 per cent of the world's total human losses; despite representing only 8% of the world's population (CEPAL 2020). No region in the world had a greater GDP contraction than LAC (-7%) (IMF 2021). With this, social and economic inequalities were exacerbated, 10.6 million jobs were lost. (IADB 2021) and, as a result, 22 million people moved into poverty, an increase of 12% compared to 2019. Women and young people were further disproportionately affected by the pandemic, they experienced job losses due to their increased presence in certain economic sectors deepening pre-existing inequalities. In short, 200 million people in the region now live in poverty, 8 million of them in conditions of extreme poverty. (CEPAL 2020).

These economic difficulties are on a par with a second, longer-lasting crisis: the climate crisis. LAC's very high vulnerability to climate change has aggravated the region's economic, social, and environmental consequences. According to the Global Commission on Adaptation, climate events are the biggest threat to development achievements in the region. By 2050, it is estimated that 17 million people (2.6% of the total population) could be displaced, and 2.6% of GDP could be lost due to climate events. This is in addition to the 1.7% of GDP already lost to climate-related disasters over the past two decades (equivalent to USD 11 billion in economic damage per year) (Global Commission on Adaptation 2019).



In this spirit, the United Nations Environment Programme (UNEP) in collaboration with the EUROCLIMA+ programme and the Green Climate Fund (GCF) developed the project "Green Economic Recovery: Mobilizing investments towards a low-emission and climate-resilient economy in Latin America and the Caribbean". This project aimed to support selected LAC countries to address the main barriers they face when designing, planning and financing post-COVID-19 recovery plans aligned with the Paris Agreement.

The project was developed at a critical time when many LAC countries were on par, designing their stimulus packages and recovery plans in response to COVID-19 and reviewing their commitments to the Paris Agreement, through the improvement of their Nationally Determined Commitments (NDCs) and Long-Term Strategies (LTS). Under this scenario, there was an opportunity to ensure that national climate ambition was an integral component of short-term economic recovery and long-term economic growth strategies. With this in mind, the evaluation focused on five countries in the region: Argentina, Costa Rica, Grenada, Honduras and Panama.

By committing to environmental policy objectives such as those defined under the Paris Agreement, LAC countries support a long-term path to climate neutrality and environmentally sustainable growth. These targets provide clear signals to the market about future economic trends, forward-looking investment opportunities, and risks. It is only through the alignment of public policies with these principles that will encourage financial market participants to redirect investment flows in support of the transition to low-emission and climate-resilient economies in the region.

The governments of LAC countries designed and planned various public policy measures, in response to the COVID-19 pandemic, aimed at boosting public and private investment, with the ultimate goal of stimulating the economy and generating jobs. These policy measures and investment decisions, framed as recovery packages, will impact the path of economic development for the next decade, accelerating or delaying progress on climate change. Therefore, linking short-term post-COVID-19 recovery frameworks with NDCs is essential to ensure that the LAC region complies with the Paris Agreement.

Low-emission and climate-resilient investments can greatly influence future socio-economic development by creating synergies between social, economic and environmental indicators in LAC countries. Understanding the systemic outcomes of action and inaction is essential to inform policymaking. This holistic approach, with low-emission and climate-resilient development strategies at the core, would unite economic development and employment, meeting climate and environmental goals, and social well-being.

The structural transformation that comes along with a low-emission, climate-resilient economic recovery has been shown to simultaneously deliver higher economic returns, social benefits, improved public health, and environmental progress than traditional short-term investments. Offering evidence of these benefits was crucial in assisting policymakers in designing and planning post-COVID-19 recovery plans to integrate low-emission, climate-resilient development strategies as part of their economic recovery plans. In this way, green projects can become critical enablers of LAC countries' recovery efforts.

According to the International Labour Organization (ILO) and the Inter-American Development Bank (IDB), the transition to a net-zero emissions economy could create 15 million net new jobs in LAC by 2030. The main sectors where job creation is identified is in agriculture and plant-based food production, renewable electricity, forestry, construction and manufacturing (ILO 2020). The projection also underlines the need to reduce inequalities and gender segregation by ensuring women and men have equal opportunities and are protected from discrimination in the labor market. In addition, according to UNEP, a coupled decarbonization of the electricity and transport sectors would create up to 35 million additional jobs by 2050. (UNEP 2021).

The region is well positioned to benefit from the transition to a greener economy. According to the International Finance Corporation (IFC), the LAC region is considered one of the great frontiers for green investment given current demographic and socioeconomic trends combined with its immense wealth of natural capital. Investments in sectors such as renewable energy, energy efficiency, zero-emission transport, nature-based solutions in rural and urban areas could lead to greater employment opportunities, increased productivity, greater innovation and economic growth while ensuring everyone has equal opportunities hence promoting gender equality. These investments would generate multiplier effects in the economies of LAC countries, through positive impacts on aggregate demand and supply.

Being able to accompany the climate planning process with modeling and consultation tools allowed us to support countries during a period of uncertainty. In particular, it was necessary to support and sustain countries' decisions through investments in areas of environmental policies with high economic multiplier potential and long-term social objectives. Through strategic investment decisions, LAC nations can protect their populations from the worst impacts of both the economic crisis and the climate crisis.

To develop the project, UNEP developed the Green Economy Model (GEM) that served to accompany both the prioritization and the evaluation of environmental and economic impact in the government programs of the countries involved. In the next section we give a brief account of this tool.

Methodology: The Green Economy Model (GEM).

The Green Economy Model (GEM), adapted to the needs of each country, was designed to evaluate the results of policies in all relevant sectors, considering a multiplicity of economic actors, development dimensions and different time periods.

The contextualization was carried out to analyze in more detail the main challenges or strategies of the various participating countries in terms of climate mitigation and risks, as well as to, identify possible synergies in investment strategies to enhance a green and resilient recovery package.

The model extends and advances policy analysis normally conducted through sectoral tools by taking into account the dynamic interaction between economic sectors, as well as the social, economic and environmental dimensions of development (Bassi 2015). The consideration of intersectoral relationships supports a broader analysis of the implications of alternative development policies and proposes a long-term perspective that allows identifying and anticipating the possible side effects and sustainability of different strategies.

The GEM was built using the System Dynamics (SD) methodology, serving primarily as a knowledge integrator. SD is a form of computer simulation modeling designed to facilitate a comprehensive approach to medium- and long-term development planning (Meadows 1980, Randers 1980, Richardson und Pugh 1981, Forrester 2002). SD operates by simulating differential equations with alternative scenarios, explicitly represents actions and flows, and can integrate optimization and econometrics. The purpose of SD is not to make accurate predictions of the future, or optimize performance; rather, these models are used to inform policymaking, forecast policy outcomes (both desirable and undesirable), and lead to the creation of a resilient and well-balanced strategy (Roberts et al. 1983, Probst und Bassi 2014).

The model was designed to include all key sectors that are relevant to the assessment of low-carbon development and climate resilience options. The main dynamics analyzed include, but are not limited to, demographic trends, impacts of COVID-19 on the economy, emissions from energy demand and supply, land management, LULUCF, IPPU and waste. The model was further strengthened and adapted to include and forecast the impacts of hurricanes in Honduras, in a variety of sectors for which data were available (DALA 2021). The hurricane's impacts were captured for agriculture, buildings, education, healthcare, industry and commerce, tourism, transport infrastructure, and water and sanitation.

The development of the model includes (1) a macroeconomic module and (2) various sectoral models. The latter, created for the relevant sectors according to the policy interests of each country. The model includes energy demand and supply, agriculture, infrastructure and emissions, and other items necessary to carry out an in-depth evaluation of sectoral performance, capable of generating valuable inputs for the development of green economy strategies. The macroeconomic module makes it possible to test the cross-sectoral coherence of proposed sectoral interventions and to assess the results of policy interventions at national level (e.g. their contribution to GDP and job creation).

The macroeconomic module includes several indicators, such as public accounts (mainly income and expenditure, and debt), household accounts (income and consumption) and a high-level estimate of GDP at national and sectoral levels (for agriculture, industry and services). As a result, the model can estimate the contribution of sectoral green economy policies to sectoral and national GDP, as well as job creation, and national accounts.

Photo: Unsplash

In particular, the public accounts module provides an overview of government expenditure and revenue, which is used to determine the net operating balance (for example, whether there will be a surplus deficit for a given year) and the budget available for government consumption and investment. Household accounts estimate total income and disposable income. In addition, it conducts an assessment to determine how private consumption and savings are affected by sectoral performance. For example, an increase in total real GDP would increase household incomes and, in turn, increase both household consumption and investment. As a result, it makes it possible to assess the extent to which policy interventions contribute to improving households' economic performance. When combined with estimates of emissions and food security, to cite two examples, the model can assess policy outcomes on overall well-being.

All sectoral modules track investments related to policies, capital accumulation, employment and the potential impact of other factors (e.g. energy expenditure) on productivity. The difference in investments between the baseline and policy scenarios is used to generate an integrated cost-benefit analysis, which provides information on additional investments, avoided costs, and additional benefits related to the scenarios analyzed. This report serves as a reference to illustrate the need to incorporate evidence-based planning tools to reconcile economic and environmental objectives. To this end, in the following section, the main challenges and results that the project had in the five countries involved (Argentina, Costa Rica, Grenada, Honduras and Panama) are presented.

Country Results

Argentina

Area	2,780,400 Km2
Total Population	46,044,703 (Census 2022)
Demographic Density	16.56 hab/km2
Population Distribution	Rural (8%), Urban (92%) (United Nations 2020)
GDP per capita at current prices	USD 10,636 (World Bank 2021)
HDI	0.842 (United Nations 2022)
GINI	42.9 (World Bank 2019)
Environmental Performance Index (EPI)	41.1 (2022)
Ranking EPI	92º of 180 countries (2022)

Photo: Unsplash

Background

In the case of Argentina, the Ministry of Environment requested technical assistance to evaluate the prioritization of the energy and transport sectors within a green recovery plan. This plan had a special focus on promoting domestic production through national manufacturing value chains. The project had the inter-ministerial leadership of the Ministry of Productive Development, together with the Ministry of Transport, the Ministry of Energy and the Ministry of Agriculture. The evaluation supported the definition of Argentina's National Electric Mobility Strategy, the country's Energy Transition Agenda, as well as the design of a green recovery economic package in line with these two public policy processes.

For the preparation of the intervention proposals, the energy transition scenarios to 2030 were used. These scenarios included objectives for the generation of electrical energy both in systems connected to the electric transmission grid and for the installation of distributed generation equipment from renewable sources, for the incorporation of electric vehicles and, finally, to achieve energy efficiency improvements. The policy objectives were constructed from different data available from official sources, whenever possible, given that so far there is no National Energy Transition Plan, projections were used that are still under review. It was sought that the proposed scenarios were aligned with the commitments assumed by the National Government linked to the energy transition and, therefore, to the reduction of greenhouse gas (GHG) emissions (PNUMA 2021).

At the same time, the capacities of national companies for the provision of goods and services for the fulfillment of the goals established in the scenarios to 2030 were analyzed.

In this way, investment and job creation opportunities linked to the expansion of renewable energy generation capacity, new distributed generation facilities, incorporation of electric vehicles and energy efficiency improvements in homes were identified.

Actions

The objective of this evaluation was (i) to assess the impact of planned decarbonization measures on the country's total GHG emissions and (ii) to analyze the opportunity to increase the contribution of domestic industries to the production of renewable capacity and electric vehicles. To this end, four scenarios were simulated, the Business as Usual (BAU) scenario and three Low Carbon Development (LCD) scenarios. The BAU scenario represents the no-action scenario that does not foresee the gradual introduction of more renewable capacity or additional energy efficiency. It serves as a baseline for assessing the impacts of simulated interventions on decarbonization scenarios. In addition to the BAU scenario, three LCD scenarios have been simulated. The three LCD scenarios assume the same share of renewable energy and additional energy efficiency improvements by sector; however, they differ in terms of the extent to which low-carbon technologies are produced in Argentina. The base assumptions for each scenario differ in 6 base elements presented below:

1. At the time of preparation of the report, the document of Energy Scenarios of the Ministry of Energy, published in 2019, was available

1 Improvement in energy efficiency in the transport sector assumed after 2020

Sector	BAU	LCD, Low LCD & High LCD
Industry	0% per year	1% per year
Residential	0% per year	1.4% per year
Transport	0% per year	1% per year
Commercial	0% per year	1% per year

2 Electric Vehicles in Fleet

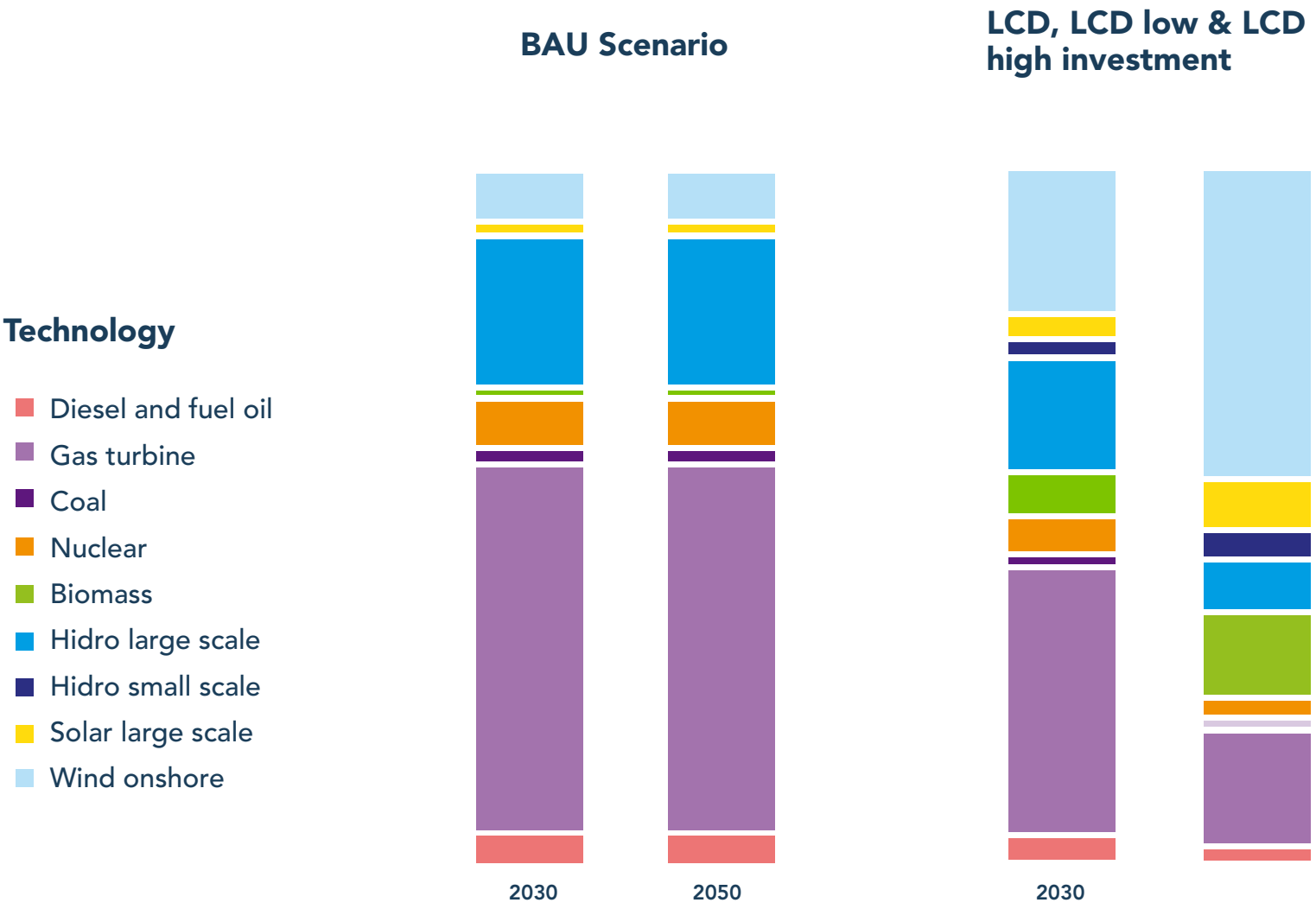
BAU		LCD, Low LCD & High LCD	
2030	2050	2030	2050
0	0	1.2 millons	4.25 millons

3 Percentage of electricity generated by renewable sources

BAU		LCD		Low Investment LCD		High Investment LCD	
2030	2050	2030	2050	2030	2050	2030	2050
34.8%	34.8%	49.9%	76.3%	49.9%	76.3%	49.9%	76.3%

Photo: Unsplash

4 Proportion of electricity generation by technology.



5

Proportion of renewable electricity produced in Argentina by 2050.

