Panama

THE ENERGY TRANSITION

as a key driver of the COVID-19 economic recovery in Panama

HIGHLIGHTS FOR POLICY-MAKERS

UN environment programme

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Lead and contributing authors
Dr. Andrea M. Bassi, Georg Pallaske, Marco Guzzetti, KnowlEdge Srl.

Project Coordination & study conceptualization
Mercedes García Fariña, UN Environment Programme (UNEP), Latin America and the Caribbean Office.

Data collection & literature review for scenario formulation
Dr. Christian Navntoft, UNEP, Latin America and Caribbean Office. Laura Dawidowski and María José (Pepa) López, Independent Senior Experts in GHG inventories.Rosilena Lindo, Deputy National Energy Secretary of Panama.

Coordinating Review Committee
UNEP´s Climate Change Unit
Gustavo Mañez, Esteban Bermudez, and Juan Luis Pardo, UNEP, Latin America and Caribbean Office.

Government of Panama
National Energy Secretariat
Dr. Jorge Rivera Staff, National Energy Secretary of Panama, SNE. Rosilena Lindo, Deputy National Energy Secretary of Panama, SNE. Dr. Guadalupe Gonzalez, Director of Electricity Department, SNE. Marta Bernal, Project Coordinator, SNE.

Ministry of Environment
Ligia Castro de Doens, Director of Climate Change. Ana Domínguez, Head of the Mitigation Department. Javier Martínez, INGEI Coordinator. Carolina Velásquez, Energy Sector Inventory Coordinator.

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Sofia Arocha and Daniel Díaz Rivas, UNEP, Latin America and the Caribbean Office.

Design and layout
Karla Delgado-Olguin and Daniela Rogoza, UNEP, Latin America and the Caribbean Office.

Micro-site development
Javier Bianchet, UNEP, Latin America and the Caribbean Office.

Translation and language editing
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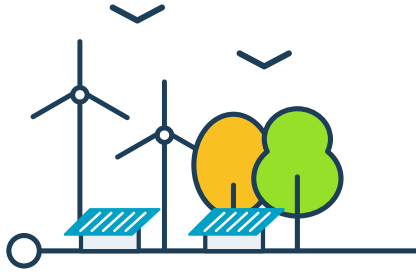

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Foreword

Leo Heileman, Regional Director and Representative, United Nations Environment Programme

Although 2020 emissions will be slightly lower than in 2019 due to the COVID-19 crisis and associated responses, GHG concentrations in the atmosphere continue to rise, with the immediate reduction in emissions expected to have a negligible long-term impact on climate change.

The United Nations Secretary-General is calling on governments to use COVID-19 recovery as an opportunity to create more sustainable, resilient and inclusive societies. Aligned with this, the United Nations Framework Convention on Climate Change (UNFCCC) has stressed that governments could integrate and specify some of their post-COVID-19 recovery plans and policies in their new or updated NDCs and long-term mitigation strategies, both of which countries are requested to submit before COP 26 takes place at Glasgow, Scotland.

Alliances like the bi-regional EU- LAC Euroclima+ Programme that allowed the present science-based data study that will definitely drive investments in the right direction in Panama, are indeed best practices to achieve the Paris Agreement mitigation goals while at the same time advancing in the 2030 Agenda, and generating prosperity and progress all along the world´s supply chains.

This study comes totally timely as many fiscal rescue and recovery measures can simultaneously support rapid, employment intensive and cost-effective economic recovery and a low-carbon transition, especially through the support of zero-emissions technologies and infrastructure, such as low-carbon and renewable energy, low-carbon transport, zero-energy buildings and low-carbon industry, considered in GEM-Panama.

UN Environment congratulates Panama for this timely exercise and will put all its effort to showcase and replicate this type of science-based data for driving more green investments in the energy sector for Latin America and the Caribbean.

Best,
Leo Heileman

Jorge Rivera Staff, Secretary of Energy, National Energy Secretariat, Panama.

The formulation and implementation of public policies always represent a great challenge for public administrators, not only because of the technical aspects to be considered, but also because of the socio-political conditions to be integrated into the process. If we add to these generic elements the complexity of the energy sector in its role as a public service, which constitutes an important input for the economic process of a country and its incidence in the fight against climate change, we can only appreciate the impact that these initiatives have on the lives of citizens.