Technology	BAU	LCD	Low Investment LCD	High Investment LCD
Solar	0%	0%	38%	49%
Wind	0%	0%	43%	77%
Biomass	0%	0%	35%	75%

6

Electric vehicle fleet local production participation.

BAU	LCD	Low Investment LCD	High Investment LCD
0%	0%	25%	40%

Results

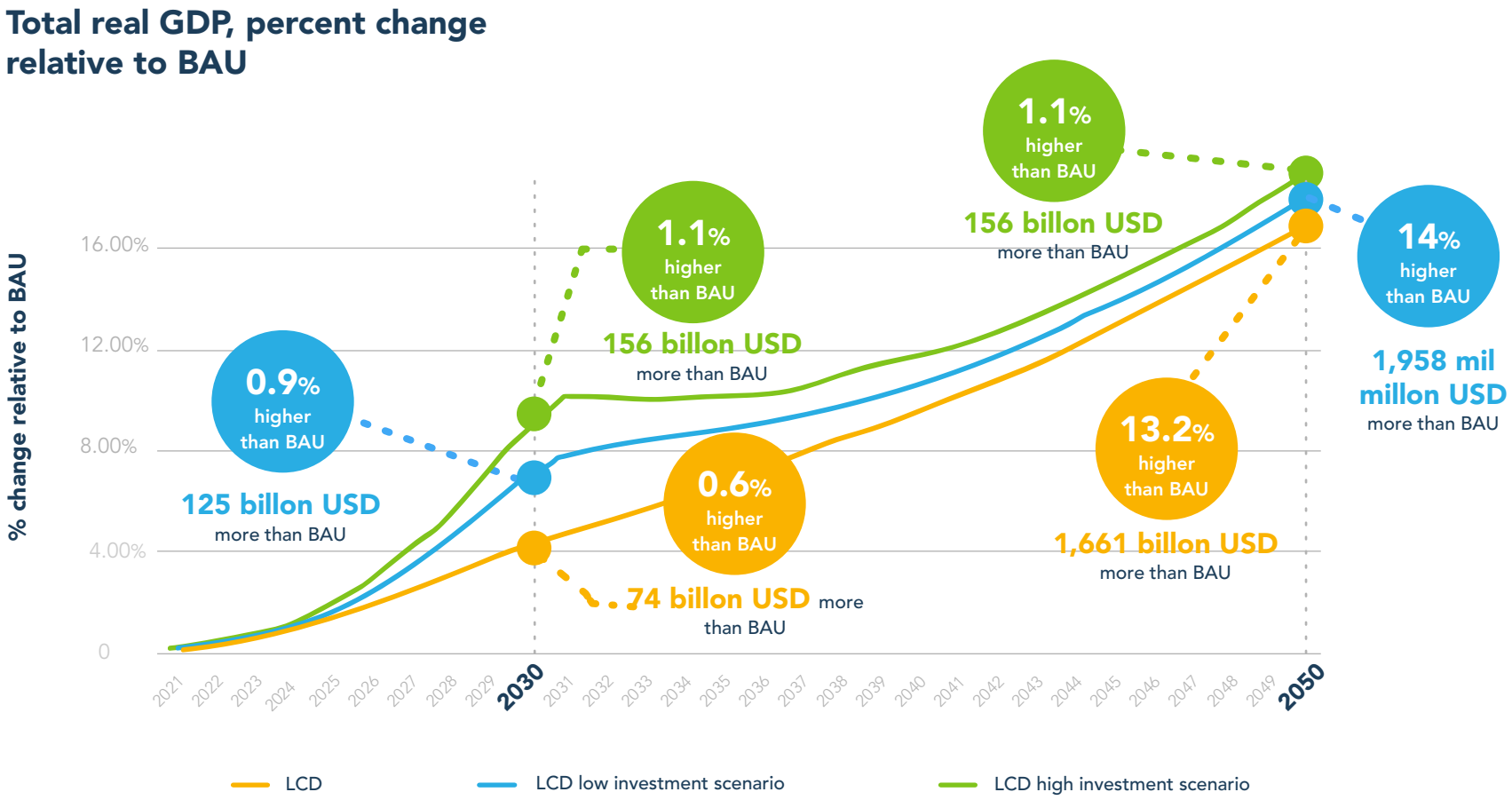
One of the features of the Green Economy Model is that decarbonization, and the resulting changes in air pollution and energy costs, translate into additional economic growth compared to a scenario in which decarbonization is not assumed. Projections for total real GDP and real GDP growth rate are presented in Figure 1. In the BAU scenario, total real GDP is projected to increase from around USD 387.75 billion in 2020 to USD 506.75 billion by 2024. In the medium to long term, total real GDP is projected to reach USD 629.11 billion in 2030 and USD 1.23 trillion by 2050.

In the LCD scenario, decarbonization induces additional economic growth as a result of reduced emissions and energy costs. In the short term, total real GDP is projected to rise to USD 510.04 billion by 2024, which is 0.6% higher compared to the BAU scenario. Between 2020 and 2024, the additional growth exhibited in the BAU scenario contributes to generating USD 5.58 billion in additional real GDP. In the medium and long term, total real GDP in the LCD scenario without additional investments in production capacity increases to USD 647.87 billion (2030, +3% vs BAU) and USD 1.39 trillion (2050, +13.2% vs BAU) respectively.

Between 2020 and 2030, this increase translates to USD 73.75 billion in additional real GDP and by 2050, the total cumulative additional value-added increases to USD 1.66 trillion.

In the low and high LCD investment scenarios, total real GDP grows faster as a result of additional investments in domestic manufacturing capacity for renewable energy and electric vehicles. In 2024, total real GDP is projected to reach USD 511.5 billion and USD 512.44 billion respectively, which is 0.9% and 1.1% higher compared to total real GDP in the BAU scenario. By 2030, total real GDP is projected to be 5.3% and 6.7% higher compared to the BAU, growing to USD 662.6 billion and USD 671.11 billion in the low-investment scenario in LCD and high-investment LCD, respectively. In the longer term, by 2050, total real GDP is projected to reach USD 1,396 billion (low LCD, +14% vs BAU) and 1,402 billion (high LCD, +14.4% vs BAU) respectively.

Figure 1. Impact on Gross Domestic Product of the different scenarios of Low Carbon Development Argentina 2020 – 2050.



The summary of the projected evolution of the total employment provided by the Argentine economy in comparison with historical data is presented in Figure 2. In the BAU scenario, total employment increases from around 23.88 million jobs in 2020 to 24.78 million jobs in 2024 and 26.66 million jobs by 2030. In the longer term, total employment in the BAU scenario is projected to reach 30.85 million jobs by 2050.

Source: United Nations Environment Programme

In the LCD scenario, additional capital accumulation resulting from higher economic growth, as well as additional green jobs induced by decarbonization interventions, increase employment in 2024 by 0.1% (24.8 million jobs) compared to baseline. In the low and high LCD investment scenarios, short-term employment increases further, driven by additional investments in domestic production capacity. By 2024, total employment in the low and high LCD investment scenarios increases by 0.7% and 1.1% compared to the BAU scenario, equivalent to the total employment of 24.95 million jobs (low LCD) and 25.04 million jobs (high LCD) respectively.

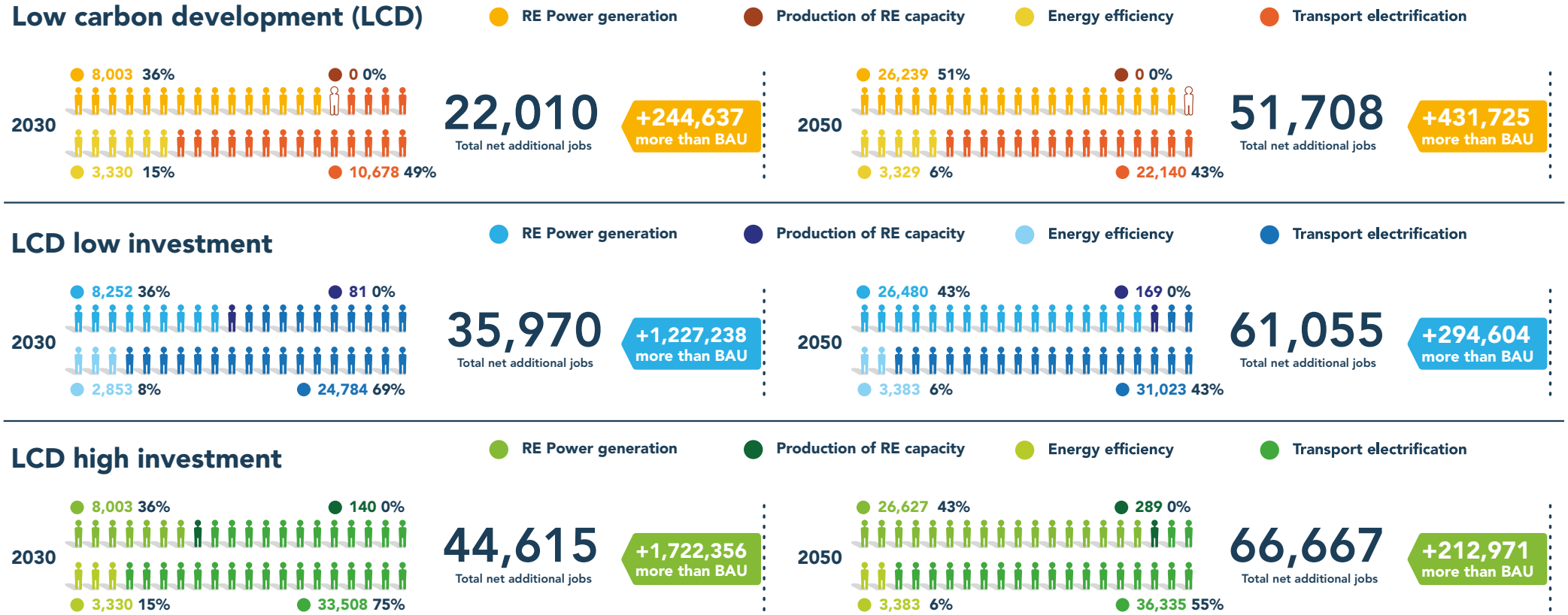
In the medium term, by 2030, total employment in LCD scenarios is projected to be 0.9% (MED scenario), 4.6% (low LCD) and 6.5% (high LCD) higher compared to the BAU scenario. This increase translates to 244,600 additional jobs in the LCD scenario, 1.23 million additional jobs in the low-investment LCD scenario. This increase in employment in the medium term continues to be attributable to additional investments in the establishment of domestic production capacity.

In 2050, total employment in LCD scenarios is projected to be around 0.7% (high LCD) 1.4% (LCD scenario) higher compared to the BAU, equating to between 212,800 and 431,600 additional jobs relative to baseline, respectively. The projected evolution of the unemployment rate highlights the opportunity to establish domestic production capacity for sustainable technologies in the generation of additional jobs that end up effectively reducing unemployment in the short and medium term.

Under the high investment scenario, 1.72 million additional jobs are added.

Photo: Unsplash

Figure 2. Total additional employment by sectoral intervention in 2030 and 2050



Source: United Nations Environment Programme

Energy efficiency improvements in LCD scenarios contribute to reducing total electricity demand relative to the baseline, despite additional electrification planned for the transport sector. The development of power generation capacity and total electricity generation in the four scenarios is presented in Figure 3, compared to historical data. In the BAU scenario, total power generation capacity is projected to increase from 41,500 MW in 2020 to 48,070 MW in 2024.

In LCD scenarios, energy efficiency improvements assumed in all sectors reduce the need for generation capacity relative to the BAU scenario. In the LCD scenario, the total power generation capacity forecast for 2024 and 2030 reaches 46,230 MW and 49,720 MW respectively, which is 3.8% and 14.3% lower compared to the BAU. By 2050, the total power generation capacity in the LCD scenario will grow to 63,860 MW, which is 36.5% lower compared to the baseline.

In the scenario of low investment in LCD, the total power generation capacity in 2024 reaches 46,320 MW (-3.6% vs BAU) and increases to 50,680 MW in 2030 (-12.7% vs BAU). In 2050, the total power generation capacity in the LCD low-investment scenario reaches 64,300 MW and is therefore 36.1% lower compared to the BAU.

By 2030 and 2050, the total power generation capacity required to meet electricity demand increases to 58,040 MW and 100,580 MW respectively.

The LCD high investment scenario exhibits slightly higher power generation capacity requirements relative to the LCD and LCD low investment scenario, with a total capacity requirement indicated of 46,380 MW in 2024, which is still 3.5% lower compared to the BAU scenario. In 2030 and 2050, the total power generation capacity required in the LCD high investment scenario increased to 51,240 MW and 64,560 MW respectively, which is 11.7% and 35.8% lower compared to the baseline.

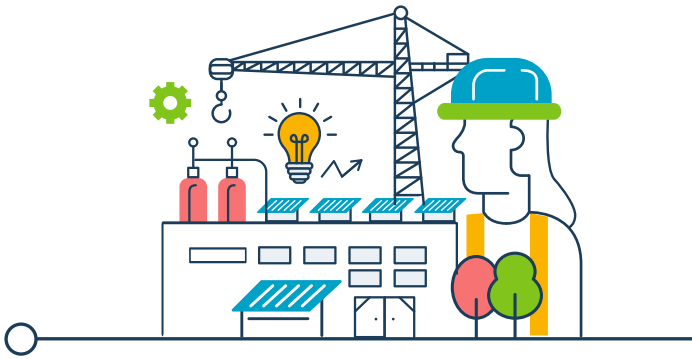
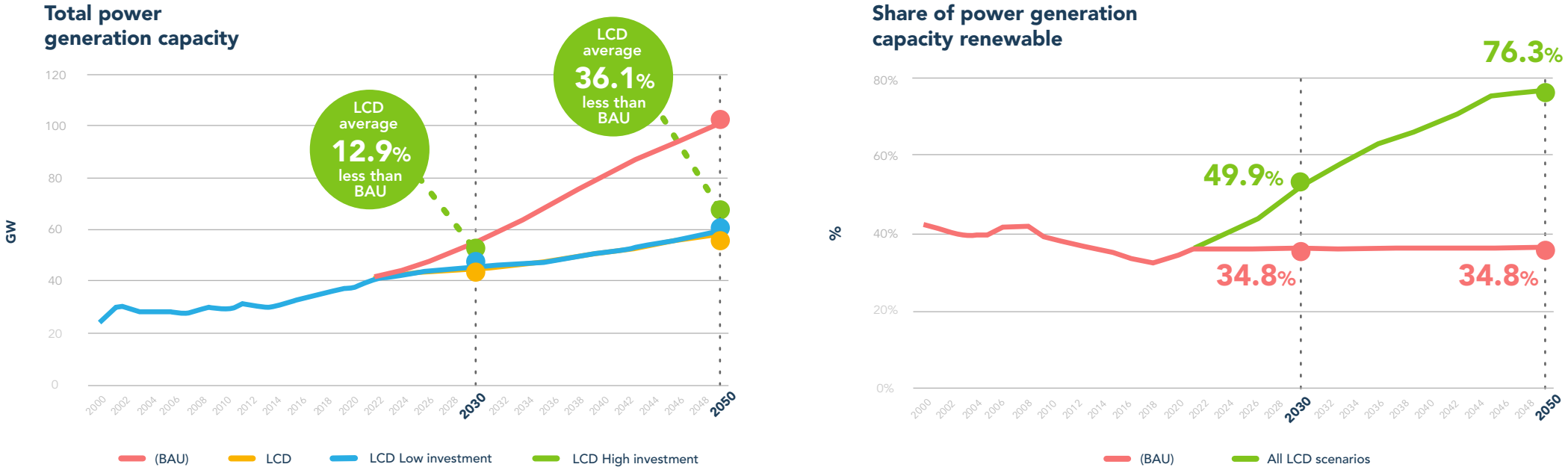


Figure 3. Total power generation capacity and share of renewable in LCD scenarios.



Source: United Nations Environment Programme

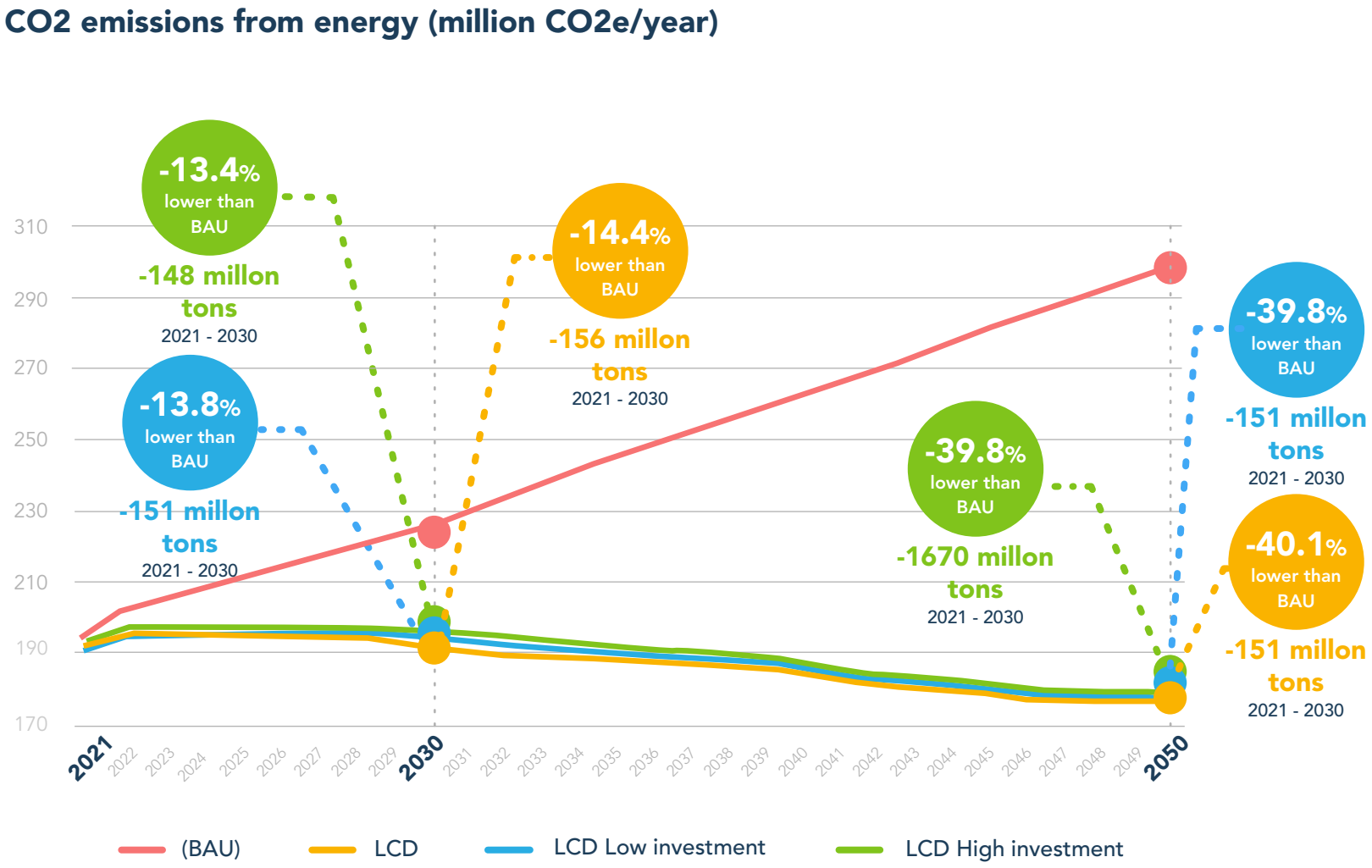
Total energy-related GHG emissions are lower relative to the BAU scenario in all three LCD scenarios. The reduction in emissions is driven by a combination of further energy efficiency improvements across all sectors and the decarbonization of the power generation sector.

In the BAU scenario, total energy-related GHG emissions are projected to increase from around 388 Mt in 2020 to 420.73 Mt in 2024. By 2030, total GHG emissions from energy will increase to 233.41 Mt and reach 300.53 Mt by 2050, indicating a 65% increase in total energy-related GHG emissions between 2020 and 2050. In the LCD scenario, improved energy efficiency and fuel switching contribute to reducing energy-related GHG emissions to 193.54 Mt in 2024 (-4.9% vs. BAU) and 190.4 MT by 2030 (-14.8% vs. BAU).

In the LCD low and high investment scenarios, total GHG emissions from energy in 2024 are projected at 193.78 Mt and 193.94 Mt respectively, which is 4.8% and 4.7% lower compared to baseline. In 2030, emissions are projected to increase to 192.42 Mt (-13.9% vs BAU) and 193.58 Mt (-13.4% vs BAU) and by 2050, energy emissions in the two investment scenarios will reach 176.97 Mt (low LCD, -41.1% vs BAU) and 177.35 Mt (high LCD, -41% vs BAU) respectively. Energy-related GHGs per capita follow the same relative trend as emissions, as population is constant across all scenarios. Total energy GHG emissions and per capita GHG emissions are presented in Figure 4 below, compared to historical data.

By 2050, total energy emissions are projected to decrease slightly to 176.35 Mt per year, which is 41.3% lower compared to the BAU scenario and 3.2% lower compared t energy-related GHG emissions in 2020.

Figure 4. CO2 emissions from energy (million-ton CO2e/year)



Source: United Nations Environment Programme

Costa Rica

Area	51,179 Km2
Total Population	5,226,362 (2022)
Demographic Density	102.12 hab/km2
Population Distribution	Rural (44%), Urban (56%) (United Nations 2020)
GDP per capita at current prices	USD 12,472 (World Bank 2021)
HDI	0.809 (United Nations 2022)
GINI	48.2 (World Bank 2019)
Environmental Performance Index (EPI)	46.3 (2022)
Ranking EPI	68º of 180 countries (2022)

Photo: Unsplash

Background

Economic activity in Costa Rica suffered a sharp drop, especially in the second quarter of 2020 with a contraction of 7.6% and by the end of 2020 GDP fell by 3.9% (BCCR 2021). The contraction in output was partly due to falling household consumption (due to mobility restrictions and reduced incomes) and lower investment. The industries that suffered the most were: i) services at -44.7% (especially those related to tourism, such as accommodation and restaurants); ii) transport and storage at -22.2%; and iii) trade at -10.2%. International tourist arrivals fell by 98.7% in the third quarter of 2020. As a result, direct employment in the tourism sector decreased by 28%, driven by restaurants and hotels, which generate the largest proportion of jobs in this sector. Overall, economic activity in the tourism sector decreased by 44.3% in 2020 (BCCR 2021).

Additionally, Costa Rica's social impact on employment was the harshest since the country's economic crisis in the 1980s. According to the Ministry of Labor, the poverty rate reached 27.7% of the population in September 2020 – an increase of 7.7 p.p. – approximately 400,000 people (MTSS 2020). The National Census Bureau (INEC) estimated the unemployment rate at 20% for the fourth quarter of 2020, a year-on-year increase of 7.6 p.p. Hours worked decreased by 37% for the informal workforce (INEC 2021). These jobs were the hardest hit and include the transportation and warehousing, hotels and restaurants, construction, agriculture and manufacturing sectors.

In response to the COVID-19 crisis, the president of Costa Rica stated that recovery was only possible with a stable economy and the fiscal deficit under control. He went on to say that economic recovery must be green, sustainable and inclusive. The president called for the National Decarbonization Plan (Gobierno de Costa Rica 2019) the "roadmap" for the coming decades. He reiterated plans to increase imports of electric vehicles and build more charging stations, increase coverage of protected lands and oceans, ban oil production and/or exploration, and active sponsorship of the Metropolitan Electric Train and the National Hydrogen Strategy. (Presidencia 2021).

To support the Government of Costa Rica's objective in designing and promoting an environmentally sustainable and socially inclusive economic recovery, the GEM-CR showed that, even in the midst of a difficult fiscal situation as a result of the impacts of a pandemic, decarbonization policies and investments framed under the NDP could become a critical enabler of Costa Rica's recovery efforts in the short (2020-2025) and long term. (2020-2030 and 2020-2050).

Costa Rica is one of the few countries that has committed to a goal of absolute and unconditional reduction of greenhouse gas (GHG) emissions mitigation. In this regard, the National Decarbonization Plan, published in 2019 by the government, establishes the objective of becoming carbon neutral by 2050. To achieve this goal, Costa Rica must match local emissions to the local sequestration provided by forests and other carbon sinks available in the country. The project demonstrated that decarbonization policies and investments under the NDP generate more jobs and foster higher economic growth, while achieving climate goals and social co-benefits in the short term and beyond. Extracting this information was crucial to inform policymaking in the context of a green and inclusive recovery from COVID-19.

Actions

The systemic evaluation developed under the project highlighted and evidenced the socioeconomic and environmental results of the sectoral policy measures and investments in decarbonization framed in the National Decarbonization Plan -transport, electricity, construction, industry, waste, agriculture, livestock and forestry- in the short term (2020-2025), medium term (2020-2030) and long term (2020-2050). Under this scenario and as a general evaluation objective, a wide range of decarbonization interventions were established in the sectors listed above to reach a net-zero economy by 2050.

The GEM Costa Rica (GEM-CR) was built on previous work done by the Inter-American Development Bank (IDB) - The benefits and costs of decarbonizing Costa Rica's economy (BID et al 2020). The GEM-CR model was customized to perform an evidence-based analysis demonstrating the impacts of implementing decarbonization strategies on the economic, social and environmental dimensions. This tool analyzed the impact of the NDP on: i) the generation of direct, indirect and induced employment; (ii) economic growth - Gross Domestic Product (GDP); (iii) public finances; and (iv) greenhouse gas (GHG) emissions and air quality.

Understanding the systemic outcomes of action and inaction is essential to inform policymaking, as it highlights the social value of decarbonization policies and investments. Therefore, under the project it was demonstrated that decarbonization efforts in Costa Rica take advantage of higher economic growth and generate more jobs, while achieving climate goals and realizing co-lateral social benefits in the short term and beyond. This robust approach, with the NDP at the heart of the national economic strategy, can play a crucial role in the country's journey out of the COVID-19 crisis.

The evaluation considered various scenarios and their socio-economic outcomes, using an integrated, science-based modelling approach. The scenarios include the baseline case (BAU scenario), which assumes the continuation of existing trends, and another that considers a net zero path (NDP scenario) 2050 based on sectoral decarbonization interventions framed in the NDP 2018-2050 (Gobierno de Costa Rica 2019). The summary of the goals or assumptions considered in the different scenarios is presented in Figure 5.

Figure 5. BAU and PND scenario assumptions

Transport (public, private, freight)

Indicators	2015 - 2020 BAU and NDP	BAU 2050	NDP 2050
Motorized passengers using public transport	39%	37%	50%
Motorized passengers using private transport	61%	63%	40%
Demand reduction due to non-motorized transport and digitalization	0%	0%	10%
Electrification of buses and minibuses	0%	0%	85%
Electrification of taxis, private and institutional transport	0%	5%	100%
Penetration of hydrogen buses and minibuses	0%	0%	10%
Demand absorbed by Limon's electric freight train and logistics	0%	0%	10%
Electrification of freight transport	0%	0%	10%
Penetration of hydrogen-fueled cargo transport	0%	0%	10%
Electricity			
Electricity from renewable resources	98.5%	100%	100%
Buildings			
Reduction in energy use per household	0%	0%	2.9%
Households electrified	62%	62%	80%

Industry

Indicators	2015 - 2020 BAU and NDP	BAU 2050	NDP 2050
Process decarbonization	0%	30%	65%
Energy demand electrified	17%	17%	60%
Waste			
Waste composted	2.2%	5%	55%
Recycled waste	3.7%	12.5%	55%
Sewage treated	3%	13.7%	75%
Agriculture, Livestock and Forestry			
Energy demand electrified	32%	32%	50%
Reduction in carbon intensity of crop production	0%	0%	30%
Enteric fermentation and manure reduction	0%	0%	60%
Deforestation reduction	0%	0%	100%
Increased sequestration per hectare	0%	0%	10%

Source: United Nations Environment Programme

The short-term horizon was essential to provide information to Costa Rica's policy makers and provide them with elements to design a green and inclusive recovery package, based on job creation, economic growth and fiscal stability; On the other hand, information was also offered in a medium and long-term horizon to show the contribution that low-emission investments, framed in the NDP, provide to sustainable and inclusive development towards 2030 and beyond.

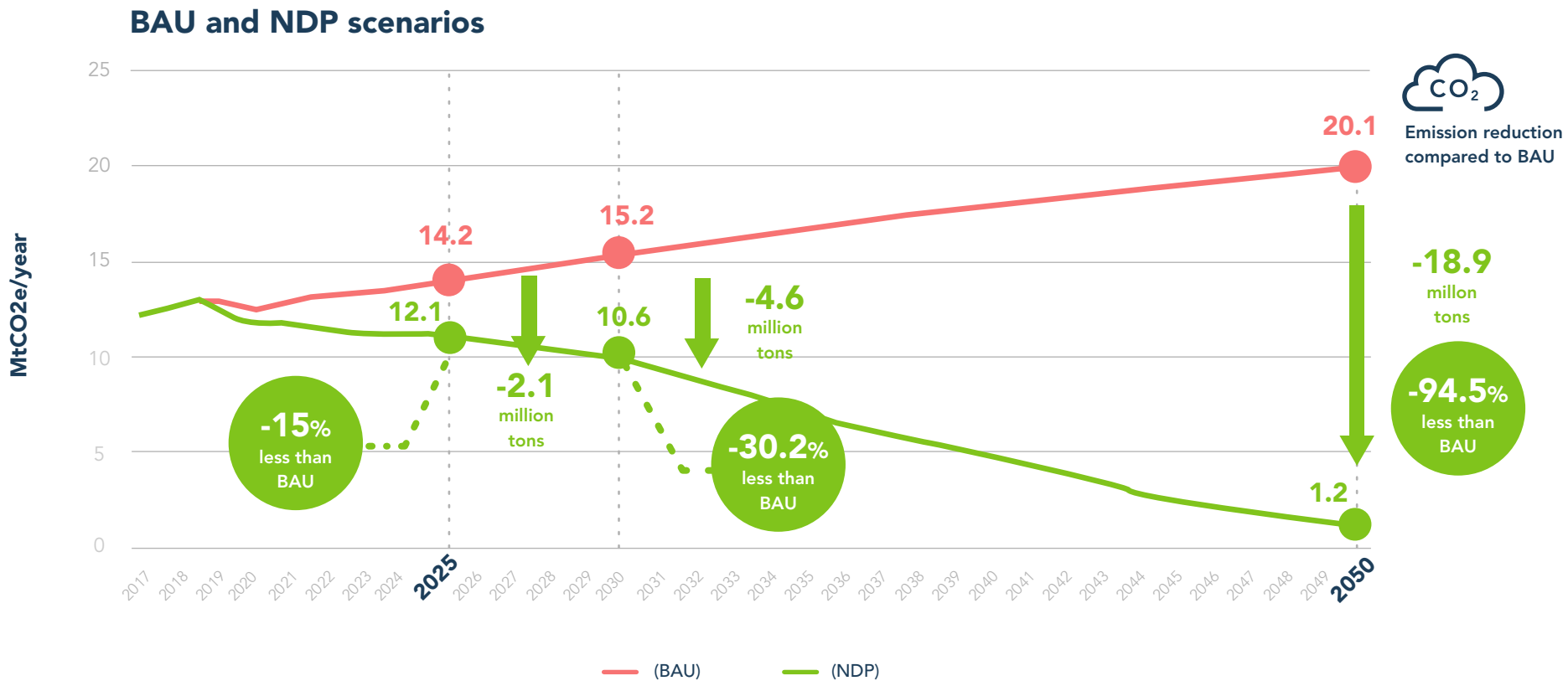
Results

The GEM-CR estimates the macroeconomic impacts, in terms of job creation, GDP growth and fiscal balance, of the decarbonization pathway established in the NDP for 2025. For the PND scenario, the sectoral decarbonization measures that would absorb the bulk of total investments are: 1) transport sector with 62.2% of the additional accumulated investment (expansion of public transport, electrification of the vehicle fleet); 2) waste management with 12.7% (improved collection, sorting, recycling and reuse, but also improved wastewater management); and energy efficiency improvements for buildings and industrial sector with 6.8%.

In the BAU scenario, countries' total GHG emissions are projected to increase by around 13 MT in 2020 to 14.24 MT and 15.16 MT by 2025 and 2030 respectively, relative to 12.1 MT and 10.58 MT in the NDP scenario over the same period (Figure 6). This indicates that decarbonization measures contribute to reducing Costa Rica's GHG emissions by 15% and 30.2% relative to the baseline for 2025 and 2030, respectively. Cumulatively, the GEM-CR forecasts indicate that low-emission investments contribute to avoiding 24.73 MT of emissions by 2030 and 276.1 MT by 2050, following a trajectory opposite to that of the BAU scenario. The reductions for 2030 and 2050 equate to average annual reductions of 2.47 MT per year and 9.2 MT per year, respectively.