As if this were not enough, the complexity to be taken into account is deepened if we include in the analysis the current and demanding challenges arising from the necessary and high priority health management of the COVID-19 pandemic and its socioeconomic effects. Precisely all these elements are combined in the preparation of Panama's Energy Transition Agenda 2030, both in its general guidelines approved by the Cabinet Council on November 24, 2020, as well as in the specific strategies that comprise it. One of the main premises for the development of this energy transition agenda has been, from the beginning, the effort to improve and strengthen the quantity and quality of the information used as work input. One of the major contributions of the study "The Energy Transition as a key driver of the COVID-19 economic recovery in Panama" was to generate the compelling data to increase the climate ambition on the energy sector and include it as a monitorable, verifiable and reportable goal in the update of the Nationally Determined Contributions, submitted by Panama to the United Nations Framework Convention on Climate Change in December 2020.

Upon receiving the "Zero Carbon" report published by UNEP in 2019, we were able to appreciate the great potential that this analysis could represent to strengthen the policy proposals that we had condensed in the energy transition agenda, after a process of sectoral dialogue. That is where Panama took the initiative and together with UNEP, we were able to carry out the first exercise to model different green economic recovery scenarios at a national level with the GEM model.

The technical and economic analysis that this document represents is of great value not only for its quantitative results based on the national and international information available for the analysis, but also for the pragmatic approach of the study, using as a short-term reference framework the Economic Recovery Plan announced by the Government of Panama in July 2020. We believe that developed analysis can be a source of reference for other countries in the region. This work confirms that the proposals included in the energy transition agenda have all the potential to serve as tools for sustainable economic reactivation within the "build back better" vision. The energy transition agenda is framed within the necessary axes of Decarbonization, Digitalization, Decentralization and Democratization of energy (the so-called 4Ds), which in turn must be assessed taking into account the energy policy objectives that remain fully in force, such as Security, Reliability, Accessibility, Affordability and Sustainability, while projecting their impact in the short, medium and long term.This is where the quantitative analysis, taking as inputs the real data available in our system, allows us to evaluate intervention alternatives among the proposals and their impact on the policy objectives mentioned above and the axes of the energy transition that we are promoting.

We thank the United Nations Environment Programme, Euroclima+, the Spanish Agency for International Development Cooperation, the Ministry of Environment of Panama and the Swedish International Development Cooperation Agency (SIDA) for their collaboration in the development of this key analysis for the economic reactivation of Panama. We are certain that this analysis and all the correlations, proposals and decisions that will continue to derive from it, will become a lever for a more sustainable and equitable economic recovery of our country, not only for the next few years to come, but as part of a seed that we are sowing for the next generations.

Kind regards,
Dr. Jorge Rivera Staff, National Energy Secretary.

Milciades Concepción, Minister of Environment, Ministry of Environment, Panama

Panama is committed to fight Climate Change. As shown in the recent National GHG Inventory Report presented in our second BUR, Panamá is a Carbon Negative country, meaning we absorb more carbon than what we emit, however we recognize the need to do more, to set the example and lead the transition of sectors that still emit and are not yet carbon neutral. The Energy sector is the main responsible for the emission of GHG within the country, therefore now we present the Green Economy Model (GEM) for the Energy Transition. A document that shows the importance of this transition, the benefits (environmental, social and economic), and will change the mindset of those who still believe that renewable energies are expensive, quite the contrary "The energy transition pays for itself". We increase the ambition in our NDC, and the energy sector is fundamental to achieve it. That is why is so important to quantify the cost of the transition, and its benefits.

The transition of the energy sector will require important investments, so will the recovery from the Pandemic of COVID-19, that is why it is crucial to joint efforts to (more than recover) renew ourselves, making sure we resurge from this difficult challenge as a better, stronger and more determined society. The Pandemic has show us how vulnerable we are, but at the end, it will show us how far and how quickly we can make changes. In some way we need those lessons to address Climate Change as we need to go a long way from where we are to where we need to be in terms of GHG emissions and a true sustainable development, and we need to do it quickly.

As a country we have signaled the way forward with the development of the Reduce Your Footprint National Program, which involves the private sector and local governments in the achievement of emission reductions and adaptation goals, it also includes the National Strategy for Low Carbon Economic and Social Development, aiming to improve our development with people and nature at the core, it also aims to prepare ourselves to grow without neglecting our future and adapt to climate change.

Panama is highly vulnerable to climate change as shown in the Climate Change Vulnerability Index recently published, that is why limiting global temperature increase to 2°C is not enough, we aim at 1.5°C. The climate is changing, and we, throughout climate action, will transform customs, knowledge and practices, whether at personal, family, community, government and business level, to adapt, so our people, ecosystems and productive systems are resilient to climate change.