Photo: Unsplash

Figure 6. Annual CO2 emissions (million tonnes of CO2e/year), 2017 – 2050



Source: United Nations Environment Programme based on GEM scenarios

The GEM-CR findings highlight that short-term decarbonization investments implemented across sectors contribute to significant reductions in GHG emissions in the long term. However, a more ambitious effort is required to reach the net-zero emissions trajectory by 2050.

The integrated Cost-Benefit Analysis (CBA) for these scenarios (CBA) provides an overview of (i) the investments required to decarbonize Costa Rica's economy and; (ii) the avoided costs and additional benefits resulting from the policy interventions implemented for the decarbonization of the national economy framed in the NDP.

Avoided costs considered in the CBA include changes in energy costs, transportation-related costs (operating costs, maintenance, and related externalities such as health costs related to air pollution improvements and costs related to traffic congestion and automobile accidents), waste management costs, and social carbon cost (climate costs). While the category of additional benefits includes aggregate real GDP, additional labor income, benefits from waste and wastewater treatment, and improved provision of ecosystem services.

The avoided costs and added benefits together far outweigh the investment required for decarbonization measures already in the short term (2020-2025) This highlights that the NDP is an economically viable and forward-looking investment, as it also creates synergies for social and environmental indicators. Cumulatively, between 2020 and 2050, NDP investments generate on average 3.93 USD2015 per USD invested. This is evident when using an integrated model such as GEM-CR. When considering both avoided costs and additional benefits, the required investment is returned almost 4 times by 2050, as stated above, with investments of USD2015 35.5 billion, avoided costs of USD2015 56.4 billion and additional benefits of USD2015 83.28 billion, resulting in discounted net profits of USD2015 104.17 billion by 2050.

Specifically, Figure 7 illustrates the avoided costs and additional benefits per USD invested in decarbonization measures. The results suggest that the planned interventions generate higher avoided costs than the required investment, starting in 2020 with 1.21 USD per USD invested; the additional benefits per USD invested in decarbonization increase from 0.57 USD per USD invested in 2020 to 0.95 USD per USD invested in 2025, growing and accumulating over time. This means that the avoided costs are just as important, if not more so, than the added benefits generated by investing in low emissions, especially in the short term and for a strong post-COVID-19 recovery that ensures fiscal balance. In the case of Costa Rica, it is highlighted that interventions related to the transport and waste sectors generate a high short-term recovery per USD invested, with 0.58 and 0.28 USD per USD invested. The benefits of ecosystem services are also significant, with a ratio of USD 0.46 per USD invested. Finally, GDP in the services sector benefits more than others from low-carbon investments in the short term, with 0.017 USD per USD invested in 2020, rising to USD 1.62 per USD invested in 2050. All of these values are destined to grow over time as investments are developed and projects are implemented, such as energy savings. In addition, tax revenues increase by 0.7% in 2025 relative to the BAU case, indicating an emerging potential for the public sector to support short-term investments in decarbonization due to improved economic performance.

For every USD Costa Rica invests in its NDP it can generate returns as high as USD 2.24 in 2025 and USD 5.93 by 2050, most often reaching an immediate payback by 2021, or within a year of implementation.

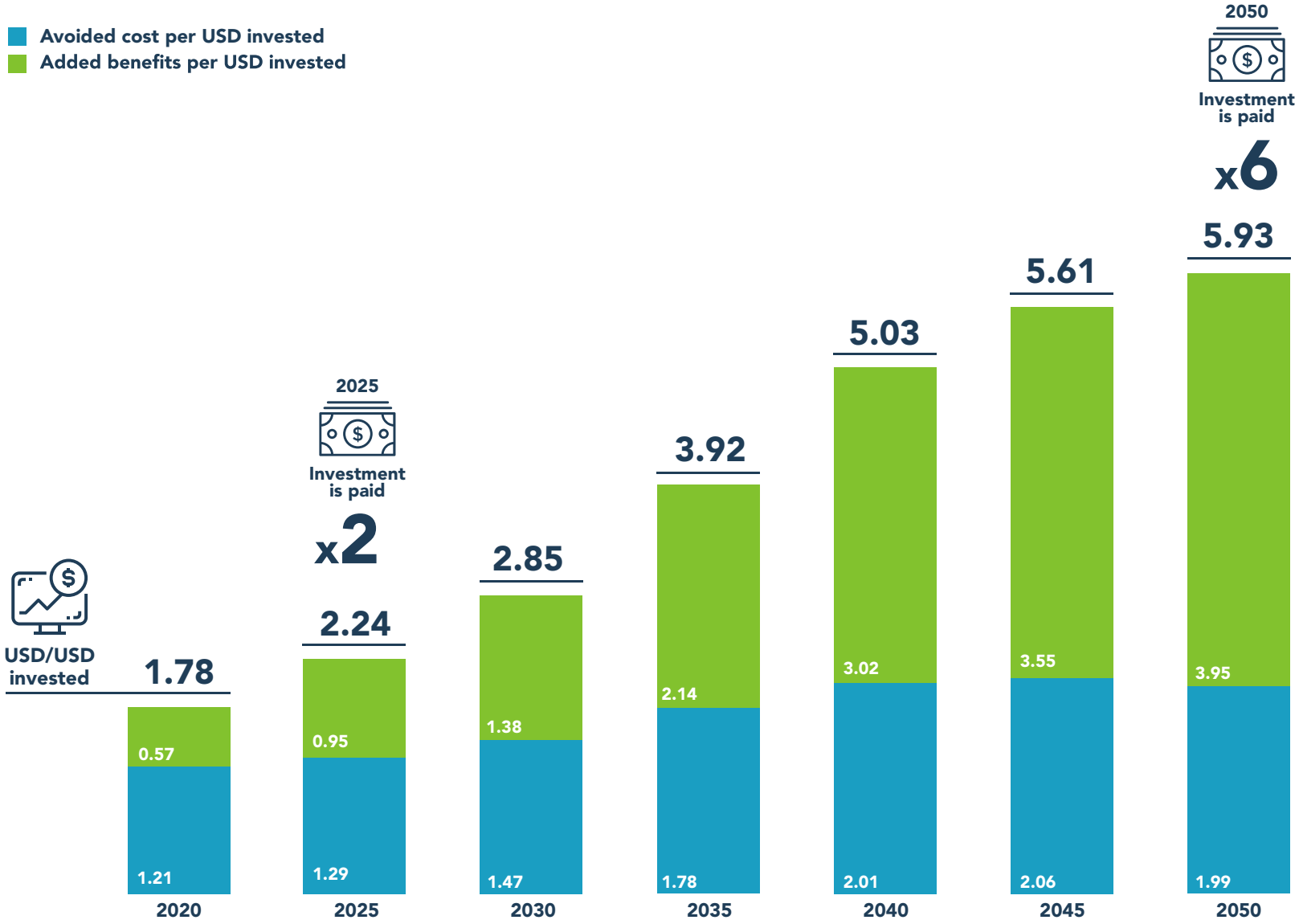
The interventions implemented in the NDP scenario show near-term productivity impacts, demonstrating that investment in decarbonization can become a critical enabler of Costa Rica's recovery efforts in the coming years. In 2025, total real GDP is projected to be 0.7% higher (+USD 0.48 billion) relative to the BAU scenario. By 2025, productivity gains induced by lower energy spending and GHG emission reductions are projected to generate USD 1.41 billion in cumulative additional real GDP (equivalent to USD 2015 0.93 billion), equivalent to an average additional real GDP of USD 78.4 million per year (equivalent to USD 2015 51.6 billion per year). Low-emission investments contribute to additional GDP growth of 0.12% on average between 2020 and 2025, relative to the BAU scenario. Average real GDP growth in the NDP scenario is projected at 2.35%, relative to 2.23% in the BAU scenario.

In addition, the decarbonization interventions foreseen in the NDP scenario are expected to generate additional employment relative to the BAU scenario in 2025 and 2050. These results suggest that total employment in 2025 and 2050 will be 0.4% higher and 6% higher, respectively, both compared to the baseline scenario (BAU); therefore, a constant investment in decarbonization will yield additional benefits in the long term.

Photo: Unsplash

Decarbonization measures in the NDP scenario will create 7,964 net additional jobs in 2025 related to current trends. This figure will be multiplied by a factor of twenty-one by 2050, reaching 172,478 net additional jobs, compared to the BAU scenario

Figure 7. Incremental avoided costs and additional benefits for every USD 1 invested in decarbonization 2020-2050. PND scenario compared to BAU



Source: United Nations Environment Programme

Grenada

Area	344 Km2
Total Population	112,003 (Census2019)
Demographic Density	326 hab/km2
Population Distribution	Rural (63%), Urban (37%) (United Nations 2020)
GDP per capita at current prices	USD 9,010 (World Bank 2021)
HDI	0.795 (United Nations 2022)
GINI	ND
Environmental Performance Index (EPI)	47.9 (2022)
Ranking EPI	58º of 180 countries (2022)

Photo: Unsplash

Background

The transition from oil-based energy sources to renewable energy is a path that several countries have committed to for a more sustainable future. Grenada started the path of decarbonization with the first Nationally Determined Contribution (NDC) in 2016, which was further developed in 2020 into a second NDC. Grenada's latest NDC indicated a target of reducing GHG emissions by 40% at 2010 emission levels by 2030 (216.9 GgCO2e). To achieve the reductions, the NDC establishes a focus on four sectors: energy (including domestic transport), forestry, waste and industrial sources.

Currently, Grenada's main sources of energy are oil, electricity, biofuels and waste. The energy basket in 2020 was composed primarily of diesel and gasoline with 98% of the share and photovoltaic solar energy (distributed and utilities) with 2% of the share. A major concern among Grenada's ministerial authorities is the dismantling of half of the fossil power generation capacity in the coming years, due to the end of its useful life. These upcoming events generate an imminent need to invest in new capacities in the short term with an eye on the future sustainability challenges that the country could face.

The assessment for the country considered the impact of low-carbon investments in the energy demand and supply sectors on social, economic and environmental indicators. Interventions in the energy sector include energy efficiency improvements, electrification of transport, fuel switching and renewable power generation. This work is carried out under the leadership of UNEP through technical accompaniment with modeling tools such as the Green Economy Model (GEM) in connection with other teams working on decarbonization studies for Grenada, such as the OSeMOSYS (Open Source Energy Modelling System) team.

To achieve this goal, a quantitative modelling exercise with a systemic approach was developed to determine whether low-carbon development policies in the energy sector (demand and supply) will stimulate the economy, create employment opportunities, deliver short-term returns per dollar spent, leverage private investment, lead to long-term cost savings, will improve human health, all while reducing greenhouse gas (GHG) emissions.

The Green Economy Model (GEM), adapted to Grenada, was used to estimate the cost of various scenarios with varying degrees of ambition for low-carbon development, as well as the resulting avoided costs and additional benefits. The scenarios modeled in GEM are aligned with the scenarios analyzed in the OSeMOSYS model, as well as with historical data on energy demand and supply. Both models aim to inform the fulfillment of NDC commitments for the medium term (2030), and GEM extends the horizon to 2050 to analyze the trajectory of long-term objectives.

The development of scenarios followed a participatory process with the UNEP team and the validation of assumptions with the OSeMOSYS team. To maintain consistency with the OSeMOSYS analysis, the scenario assumptions for GEM, specifically for power generation shares by technology, are aligned up to 2030 with the assumptions extended up to 2050 towards a zero-carbon scenario in the energy sector. All three scenarios have the following characteristics:

A **Low ambition scenario or Business As Usual (BAU) scenario:** This scenario shows the performance of the energy sector by following historical dynamics and trends, keeping decarbonization ambitions at a low level. Overall, this scenario shows a future dependent on fossil fuels for the energy sector in Grenada.

The scenario does not imply additional improvements in energy efficiency, remaining at an increase of 1% per year throughout the time horizon. Power generation is based on two main sources in the BAU scenario: diesel with 98% of the share and distributed solar (rooftops) with 2% of the share in the energy mix. In terms of fuel switching, the BAU scenario assumes an increase in electrification across all sectors to 30% in 2050 with a linear increase from 2022.

B **Medium ambition scenario:** This scenario assumes a medium level of ambition for decarbonization interventions compared to the BAU scenario and NDC targets. As in OSeMOSYS, this scenario aims to reduce impacts on the environment by replacing diesel-based power generation with natural gas and introducing wind power generation into the energy mix. The scenario assumes an additional annual rate of energy efficiency of 2% in the medium term, which decreases towards 1% in the long term due to uncertainty about technological advances. As considered for total energy demand, this scenario assumes efficiency improvements for electrified energy that is highest (2%) when the electrification process begins and decreases (1%) when electrification is at the maximum possible ratio. Finally, the medium ambition scenario foresees an increase in fuel switching between sectors of 20% by 2030, rising to 70% by 2050.

C **High-ambition scenario:** This is the most ambitious low-carbon scenario, assuming 100% renewable energy for power generation through solar and wind technologies and 100% electrification across all sectors by 2050, which will generate a carbon-free energy sector in the long term. The high-ambition scenario sees an additional energy efficiency of 4% per year in the medium term and 3% per year in the long term, and energy efficiency for electrification ranging from 4% to 1% as electrification is implemented.

1 The first assumption refers to the additional annual improvement of energy efficiency.

Low ambition scenario (BAU)				Medium ambition scenario (BAU)				High ambition scenario (BAU)			
2022	2030	2040	2050	2022	2030	2040	2050	2022	2030	2040	2050
0%	0%	0%	0%	0%	2.0%	1.5%	1.0%	4.0%	4.0%	3.5%	3.0%

Photo: Unsplash

2 Proportion of electrification and energy efficiency

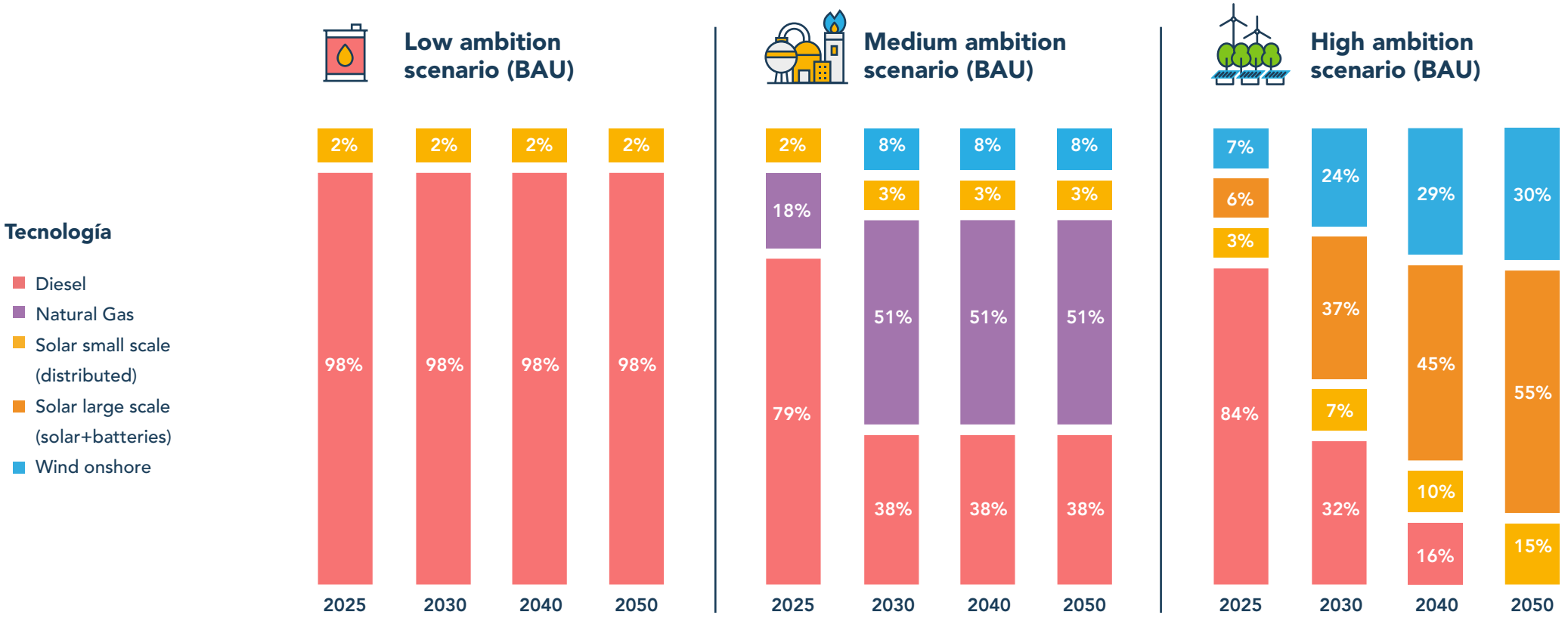
	Medium ambition scenario (BAU)		High ambition scenario (BAU)	
Electrification percentage	0%	100%	0%	100%
Energy efficiency	2.0%	1.0%	4.0%	1.5%

3 Sectoral energy transition

Sectors
industry, transport, residential, commercial, agriculture, fishing and mines

Low ambition scenario (BAU)				Medium ambition scenario (BAU)				High ambition scenario (BAU)			
2025	2030	2040	2050	2025	2030	2040	2050	2025	2030	2040	2050
0%	10%	20%	30%	5%	20%	40%	70%	20%	40%	70%	100%

4 Proportion of energy generation by source.



Results

This section presents the short-, medium- and long-term results of decarbonization interventions in Grenada, represented in the medium and high ambition scenarios. Investments are divided into power generation (capital costs, operation and maintenance costs, transmission line costs and battery costs), energy efficiency and electric vehicles (cars and buses). These investments in emission reductions are expected to generate avoided costs and additional benefits. The country's total energy costs, conventional capacity costs, social carbon cost, and transport-related indicators (cost of air pollution and cost of conventional vehicles) are considered among the avoided cost categories. In addition, additional benefits, such as additional GDP and labor income from various sectors, arise from the implementation of low-carbon scenarios.

Integrated CBAs indicate the cumulative amount needed for the implementation of interventions over time. The results illustrate that while the avoided costs and additional benefits are insufficient to cover the investment required by 2025 (because the investments implemented have a much longer lifespan than 5 years), low-carbon interventions generate net benefits for the entire economy if the respective ambitions continue until 2050.

In the medium term, in the medium ambition scenario, for every USD Grenada invests in decarbonizing its energy sector, USD $0.82 of economic benefits are achieved by 2025. Returns per USD invested increase to USD 1.07 (by 2030) and long-term economic benefits reach USD 2.6 (by 2050). Overall, for every million dollars invested in decarbonization interventions under the medium ambition scenario, 3.98 jobs are created on average between 2022 and 2050.

For the high-ambition scenario, for every USD invested by the country, USD $0.56 of economic benefits are achieved by 2025. In the medium term, the benefits per USD invested increase to USD $ 0.65 (by 2030) and in the long term the economic benefits reach USD $ 2.91 (by 2050). For every million dollars invested in decarbonization interventions under the medium ambition scenario, 11.37 jobs are created on average between 2022 and 2050. The results of the cost-benefit analysis are summarized in Figure 8

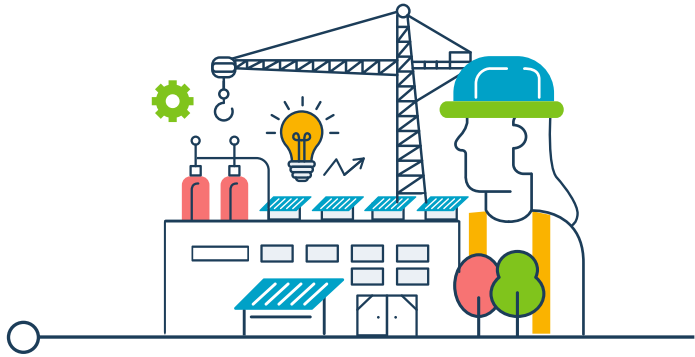
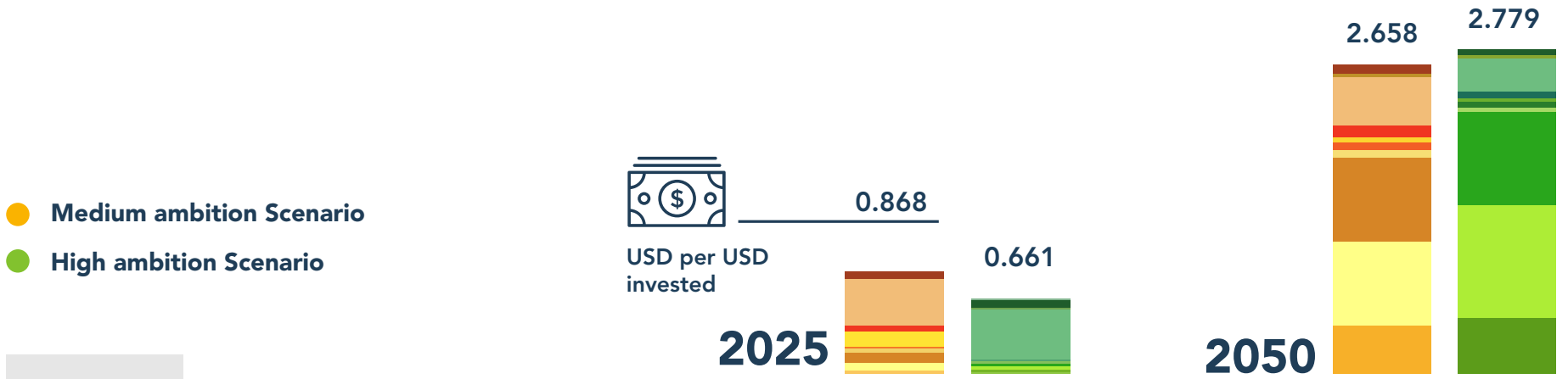


Figure 8. Cost-benefit analysis under High and Low emission scenarios 2022-2050 Grenada



		2025		2050	
Added benefits	PIB Real	0.049	0.014	0.418	0.480
	Labor income	0.074	0.057	0.733	0.978
Avoided costs	Energy cost	0.116	0.033	0.696	0.789
	Air pollution	0.029	0.011	0.065	0.040
	Social cost of carbon (SCC)	0.017	0.006	0.065	0.049
	Investment fossil fuel power capacity	0.100	-0.012	0.043	0.023
	O&M fossil fuel power generation	0.047	0.004	0.100	0.053
	Investment conventional vehicles	0.368	0.463	0.428	0.290
	O&M conventional vehicles	0.005	0.007	0.024	0.018
	Investment conventional buses	0.059	0.074	0.069	0.047
	O&M conventional buses	0.004	0.005	0.017	0.013

Source: United Nations Environment Programme

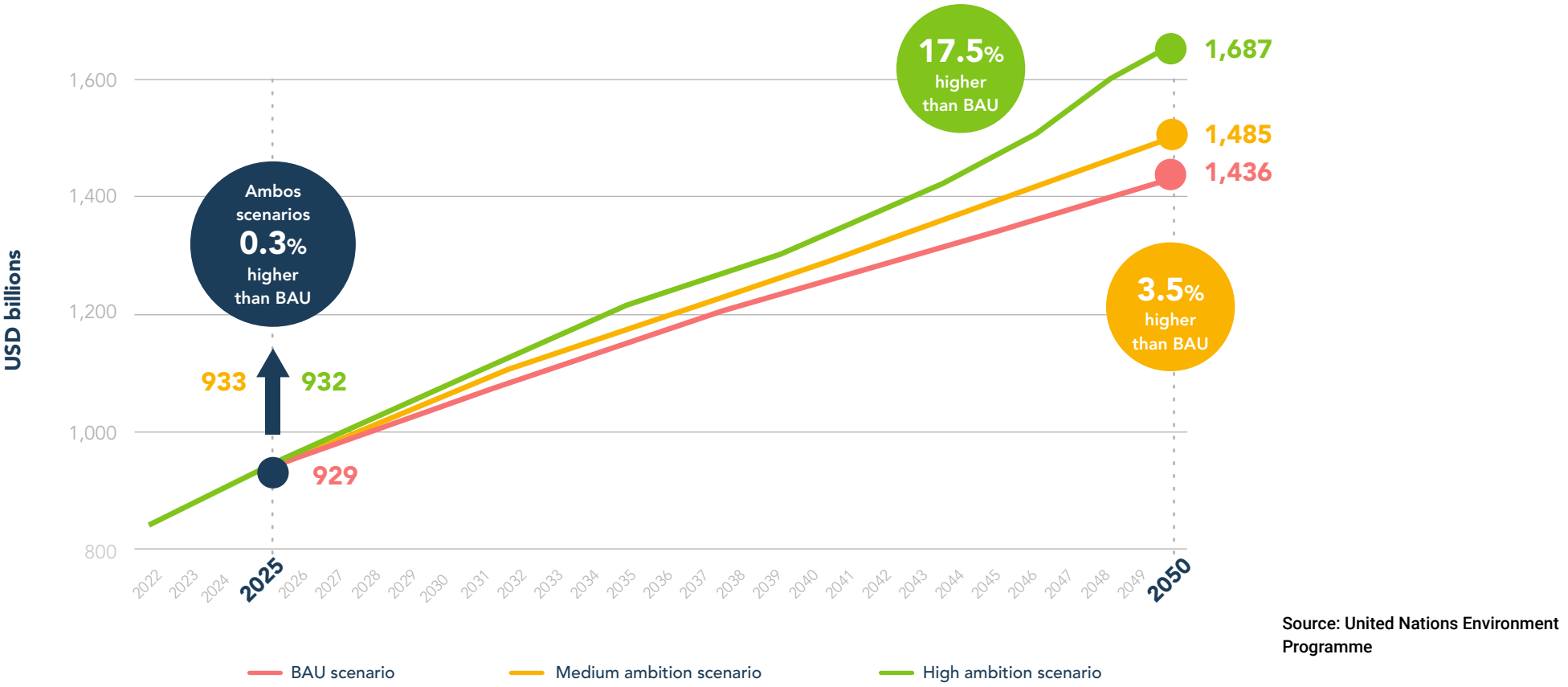
The evolution of real GDP in the BAU, medium ambition and high ambition scenarios is presented in Figure 9. The low-carbon interventions implemented in the medium and high ambition scenarios make Grenada's overall economic performance improve compared to the BAU scenario.

For 2050, projections indicate that total real GDP is 3.5% higher in the medium ambition scenario and 17.4% higher in the high ambition scenario compared to the baseline.

The medium ambition scenario generates on average an additional real GDP per year of USD 10.05 million between 2022 and 2050, compared to the BAU scenario. The high ambition scenario presents higher growth with an average of USD 30.54 million between the mentioned years, compared to the BAU scenario.

Compared to the current year, 2022, the real GDP of the medium ambition scenario will grow by 77.23% in 2050 (from USD 840 million to USD 1.48 billion) and the real GDP of the high ambition scenario will grow by 101.08% by 2050 (from USD 836.25 million to USD 1.68 billion).

Figure 9. Total real GDP (USD million, base year 2000), 2022-2050 BAU and decarbonization scenarios.



Source: United Nations Environment Programme

It can be observed that, in the long term (2022-2050), the high ambition scenario presents the highest growth rate with 2.53% per year and the medium ambition scenario follows with 2.10%, while the GDP growth rate of the BAU scenario is 1.99% per year. It can be observed that, in the short and medium term, the average real GDP growth rate is higher than in the long term, as a result of the economic recovery process after COVID-19 and the short-term impacts of low-carbon development investments on the economy.

Economic growth resulting from interventions in medium and high ambition scenarios improves public finances, for example through additional tax revenues (i.e. as GDP increases, tax revenues increase, even when the same tax rate on personal and corporate profits, or value added tax, is maintained). By 2050, the model projects a 3.5% and 17.4% increase in government revenues from the medium ambition and high ambition scenario, respectively, compared to the BAU scenario. This equates to the cumulative additional government revenues between USD 25.69 million (medium ambition scenario) and USD 129.38 million (high ambition scenario).

The results of three scenarios, characterized by low (BAU scenario), medium (emphasis on natural gas for power generation and electrification) and high ambition (focus on renewable energy, energy efficiency and full electrification) for decarbonization, show that the higher the ambition, the stronger the social, economic and environmental outcomes.

Similarly, the use of renewable energies translates into lower electricity prices, which are also stable over time. As a result, the energy bill is 14.47% lower in 2050 in the medium ambition scenario relative to BAU and 66.2% lower in the high ambition scenario.

Economic performance is stimulated by lower energy prices. For 2050, projections indicate that total real GDP is 3.5% higher in the medium ambition scenario and 17.4% higher in the high ambition scenario compared to the baseline. In both the short and long term, the high-ambition scenario features the highest annual growth rate, stimulated by lower energy costs and higher job creation. Low-carbon development creates synergies between sectors and outcomes. At the same time, we see higher GDP, reduced emissions and strong job creation potential. The high ambition case shows better overall performance than the medium case, with renewable energy being more labor-intensive, offering lower power generation costs (LCOE) and greater potential for the creation of local value chains.

Honduras

Area	112,492 Km2
Total Population	110,590,864 (Census 2019)
Demographic Density	94.15 hab/km2
Population Distribution	Rural (41%), Urban (59%) (United Nations 2020)
GDP per capita at current prices	USD 2,771 (World Bank 2021)
HDI	0.621 (United Nations 2022)
GINI	48.2 (World Bank 2019)
Environmental Performance Index (EPI)	36.5 (2022)
Ranking EPI	121º of 180 countries (2022)

Photo: Flickr

Background

Honduras is one of the poorest and most unequal countries in the Latin American and Caribbean (LAC) region. World Bank estimates for the last year indicate that before the dual impact of the COVID-19 pandemic and hurricanes Eta and Iota (2019), almost half of the Honduran population (49.5 percent) lived on less than USD 6.85 a day (PPP 2017) in 2019 (Banco Mundial 2023). This implies that almost half of the population (4.4 million people) was considered in moderate poverty in 2019, and that more than a quarter (25.2 percent) lived in extreme poverty. (Banco Mundial 2023). The COVID-19 pandemic and hurricanes Eta and Iota resulted in significant income and welfare losses, and moderate national poverty increased to an estimated 55 percent in 2020 (OIT 2020). These numbers represent the second highest poverty rate in LAC after Haiti.

Anti-poverty policies have had little impact on poverty reduction since 2014. Extreme poverty increased in rural areas since 2014 and in urban areas since 2017. Rural inequality also increased sharply during the period, from a Gini index of 0.431 in 2014 to 0.486 in 2019. Overall, Honduras in 2019 was the fourth country with the highest level of income inequality (Gini index of 0.482) in the region (Banco Mundial 2022).

International estimates hinted at the high level of vulnerability that Honduras has in terms of jobs. Derived from the pandemic, a high percentage of total employment were at high risk (40.2%). That is, around 1,600,000 people employed in the economic sectors most affected by the economic crisis were in danger of losing their jobs. In particular, women were in conditions of high exposure due to their participation in the sectors most at risk from the crisis: households as employers and hotels and restaurants (91.4% and 75.5% respectively) (OIT 2020). People's limited ability to work from home and a strong urban-rural digital divide posed significant challenges during quarantine times in 2020. Likewise, recent evidence highlights the vulnerabilities faced by many Hondurans, especially in access to labor income and food; in fact, job losses and food insecurity in Honduras were among the worst in the region in 2020 (Banco Mundial 2023).

The increasing frequency and magnitude of extreme weather events, as well as the devastating hurricanes of recent years, are just the most noticeable and visible effects of climate change in Honduras. The associated crisis has already generated billions of dollars in infrastructure and productivity losses, disease, poverty and death. This trend threatens productivity, food security and, above all, the health and well-being of the population..

Unlike most regions, LAC emissions come largely from agriculture, land-use change, and forestry. Honduras' National Climate Change Adaptation Plan (SERNA et al 2019) shows that more than 60% of the land used for livestock is located in mountainous areas and 32% of these show strong signs of degradation. From 1990 to 2006 vegetation cover decreased from 66% to 41.5% and the average national deforestation rate is 24,051 hectares per year. The main causes of deforestation are fires, pests, expansion of land for agriculture and livestock, as well as illegal logging.

The Global Climate Risk Index identifies Honduras as the second most vulnerable country in the world, given the presence of extreme weather events, only surpassed by Puerto Rico (Germanwatch 2019). It is important to highlight that the territory of Honduras is exposed to hydrometeorological events with a low adaptive capacity and to conditions of high vulnerability of the population, derived from the high percentage of people who are under the poverty line, conditions of inequality, little urban planning, among other factors. All this contributes to the fact that, in recent years, the Global Climate Risk Index places Honduras as one of the countries most affected worldwide by the adverse effects of the climate crisis.

The project supported Honduras within the short-term post-COVID-19 recovery framework with the Nationally Determined Contribution (NDC) and the Honduras Decarbonization and Climate Resilience Strategy (ENDRCH), currently under construction in the country. Both instruments are essential to underpin the transformation towards a new green and inclusive economic model. Post-COVID-19 recovery measures, based on NDCs, represent a crucial opportunity to ensure the country meets its own development goals, as well as the Paris Agreement on Climate Change.