This GEM not only shows the potential scenarios, but it also shows the benefits and more important it provides a series to steps that we need and will follow. Panama is carbon negative, and we are going to remain so. It will not be easy, and it will require support (local and international), but we are going to do it. This document is a key piece of this transition, so I thank all those that have make this GEM possible, especially our team of Climate Change in the Ministry of Environment, the Secretariat of Energy, UNEP, EUROCLIMA+, AECID and SIDA. This effort will have a powerful impact on our country and will be important to shape the legacy we leave to current and future generations, proving that a small country with a firm commitment and will, can leave his mark in the global stage, and can help to change the course of history.

Kind regards,
Milciades Concepción

Jolita Butkeviciene, Director of Development and Cooperation in Latin America and The Caribbean, European Commission

The EU will be climate neutral by 2050. To do this, new growth strategy – the European Green Deal - that will transform the Union into a modern, resource-efficient and competitive economy, where there are no net emissions of greenhouse gases; economic growth is decoupled from resource use; and no person and no place is left behind. The European Green Deal is our plan to make the EU's economy sustainable, by turning climate and environmental challenges into opportunities, and making the transition just and inclusive for all.

The European Green deal's action plan will boost the efficient use of resources by moving to a clean, circular economy, as well as restore biodiversity and cut pollution. A key policy area is Clean, Affordable and Secure Energy. Currently, the production and use of energy accounts for more than 75% of the EU's greenhouse gas emissions. The EU is committed to mobilizing every effort to ensure policy alignment, effective collaboration across sectors, and support to science and technology based innovative solutions that contribute to a zero-emission energy sector. A clear example of this commitment is the European Green Deal's support to the further development of offshore renewable energy to help reach the EU's ambitious energy and climate targets. In 2020, we launched the EU Strategy on Offshore Renewable Energy, a key enabling condition to both understand the massive potential contribution of this sector to climate-neutrality, and to propose a concrete roadmap towards long-term sustainable development of this sector. Through cross-border collaboration and harmonised regulations, the conditions will be set to foster investment security in the sector; guarantee access to sea-space; facilitate industrial and employment planning; stimulate regional and international cooperation; and encourage technology transfer and scaling from laboratory-based research projects into applied practice.

Panama is undergoing a similar energy transformation, as detailed in this important report. The Government of Panama, with the technical support of UNEP, financed by the European Union through the EUROCLIMA+ Regional Programme, helps public and private sectors to understand the clear benefits of decarbonizing energy sources by integrating and modelling several energy transition scenarios with the Green Economy Model (GEM). The GEM provides robust economic modeling and data that helps investors to calculate and forecast risk reduction in their pre-investment feasibility studies, and provides an entry point for new investors to come into the field for full transformation.

The GEM will facilitate the flow of resources for Panama's COVID-19 recovery towards the implementation of measures for efficient use of energy, renewable power generation, and electric mobility.Panama is a model for Latin America, in terms of energy transition. To reach Paris Agreement's 1.5-degree goal and reduce the huge emissions gaps identified in UNEP's latest Emissions Gap Report, we need robust partnerships that support solid data, models and plans that set the groundwork for zero-emissions pathways such as Panama's. On behalf of the European Commission and EUROCLIMA+, it is my honour and pleasure to support Panama's ambitions, and indeed Latin America's, as a privileged partner in the collective efforts towards a global green and resilient recovery from COVID-19, towards a zero-emissions planet.

Best,
Jolita Butkeviciene

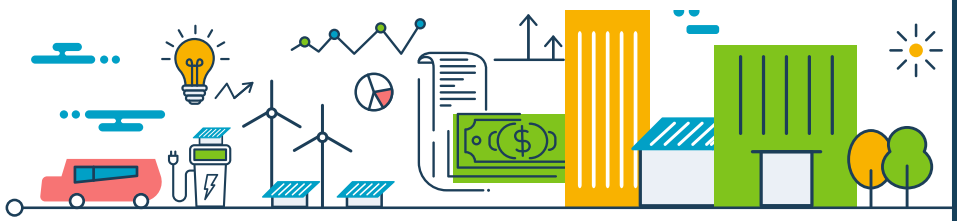
Key findings

Going forward, an effective response to the COVID-19 health, social, and economic crisis requires political leadership through a decisive and ambitious policy making, accompanied by significant recovery investments. The mobilization of vast public resources represents a unique occasion to boost economic output and seed employment opportunities, while setting a prosperous economic development path for the next decades. The Government of Panama can link today´s recovery efforts to guide sustainable development that stimulates economic growth, creates employment opportunities, ensures competitiveness, and promotes innovation towards the imminent fourth industrial revolution in the short, medium, and long-term.