The report developed within the framework of the project was entitled "Evaluation of Possible Decarbonization Routes of Honduras Using the Green Economy Model" and was developed under the leadership of the Secretariat of Natural Resources and Environment of Honduras (SERNA). The outcome of the report is a quantitative assessment to comprehensively inform the integration of decarbonization pathways into post-COVID-19 economic recovery measures. This holistic approach, with potential decarbonization pathways at the core, linked economic development, employment, meeting climate goals and social well-being. In this sense, the scenarios were proposed, Business as Usual (BAU),

Photo: Unsplash

Early Action (Early Action 2045), Early Action (Early Action 2050), Late Action (Late Action 2045) and Late Action (Late Action 2050).

The systemic assessment presented in the evaluation highlights the socio-economic and environmental outcomes of sectoral policy measures and decarbonization investments framed in the short term (2020-2025), medium term (2020-2030) and long term (2020-2050). Potential decarbonization pathways set out a wide range of possible decarbonization interventions in various strategic sectors to reach a net-zero economy by 2050. The Green Economy Modeling for Honduras (GEM) has been built on the foundations of the advances of the Honduras Decarbonization and Climate Resilience Strategy (ENDRCH), which is currently under construction.

The GEM-Honduras (GEM) was customized to conduct an evidence-based analysis demonstrating the impacts of implementing mitigation and adaptation actions on the economic, social and environmental dimensions. The GEM analyzes the impact on: i) the generation of direct, indirect and induced employment; (ii) economic growth - Gross Domestic Product (GDP); (iii) public finances; and (iv) greenhouse gas (GHG) emissions.

In order to align the packages of the modeled preliminary sectoral decarbonization measures provided by SERNA, a qualitative analysis of the GEM model policies was carried out with the preliminary decarbonization results. The analysis considered the 17 policies modeled in GEM and the 15 axes provided by SERNA. The comparison was made with a qualitative approach in line with the information shared by the consultants who assisted SERNA in the preliminary decarbonization exercise on policy assumptions/ambitions. Based on the comparison made, the GEM has corresponding policies for 12 of the 15 axes proposed by SERNA, covering 80% of the policies.

Photo: Unsplash

Actions Considered

For the assessments, basic political scenarios were defined and then simulated using different assumptions about climate variables and extreme events. Five scenarios were simulated for Honduras' assessments, one baseline scenario and four net-zero scenarios that consider climate crisis interventions for both mitigation and adaptation.

The baseline scenario (BAU) represents the baseline scenario, with no additional ambition for low-carbon development and climate adaptation. In the BAU, historical trends are assumed to continue, as no additional policies aimed at sustainable development are being implemented. The BAU scenario presented in the description of the results includes the impacts of both COVID-19 and the hurricane that occurs in 2020.

For the Net Zero scenarios, a number of policies targeting agricultural productivity, emissions from livestock production, energy demand, land degradation and hurricane resilience were implemented. The main differences between the scenarios derive from the target year to reach net zero emissions at the country level and the possibility of starting with the decarbonization strategy immediately (early action) or gradually (late action). These scenarios are consistent with the decarbonization routes considered by the national authorities as indicated in the following description:

1 **Net Zero Early Action Scenario, Target 2045 (EA 2045):**
This scenario assumes the implementation of mitigation and adaptation policies with the 2030 goals established with the government (DNCC, SERNA, SEN, ICF and SAG), with an extension of the goal until 2045 to achieve zero emissions in that year.

2 **Net zero emissions late action scenario, target 2045 (LA 2045):**
This scenario assumes a post-previous decarbonization path, delaying the 2030 targets by 5 years and setting the ambitions to achieve zero emissions by 2045.

3 **Net zero early action scenario, 2050 target (EA 2050):**
This scenario assumes the same objectives as early action (EA 2045) until 2030, and an extension of the ambitions of interventions to achieve zero emissions until 2050.

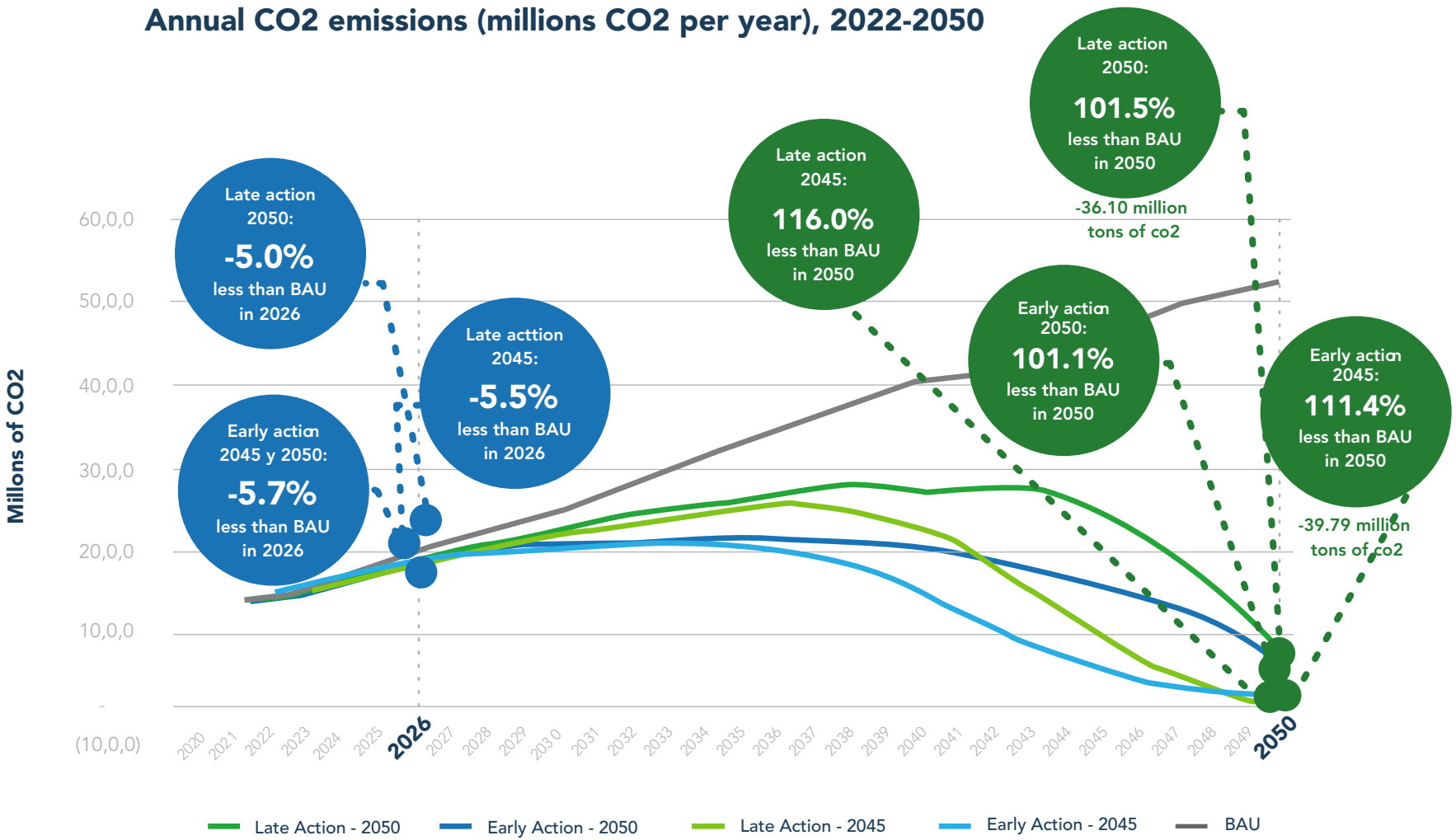
4 **Net zero late action scenario, 2050 target (LA 2050):**
This scenario assumes a later decarbonization path than the previous scenario, delaying the 2030 targets by 5 years and setting ambitions that achieve zero emissions by 2050.

The formulation of simulated scenarios for the Green Economy Model was used to mimic the decarbonization paths that SERNA has designed preliminarily for the development of Honduras' Decarbonization and Climate Resilience Strategy (ENDRCH). The main results of the evaluation are presented below.

Results

In terms of the environmental projections of the different modeled scenarios, it was identified that in the trend scenario (BAU), total CO2e emissions increase from 14.7 Megatons (MT) in 2022 to 54.8 Mt in 2050, indicating that emissions are projected to increase by 58% in the next 28 years. The interventions and ambitions set for the four Net Zero scenarios reach zero emissions in Honduras by 2045 in two of the scenarios and by 2050 in the other two scenarios. The maximum decrease to 2030 is presented by the early and late action scenarios-2045, with a decrease of 19.1% compared to the BAU scenario. The minimum decrease is 14.7%, presented by the late-2050 action scenario. These evaluated scenarios are reflected in Figure 10.

Figure 10. Annual CO2 emissions (million ton CO2e/year). Scenarios for decarbonisation routes from 2020 to 2050.



Source: United Nations Environment Programme

The interventions implemented in the decarbonization routes show impacts on productivity in the short term, demonstrating that investment in the SERNA decarbonization scenarios can become a critical facilitator of Honduras' recovery efforts in the coming years. Total real GDP in the BAU scenario is projected to increase from around USD 9.07 billion in 2022 to USD 23.4 billion in 2050. The early action scenario 2045 presents the same growth, and the late action scenarios present a growth of 10.0% (LA 2025) and 8.7% (LA 2050). Overall, this indicates that increased investments in low-carbon development contribute to higher economic growth.

GDP grows the most in all Net Zero scenarios for two main reasons:

1. **Improving climate resilience:** The impact of climate change, both annual and extreme weather events, is less pronounced in the GE and DD scenarios. This makes land and economic productivity greater. This is visible both annually and by 2038, when a second major hurricane is simulated. The long-term economic damage is less, and the short- and medium-term economy grows more.

2. **Cost reduction and productivity improvement:** The simulated investments in the GE and DD scenarios aim to reduce the running cost of the economy. This is the case of energy efficiency, which reduces energy use and energy costs, or sustainable agriculture, which increases productivity and production in the field. As a result of these interventions, which also stimulate investment, the economy grows more.

Additional green jobs are also the result of decarbonization interventions in Net Zero scenarios. The number of green jobs depends on the ambitions of the interventions and whether their implementation is early or late. In general, early and late action scenarios with a 2050 target present a higher number of cumulative jobs.

In the Early Action 2050 scenario, GDP grows by 14.8% compared to BAU, with USD 26.95 billion by 2050.

For both Early Action scenarios, total employment by 2050 is projected to be 3.1% higher compared to baseline. For the other two scenarios, the increase is smaller, being 2.1% for LA 2045 and 1.8% for LA 2050. The increase for the EA 2050 scenario is equivalent to 178,840 additional jobs, and in the EA 2045 it is 179,194 additional jobs for 2050 respectively to the BAU.

The integrated Cost-Benefit Analysis (CBA) provides an overview of (i) the investments required to decarbonize Honduras' economy and; (ii) the avoided costs and additional benefits resulting from policy interventions implemented for the decarbonization of the national economy.

The category of avoided costs includes changes in energy costs, transportation-related costs (O&M costs and transportation-related externalities such as health costs related to improvements in air pollution and costs related to traffic congestion and car accidents), waste management costs, and social cost of carbon (climate costs). While the category of additional benefits includes aggregate real GDP, additional labor income, benefits from waste and wastewater treatment, and improved provision of ecosystem services.

The results indicate that, in the medium term (2030), the best performing scenario based on cost-benefit is Late Action 2045, with a benefit of $2.90 for every USD 1 invested, followed by the Early Action 2045 scenario with $2.63. In the long term (2050), it can be observed that the highest scenario is the Late Action 2045 scenario with 11.89 USD, followed by the Early Action 2045 scenario with 11.57, then the Early Action 2050 scenario with 11.51 and finally the Late Action 2050 scenario with 9.04. Figure 11 illustrates the avoided costs and additional benefits per USD invested in decarbonization measures. The results suggest that the planned interventions generate higher avoided costs than the required investment, starting in 2026 with up to USD 1.58 per USD invested. The late action scenario 2050 shows economic losses in the short term (-0.25 USD) and the lowest profits per USD invested in the period 2050 with 9.04 USD profit per USD invested. Also, in Figure 11, the costs avoided are as important, if not more so, than the added benefits generated by investing in low emissions, especially in the short term and for a strong post-COVID-19 recovery that ensures fiscal balance.

Figure 11. Avoided incremental costs and additional benefits per USD 1 invested in decarbonization (USD), 2022-2050 scenarios compared to BAU scenario

Early Action Scenario - 2045	2022	2026	2030	2035	2040	2045	2050
Avoided costs per dollar invested	0.73	1.15	1.85	2.82	3.97	5.27	6.69
Added benefits per dollar invested	0.36	0.43	0.78	1.27	2.12	3.29	4.87
Total benefits per dollar invested	1.09	1.58	2.63	4.09	6.08	8.56	11.57
Late Action Scenario - 2045	**2022**	**2026**	**2030**	**2035**	**2040**	**2045**	**2050**
Avoided costs per dollar invested	0.82	1.28	2.17	3.56	4.42	5.62	7.01
Added benefits per dollar invested	-0.04	0.25	0.74	1.56	2.31	3.39	4.87
Total benefits per dollar invested	0.78	1.53	2.90	5.12	6.73	9.01	11.89
Early Action Scenario - 2050	**2022**	**2026**	**2030**	**2035**	**2040**	**2045**	**2050**
Avoided costs per dollar invested	0.73	1.15	1.85	2.81	3.95	5.24	6.66
Added benefits per dollar invested	0.36	0.42	0.77	1.25	2.09	3.27	4.85
Total benefits per dollar invested	1.09	1.57	2.62	4.07	6.04	8.51	11.51
Late Action Scenario - 2050	**2022**	**2026**	**2030**	**2035**	**2040**	**2045**	**2050**
Avoided costs per dollar invested	0.88	1.25	2.09	3.41	4.83	5.14	6.24
Added benefits per dollar invested	-1.13	-0.52	-0.15	0.51	1.39	1.89	2.80
Total benefits per dollar invested	-0.25	0.73	1.95	3.92	6.22	7.04	9.04

Source: United Nations Environment Programme

Panamá

Area	75,517 Km2
Total Population	4,279,000 (2020)
Demographic Density	57 hab/km2
Population Distribution	Rural (31%), Urban (69%) (United Nations 2020)
GDP per capita at current prices	USD 14,617 (World Bank 2021)
HDI	0.805 (United Nations 2022)
GINI	50.9 (World Bank 2019)
Environmental Performance Index (EPI)	50.5 (2022)
Ranking EPI	47º of 180 countries (2022)

Photo: Unsplash

Background

In collaboration with the National Secretariat of Energy of Panama and the Ministry of Environment, a quantitative analysis was carried out to evaluate the impacts of the incorporation of the Energy Transition Agenda (ATE) in the post-COVID-19 economic recovery plan and in the first update of Panama's NDC. The energy sector plays a crucial role in the COVID-19 crisis as it is closely linked to national economic performance. In the same way as in the case of Argentina, the Government of Panama promoted the energy transition as a cornerstone of an inter-ministerial political dialogue for the climate, energy and economic agendas.

The ATE offers ample opportunities to create a local value chain aligned with Panama's strategic industrial objectives. Investing in sectors related to the energy transition through Panama's recovery package requires developing industrial policies and training and education programs aimed at building local supply chains and developing the skills and competencies needed across industries to adapt to this transformation. It is essential to take into account the current competencies and strengths of the existing industrial sector in Panama for the development of coherent labor market policies that accelerate the transformation by matching demand to supply.

Sound gender and inequality responsive policies, technological leaps and large-scale investments are needed to reach net zero emissions. The planned cross-sectoral decarbonization measures implemented in the energy sector are insufficient to reduce fossil fuel use to zero in all sectors. This last part of CO2 emissions (heavy transport, aviation, maritime transport and industrial processes) is the proportion of the economy most difficult and costly to decarbonize. It recommended developing more ambitious policies that are at the heart of transformative changes in Panama's energy system, increasing investment to ensure the entire energy system operates flexibly, and bringing to market other gradual low-carbon technologies, such as next-generation batteries, hydrogen, and fuel from clean, synthetic species.

Actions

The evaluation presented the cost-benefit analysis of achieving the energy transformation envisaged in each scenario. The analysis considers various scenarios and their socio-economic outcomes, estimated using an integrated, science-based modelling approach. The scenarios include the base case (BAU Scenario), which assumes the continuation of existing trends, and two low-carbon development scenarios. The scenarios and actions considered for each of them are described in more detail below.

A **BAU (Business as Usual) scenario** It refers to the base case that reflects a continuation of historical trends. No new policies are introduced in this scenario. In the short term (2020-2024), the COVID-19 economic recovery plan is supposed to be implemented as announced, with no particular emphasis on low-carbon development. Through Panama's economic recovery package, USD 8,000 million are injected into the economy over the next 5 years.

B **Energy Transition Agenda (ATE Scenario)** This scenario reviews ATE targets, the Panamanian government's current energy plans, and other anticipated targets and policies, including the first NDC1 update recently introduced under the Paris Agreement. In the short term (2020-2024), part of the recovery package is focused on low-carbon investments in line with ATE objectives. In particular, 39% of the recovery package ($3.14 billion) is earmarked for public investment in the electrification of passenger transport (metro lines and MiBus buses), improving the energy efficiency of public buildings and the introduction of solar thermal energy, in government buildings and associated public infrastructure. Likewise, this public investment considers that USD 33.5 million of the USD 150 million credit line for micro, small and medium-sized enterprises, announced under the recovery package, are destined to the acquisition of energy efficiency equipment, renewable distributed generation systems, solar thermal systems and two-wheeled electric vehicles with the objective of constituting a specific credit package to promote private investment in the energy transition. The scenario foresees that from 2020 no new power plants based on fossil fuels will be commissioned, except for natural gas plants. Coal-fired power generation is dismantled by 2026. Electricity subsidies are eliminated by 2025. It includes the expansion of Metro lines and passenger transport by train.

C Zero Carbon Scenario

The most ambitious low-carbon scenario. The zero-carbon trend has the goal of reaching net zero in the electricity and passenger transport sectors by 2050. In the short term (2020-2024), part of the stimulus package is earmarked for low-carbon investments, in line with ETA's objectives. Specifically, 71% of the volume of the stimulus package ($5.71 billion) is expected to be earmarked for public investment in the electrification of passenger transport (metro lines and MiBus buses), the improvement of energy efficiency in public buildings and the use of solar thermal energy in government buildings and associated public infrastructure. In addition, this public investment is expected to use USD 67 million of the USD 150 million credit line announced under the stimulus package for micro, small and medium-sized enterprises for the purchase of energy-efficient appliances, distributed renewable energy generation systems, solar thermal energy and electric two-wheelers with the aim of forming a specific loan package to promote private investments in the transition. energetics. This scenario foresees that from 2020 no new fossil-fuel-based power plants will be put into operation. Existing coal and natural gas capacity will be phased out by 2026 and 2030. Similarly, energy subsidies to consumers are expected to expire in 2025. This investment program includes the expansion of the metro network and passenger rail transport.

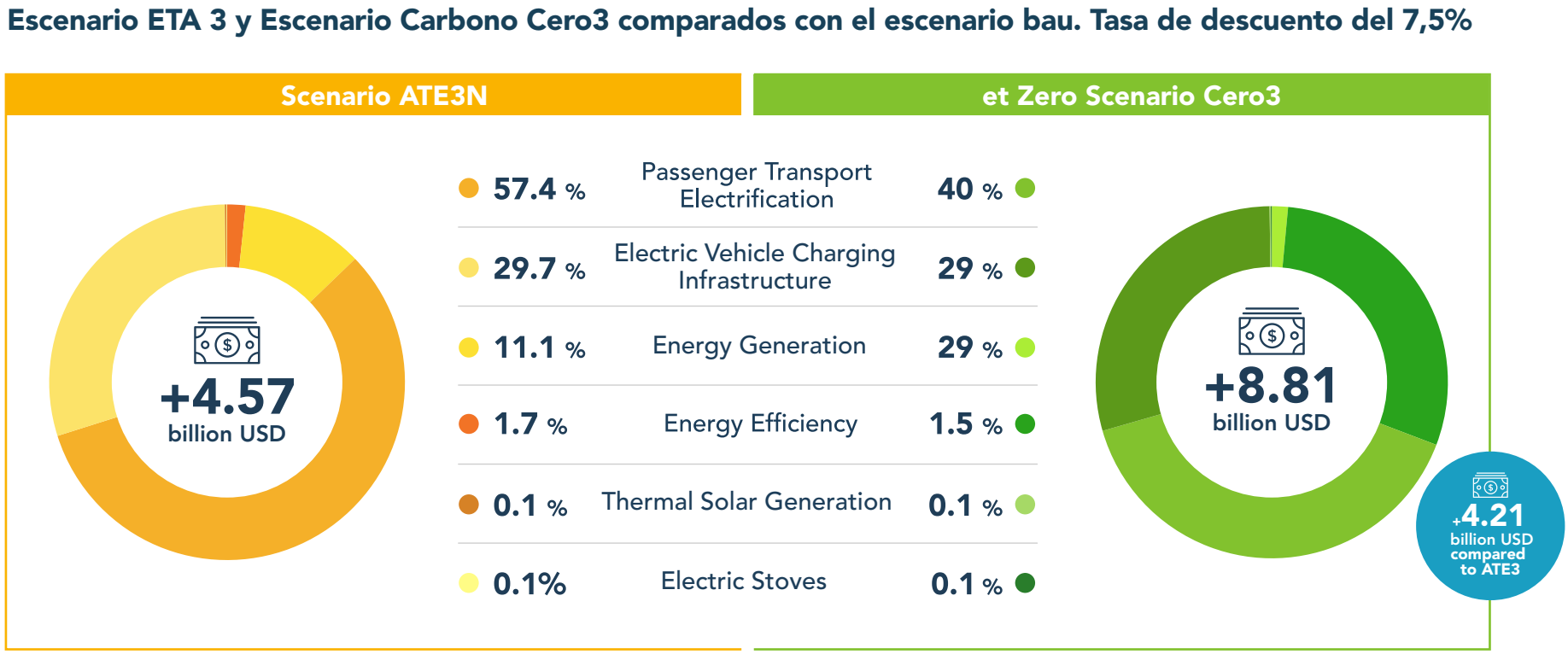
As for the planned targets, the first of them assumes moderate ambitions, consistent with the ATE objectives (ATE scenario). The second discusses higher targets that provide a deeper trajectory for the decarbonization of the energy sector up to 2050 (zero-carbon scenario). Despite differences in the level of ambition, each scenario is based on the main pillars of the energy transition, which are: renewable energy technologies for electricity and heat generation, electric mobility for passenger transport and energy efficiency equipment in buildings. Compliance with the ATE and Zero Carbon scenarios requires a joint effort by all economic actors in the country. The interventions considered in this report are many and varied and include: (i) investments in public infrastructure, which are normally the responsibility of the public sector; (ii) investments in household appliances, equipment and vehicles, which are normally the responsibility of the private sector and households and; (iii) change in citizens' consumption patterns to encourage efficient and responsible use of energy.

As for the planned targets, the first of them assumes moderate ambitions, consistent with the ATE objectives (ATE scenario). The second discusses higher targets that provide a deeper trajectory for the decarbonization of the energy sector up to 2050 (zero-carbon scenario). Despite differences in the level of ambition, each scenario is based on the main pillars of the energy transition, which are: renewable energy technologies for electricity and heat generation, electric mobility for passenger transport and energy efficiency equipment in buildings. Compliance with the ATE and Zero Carbon scenarios requires a joint effort by all economic actors in the country. The interventions considered in this report are many and varied and include: (i) investments in public infrastructure, which are normally the responsibility of the public sector; (ii) investments in household appliances, equipment and vehicles, which are normally the responsibility of the private sector and households and; (iii) change in citizens' consumption patterns to encourage efficient and responsible use of energy.

Investment in the energy transition could become a critical factor in Panama's recovery efforts in the near term. The green recovery plans formulated in the ATE3 and Zero Carbon3 scenarios call for increased and reallocated investment in clean energy technologies that are commercially mature, economically competitive and technically reliable, seek economies of scale and allow access to finance. Recovery plans aligned with the energy transition also contemplate the elimination of fossil fuel subsidies. Additional investment is equivalent to around 2.55% and 4.91% of average annual GDP in the same period. (PNUMA et al 2020).

In 2024, the accumulated additional investment for the sectors considered is 26.19% and 50.84% higher in relation to the BAU for the ATE3 and Zero Carbon scenario3. Of this total, more than 90% is invested in the electrification of passenger transport and in renewable energies for electricity generation. Renewable energies represent 75% and 98% of the total investment in electricity generation in the ATE3 and Zero Carbon scenarios3 (PNUMA et al 2020) (Figura 12).

Figure 12. Investment priorities of the energy transition in renewable energy, energy efficiency and electrification of passenger transport. Discounted cumulative additional investments (billions of dollars) 2020-2024.



Source: United Nations Environment Programme

Early action is needed to direct investments, along with policies to promote appropriate energy technologies to reduce energy-related CO2eq emissions . Renewable energies, the electrification of transport and energy efficiency are the main pillars of Panama's energy transition. The accelerated deployment of these clean technologies must begin now to enable the achievement of Panama's NDC1 targets for 2030 and 2050. Panama's ultimate climate goal is to achieve net-zero emissions by mid-century. The ATE3 Scenario ensures compliance with NDC1 by 2030, while the Zero Carbon Scenario3 puts the country on track to a net-zero emissions path. The ATE3 Scenario meets the energy-related reduction targets defined in Panama's NDC1. Compared to the BAU scenario, energy-related CO2eq emissions would decrease by 14% and 27% by 2030 and 2050. On the other hand, the Zero Carbon Scenario3 contributes more significantly to achieving Panama's climate goals. Compared to the BAU scenario, energy-related CO2eq emissions would decrease by 34% and 58% by 2030 and 2050 respectively (PNUMA et al 2020).

In the ATE3 and Zero Carbon scenarios, emissions from the energy sector are expected to decrease by 10% and 20.8% respectively in 2024 compared to the BAU, corresponding to 1.4 and 2.6 million tons of CO2eq in avoided emissions. This would be equivalent to 3.3 and 6.5 million tons of CO2eq accumulated in 2024. The ATE3 scenario would achieve the 2050 reduction target for energy-related CO2 emissions of NDC1 in 2048, while in the Zero Carbon scenario3 this target would be reached in 2025. In the ATE3 Scenario, the reduction of CO2 emissions associated with oil and electricity represent 20.9% and 79.5% by 2024 respectively (PNUMA et al 2020). The transport and residential sectors are the ones that contribute most to the reduction of oil emissions, constituting 94.3% and 5.6% respectively, the first being linked to the electrification of transport and the second to the replacement of the domestic use of LPG by thermo-solar and electric cookers. In the Zero Carbon Scenario3, in 2024 the reduction of CO2 emissions associated with oil and electricity represent 16.0% and 84.4% respectively. The transport and residential sectors contribute the most to the reduction of oil emissions, with 93.1% and 6.9% respectively (PNUMA et al 2020).

Measures to support investment in the energy transition can significantly boost economic recovery. Both low-carbon scenarios show a consistently positive effect on Panama's real GDP compared to the BAU scenario.

By 2024, energy transition interventions could boost Panama's economy by an additional 0.52% of real GDP in the ATE3 Scenario.

If higher ambitions are considered, as in the Zero Carbon scenario3, real GDP would more than quadruple (2.35%). In the ATE3 Scenario, the cumulative incremental benefit of real GDP growth from 2020 to 2024 would be USD 480 million, generating an average of USD 120 million in incremental real GDP per year over the next 4 years, an additional average annual growth of 0.11% higher than the BAU. On the other hand, the Zero Carbon scenario3 would add an additional USD 2.33 billion to the economy through cumulative real GDP growth by 2024. As shown in Figure 11, low-carbon interventions would generate an average of USD 580 million in additional real GDP per year over the next 4 years, representing an additional compound annual growth rate of 0.50% (PNUMA et al 2020).

Figure 13. Positive effects on Panama's real GDP compared to the BAU scenario, 2020-2024

Indicator	ETA3 Scenario	Zero Carbon3 Scenario
Real GDP growth rate in 2024	+0.52 %	+2.35 %
Cumulative additional real GDP by 2024	USD$ +0.48 billion	USD$ +2.33 billion
Additional annual average real GDP 2020-2024	USD$ +0.12 billion	USD$ +0.58 billion
Additional annual average GDP growth rate 2020-2024	+0.11 %	+0.50 %

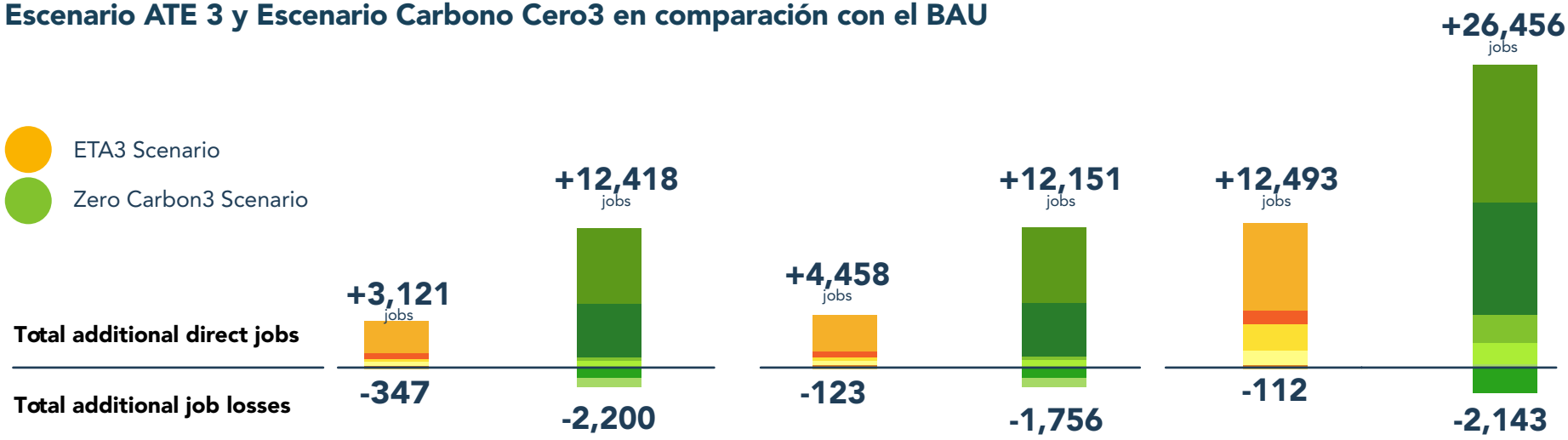
Source: United Nations Environment Programme

Refocusing investments towards the energy transition can create much-needed employment opportunities. In the ATE3 scenario, 15,687 net jobs would be created by 2024. This represents 0.5% more than in the BAU scenario. This would result in a -0.4% reduction in the unemployment rate in 2024 compared to a BAU approach. Of the total additional jobs created, 15.9% are direct jobs in the energy sector – which includes technologies related to the transition – and the remaining 84.1% are indirect jobs spread throughout the economy. The Zero Carbon scenario3 would create 53,959 net additional jobs by 2024. This is 1.8% more than in the BAU scenario (PNUMA et al 2020). This would result in a reduction in the unemployment rate of -1.5% in 2024 compared to the BAU. Overall, more jobs would be created in the energy sector than would be lost in the fossil fuel industry. The loss of jobs would be -1,403 in 2024 attributable to the sector of electricity generation in thermoelectric plants. Of the total new jobs, 18.6% correspond to direct employment in the energy sector. In both scenarios, direct employment is higher in the short term, when the first investments are made. Indirect job creation is steadily increasing as economic gains accumulate over time.

Compared to the BAU scenario, jobs will increase by 1.1% and 4.5% in 2030, in both the ATE3 and Zero Carbon scenarios3. As can be seen in Figure 12, in net absolute terms, energy transitions will create 35,805 and 141,951 additional jobs by 2030. These figures will nearly triple and more than double by 2050, reaching 102,098 and 336,373 additional new jobs, respectively. By 2050, of the total additional net jobs created, 10% and 7% are related to direct jobs (PNUMA et al 2020). In both scenarios, it is concluded that direct employment is higher in the short term, when investments are applied for the first time.

Figure 14. Distribution of net employment in Panama's energy sector (thousands of jobs) in 2024, 2030 and 2050

Escenario ATE 3 y Escenario Carbono Cero3 en comparación con el BAU



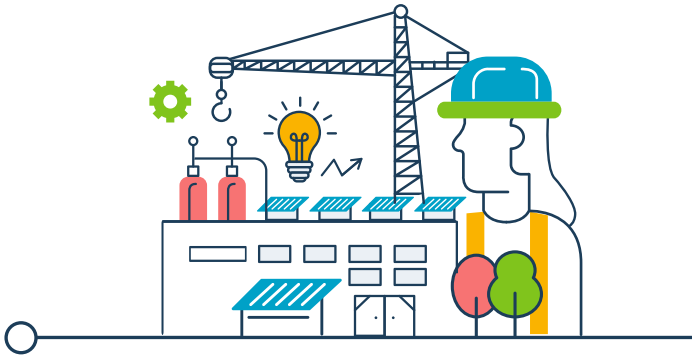
	2024	2024	2030	2030	2050	2050
EV charging infrastructure	2,152	4,021	3,186	6,614	7,668	12,117
Renewable power generation	362	7,939	495	4,709	1,180	9,854
Energy efficiency	357	345	307	277	2,310	2,427
Solar thermal generation	76	113	367	551	1,291	1,900
Fossil fuels power generation	174	-1,620	103	-973	44	-2,143
Bus transport	-347	-580	-123	-783	-112	158
Jobs						
Net direct	2,773	10,218	4,335	10,395	12,381	24,313
Indirect	12,913	43,741	31,470	131,556	89,717	312,060
Total additional jobs	**+15,687**	**+53,959**	**+35,805**	**+141,951**	**+102,098**	**+336,373**

Source: United Nations Environment Programme

The benefits of Panama's energy transition outweigh the costs. By redirecting investments, Panama would generate higher returns even without calculating the avoided social and climate costs.

By 2030, the ATE3 and Zero Carbon3 scenarios would require an investment of USD 9,030 million and USD 20,010 million more than the BAU scenario. However, they would bring in $7 billion and $26.7 billion in additional cumulative earnings, respectively. (PNUMA et al 2020). For every dollar that Panama invests in the energy transition, it would generate USD 0.78 and USD 0.33 in benefits by 2030. With a different global composition of the energy matrix and with only $20 billion of total investments, Panama's energy sector could become more climate resilient, with renewable energy generation technologies currently available on the market. For The project developed a series of assessments that look at opportunities to integrate low-emission climate-resilient development strategies into recovery packages. These analyses demonstrate that economic recovery plans aligned with the Paris Agreement are a forward-looking investment for LAC governments. In the period to 2050, the total incremental investment needs in the ATE3 and Zero Carbon Scenarios3 are USD 21 billion and USD 47 billion, which would generate USD 44.5 billion and USD 160.65 billion in cumulative additional gains respectively. These scenarios would generate profits well above the additional investments required for this period. (PNUMA et al 2020).

In the ATE3 Scenario, every US dollar invested by Panama in the energy transition could generate returns of up to USD 2.11, reaching a payback period in eleven years. On the other hand, in the Zero Carbon Scenario3, for every dollar that Panama invests in decarbonizing its energy sector, an economic benefit of USD 3.4 is achieved, achieving returns in a period of between six and seven years. Of these cumulative additional benefits, USD 44.5 billion and USD 148.37 billion correspond to added economic gains in the ATE3 and Zero Carbon Scenarios3. These figures would double and triple investments, respectively. 70% of the additional economic benefits correspond to incremental gains in real GDP, 26% to government revenues, and 4% to labor income in both scenarios (PNUMA et al 2020).



In addition to the economic benefits, both low-carbon development scenarios result in substantial cost savings compared to the BAU case, accounting for a quarter of the investment required. Avoided costs total $5.4 billion and $12.3 billion under the ATE3 and Zero Carbon scenarios3. Energy cost savings, energy subsidies, social carbon costs (CSCs) and transport-related externalities fall into the category of avoided costs. Shifting investment towards renewable energy technologies supported by the use of efficiency and together with the electrification of the transport sector will mean greater energy cost savings in the Zero Carbon Scenario3 than in the ATE3 Scenario, worth USD 92 billion and USD 5.5 billion. (PNUMA et al 2020).

In both low-carbon scenarios, coherent energy policies are seen as reflecting not only an affordable and reliable electricity supply, but also lower impacts on public health, climate change and environmental degradation. Under these assumptions, fossil fuel subsidies are difficult to justify. Fossil fuel subsidies are prohibitively expensive for the Government of Panama and undermine the decarbonization of the energy sector. Eliminating 100% fossil fuel subsidies from 2025 would free up $3.5 billion and $3.7 billion by 2050, helping to level the playing field for investment in non-conventional renewables for the private sector. Finally, it is estimated that the additional social and climate costs avoided would be reduced by USD 2 billion and USD 3 billion, in the ATE3 and Zero Carbon scenarios3 (PNUMA et al 2020).

Photo: Unsplash

Conclusions

The coronavirus disease (COVID-19) pandemic severely deepened structural and institutional gaps in Latin America and the Caribbean. The crisis seriously affected production chains and the labor market: more than 2.7 million companies closed and the number of unemployed people stood at more than 44.1 million (CEPAL 2021)This crisis exposed the fragility of the prevention, planning and response systems needed to address complex challenges or shocks such as the climate crisis. In light of recent events, the need to pay for the construction of a more sustainable development model that offers greater social benefits and contributes to the reduction of inequalities becomes clear.

The countries of the region saw the need to increase spending and accelerate decision-making processes to establish economic recovery packages and thus be able to face the crisis. Several leaders of the region highlighted the need not only to think about palliative or contingent actions but also to favor structuring actions and thus prevent future shocks. Covid-19 generated conditions of social and political consensus that favor the need to implement ambitious reforms that address the gender impacts of the pandemic and place equality and environmental sustainability at the center of the recovery phase

It is under this framework that the United Nations Environment Program developed this project of technical accompaniment to countries of the region with the objective of matching the goals of economic recovery with the principles of preparation and planning for future environmental crises. To this end, synergies and alignments between sectoral policies relevant to low-emission and climate-resilient development strategies were identified.

The complexity of the various sectoral policies that foster low-emission and climate-resilient economic recovery required high-level technical and political commitment between national environmental and sectoral authorities with a long-term view. It involved a wide interdisciplinary range of authorities that lead planning in strategic sectors (Ministries of Environment, Ministries of Energy, Ministries of Transport, Ministries of Agriculture, Ministries of Productive Development, among others) as well as those that define the destination of public investments and that are ultimately responsible for designing long-term policies for an economic recovery (Ministries of Finance, Ministries of Finance, Ministries of Economy and/or Departments of National Planning).

Studies conducted at the national level prove that recovery investment plans focused on enabling net-zero emissions economies help reap economic, social and public health benefits from cost-effective decarbonization and climate resilience strategies.

As can be seen from the results of this report, it can be seen that in countries such as Honduras, environmental, economic and social benefits of up to USD 12 are achieved for every dollar invested by 2050. Similar benefits are identified in the long term in the other countries, the ratio between benefit cost in the other countries was: Argentina 8:1 USD, Costa Rica 6:1 USD, and Panama 3.4:1 USD.

Green recovery strategies showed positive impacts on economic growth. The developed scenarios identified growth of up to 14.4% increase in GDP in Argentina by 2050, in Costa Rica up to 9.8%, in Grenada forecasts indicate that real GDP could be 17.4% higher in the high ambition scenario compared to the baseline, in Honduras GDP is projected to grow by 14.8% compared to the current trend and, finally, in Panama there is an increase of 14.4% projected in the same period (2050).

In terms of employment, we see a high potential impact of a low-carbon and climate-resilient investment strategy. By way of illustration, in Argentina, the modeled scenarios show an impact by 2050 of up to 1.72 million additional jobs under high investment conditions. Similar impacts were identified in the modeling of the most ambitious scenarios for the different countries. In Costa Rica an increase of 172,500 jobs was estimated by 2050, in Panama 363,000 and in Honduras 179,000 additional jobs.

The results show that sectors with productive chains intensive in local employment showed a greater impact on employment generation. These estimates highlight the importance of promoting domestic industry in the production of clean technologies as a mechanism for generating new jobs and effectively reducing unemployment in the short and medium term.

Photo: Flickr

Recent pandemic events and extreme hydrometeorological events (e.g. Hurricanes Eta and Iota) have shown the potential magnitude of the impacts that climate change can have on public health and social backwardness for the most vulnerable especially women, children, people with disabilities, poor etc. are more susceptible to disaster impacts hence widening inequality In order to foresee similar future impacts, environmental planning actions must be mainstreamed in planning, regulation and investment exercises in infrastructure in all sectors.

The development of new infrastructure plays a prominent role in strategies to mitigate environmental vulnerability and adapt to the effects of climate change, however, the government response to the emergency together with the drastic fall in tax revenues, has increased the fiscal deficit and aggravated the debt burden, especially in smaller economies.

Based on the latest available data (CEPAL 2021), in all countries, without exception, the fiscal situation has deteriorated and the level of indebtedness has increased. The Economic Commission for Latin America and the Caribbean (ECLAC) expects this indebtedness to increase from 68.9% to 79.3% of GDP between 2019 and 2020 at the regional level, making Latin America and the Caribbean the most indebted region in the developing world and the one with the highest external debt service in relation to exports of goods and services (57%).

The clarity of the impact of the crisis on public finances was a constant concern for the authorities of the region and is directly linked to the feasibility of achieving the objectives of the Paris Agreement. The recommendation that ECLAC (2021) gives in this regard to increase the margin for applying policies is to seek to reduce tax avoidance and evasion, as well as to favor taxation in direct taxes on property and wealth. They also, coincidentally, recommend redirecting public spending towards job creation and transformative and environmentally sustainable activities. To this end, they recommend prioritizing public investment, basic income, universal social protection, support for small and medium-sized enterprises (SMEs), digital inclusion and the development of green technologies.

It is relevant to highlight that the economic impact assessments also reflected an impact of job losses focused on polluting industries. This effect represents an important challenge to consider, plan and address in the region in order to catalyze a green recovery. Accompanying decarbonization and resilience investment plans with just transition programmes would reduce significant barriers and increase the potential for economic and environmental impact. In addition, to promote gender equality in the labor market, there is need to collect gender disaggregated data for women to participate since jobs in the decarbonization agenda is male dominated.

The International Labor Organization (ILO) determines that just transition means, "making the economy as fair and inclusive as possible for all stakeholders, creating decent work opportunities and leaving no one behind. A just transition involves maximizing the social and economic opportunities of climate action, while minimizing and carefully managing challenges, including through effective social dialogue between all affected groups and respect for fundamental labor principles and rights." (OIT 2023).

The objectives of energy transition, decarbonization and climate resilience represent radical transformations in the labor market. Ensuring a gender-responsive just transition is key to achieving these goals in the countries of the region.

Additionally, building the capacity of energy ministries and local authorities and implementing gender-responsive sustainable energy laws, policies and strategies that fully use the potential of women as agents of change can lead to a just transition towards environmentally sustainable economies.

References

Banco Mundial. Consolidando La Recuperación : Aprovechando el Crecimiento Verde. Washington DC: Banco Mundial obtenido en https://doi.org/10.1596/978-1-4648-1868-4, 2022.

Banco Mundial. Honduras Estudio de Pobreza: Una Senda Hacia la Reducción de la Pobreza y el Crecimiento Inclusivo. Washington DC: Banco Mundial, 2023.

Bassi, A.M. «Moving towards integrated policy formulation and evaluation: the Green Economy Model (GEM) .» Environmental and Climate Technologies, 2015: Volume 16, Issue 1.

Banco Central de Costa Rica (BCCR). BCCR proyecta crecimiento. 29 de Enero de 2021. https://www.bccr.fi.cr/Paginas/PageNotFoundError.aspx?requestUrl=https://www.bccr.fi.cr/comunicacion-y-prensa/Docs_Comunicados_Prensa/CP-BCCR-006-2021BCCR_proyecta_crecimiento_en_2021_y_2022_mantiene_meta_inflacion.pdf.

Banco Interamericano de Desarrollo (BID) et al. The Benefits and Costs of Decarbonizing Costa Rica´s Economy. San José: Banco Interamericano de Desarrollo, 2020.

Comisión Económica para América Latina (CEPAL). Financiamiento para el desarrollo en la era de la pandemia de COVID-19 y después. . Informe Especial, Santiago: Comisión Económica para América Latina y el Caribe, 2021.

Comisión Económica para América Latina (CEPAL). Horizontes 2030: La igualdad en el centro del desarrollo sostenible. Santiago: Comisión Económica para América Latina y el Caribe, 2016.

—. Social Panorama of Latin America. Santiago de Chile: Comisión Económica para América Latina y el Caribe. Obtenido de https://repositorio.cepal.org/bitstream/handle/11362/46688/8/S2100149_en.pdf, 2020.

DALA. «Evaluación de daños y pérdidas causadas por las tormentas tropicales Eta e Iota.» 2021.

Forrester, J.W. Road Maps: A guide to learning System Dynamics. Camebridge: Systen Dynamics Group, Sloan School of Management, MIT, 2002.

Global Commission on Adaptation. Adapt Now: A Global call for Leadership on Climate Resilience. Global Commission on Adaptation. Obtenido de https://gca.org/wp-content/uploads/2019/09/GlobalCommission_Report_FINAL.pdf, 2019.

Gobierno de Costa Rica. «Plan Nacional de Descarbonización 2018-2050.» 2019.https://cambioclimatico.go.cr/wp-content/uploads/2019/02/PLAN.pdf.

Inter American Development Bank (IADB). Observatorio Laboral COVID-19. Inter-American Development Bank (IADB). (s.f.) Obtenido de https://observatoriolaboral.iadb.org/es/ , 2021.

International Labor Organization (ILO). Jobs in a net-zero emissions future in Latin America and the Caribbean. Washington DC and Geneva: : Inter-American Development Bank (IADB) and International Labour Organization (ILO). Obtenido de https://www.i, 2020.

International Monetary Fund (IMF). World Economic Outlook Database. International Monetary Fund. Obtenido de https://www.imf.org/en/Publications/WEO/weo-database/2021/April, 2021.

Instituto Nacional de Estadística (INEC) Instituto Nacional de Estadística. 2021. https://inec.cr/noticias/desempleo-cerro-el-ano-20.

Meadows, D.H. «The unavoidable A Priori.» En Elements of the system dynamics method, de J. Randers, 23-57. Camebridge: MIT Press, 1980.

Ministerio de Trabajo y Seguridad Social (MTSS). Septiembre de 2020. https://www.mtss.go.cr/elministerio/despacho/covid-19-mtss/plan_proteger/archivos/quinto_informe_anexo2.pdf.

Organización Internacional del Trabajo (OIT). COVID – 19 y El Mundo Del Trabajo: Punto de Partida, Respuesta y Desafíos En Honduras. Organización Internacional del Trabajo. Obtenido en <https://www.ilo.org/wcmsp5/groups/public/—americas/—ro-lima/—sro, 2020.

—. Organización Internacional del Trabajo. 20 de Julio de 2023. https://www.ilo.org/global/topics/green-jobs/WCMS_824947/lang–es/index.htm.

Programa de Naciones Unidas para el Medio Ambiente (PNUMA). Reactivación Económica Post COVID, Conforme al Acuerdo de París. Buenos Aires: Programa de Naciones Unidas para el Medio Ambiente, 2021.

Programa de Naciones Unidas para el Medio Ambiente (PNUMA), Ministerio de Ambiente . La Transición Energética como motor de la recuperación económica de la COVID-19 en Panamá. Panamá: Programa de las Naciones Unidas para el Medio Ambiente, 2020.

Presidencia. Estabilidad económica y política son condiciones indispensables para el crecimiento y el bienestar. 2021. https://www.presidencia.go.cr/comunicados/2021/05/estabilidad-economica-y-politica-son-condiciones-indispensables-para-el-crecimiento-y-el-bienestar/.

Probst, G., y A.M. Bassi. Tackling Complexity: A systematic approach for decision makers. Sheffield, UK: Greenleaf Publishing, 2014.

Randers, J. Elements of the System Dynamics method. Camebridge: MA: MIT Press, 1980.

Richardson, G., y A. Pugh. Introduction to System Dynamics with Dynamo. Portland: OR: Productivity Press, 1981.

Roberts, N., D. Andersen, R. Deal, M. Garet, y W. Shaffer. Introduction to Computer Simulation. The System Dynamics Approach. MA: Addison-Wesley, 1983.

Secretaría de Recursos Naturales y Ambiente (SERNA), et al. Plan Nacional de Adaptación al Cambio Climático. Tegucigalpa: Secretaría de Recursos Naturales y Ambiente, 2019.

United Nations Environment Programme (UNEP). Is the COVID-19 economic recovery building a sustainable future? A snapshot from Latin America and the Caribbean. Obtenido de https://recuperacionverde.com/en/tracker/: United Nations Environment Programme, 2021.

UN environment programme