Linking the short-term post-COVID19 recovery framework to NDC1 and long-term low GHG emission development strategy is essential to ensure Panama meets the Paris Agreement on Climate Change. The post-COVID19 recovery measures based on the energy transition represents a crucial phase in the energy-related CO_2 emission reduction to avert devastating climate change. It promotes a fundamental shift in how the energy is produced and consumed, bringing a long-term energy transformation.

The energy transition, integrated into the stimulus and recovery plans, proves to be a forward-looking investment. Even in the midst of a difficult fiscal situation, as a result of the COVID-19 impacts, investments in the energy transition, as part of the Panama´s COVID-19 economic recovery plan, could become a critical enabler of Panama´s recovery efforts over the next four years and beyond.

Policy interventions and investments for stimulus and recovery can lead to a paradigm shift of Panama´s energy system that, in turn, can underpin a more resilient economy and society. Investing in energy transformation can heavily influence future socio-economic development through creating synergies across social, economic, and environmental indicators in Panama. Therefore, understanding systemic outcomes of action and inaction is essential to inform policy making. This holistic approach, with the energy



transition at the heart, would bring together economic development and employment, meeting climate goals, and social well-being.

The energy transition would pay for itself. The benefits resulted of Panama´s energy transition outweigh the cost. By redirecting investments towards the energy transition, Panama would achieve higher return on investment compared to current plans. By 2050, the ETA3 and Zero Carbon3, overall incremental investment needs are USD$21 billion and USD$47 billion, while bringing cumulative additional gains worth USD$44.5 billion and USD$160.65, greatly exceeding the additional investments needed. In the ETA3 Scenario, every U.S. Dollar that Panama invests in energy transition can bring returns as high as USD$ 2.11, reaching the payback period in eleven years. On the other hand, in the Zero Carbon3 Scenario, for every U.S. Dollar that Panama invests in decarbonizing its energy sector, USD$ 3.4 of economic benefits are achieved, reaching the payback in six to seven years.

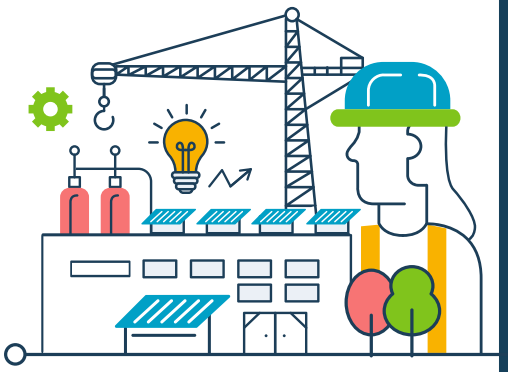
A green recovery package based on the energy transition can boost Panama's economy over the 2020-2024 recovery phase and strengthen macroeconomic stability in the long-term. Investing in the energy transition would stimulate economic activity further than under current plans. A net investment stimulus in clean technologies along with the phase-out of fossil fuel subsidies would boost real GDP by 0.52% more in 2024 in the ETA3 Scenario than in current plans. When a higher ambition is considered, Zero Carbon3 Scenario, this figure would be multiplied by more than four times; 2.35% higher than BAU Scenario. The additional cumulative gain through increased real GDP over the 2020-2024 would amount USD 0.48 billion in the ETA3 Scenario and USD 2.33 billion in the Zero Carbon3 Scenarios. Considering the long-term, by 2050, real GDP would be 6.5% and 21% higher in 2050 in the ETA3 and Zero Carbon3 Scenarios than in

BAU Scenario. The cumulative gain through increased real GDP would amount to USD 125.7 billion and USD 455.22 billion by 2050, greatly exceeding the additional investments needed for transforming the energy system. The Zero Carbon3 Scenario has consistently higher positive effects on real GDP over time, compared to the ETA3 Scenario.

Investments in the energy transition can create more wide range jobs in the short-term and beyond. Both Low Carbon Development Scenarios raise higher employment across the economy than the BAU approach, with faster tendency under the deeper energy decarbonization scenario. Under the ETA3 Scenario 15,687 net additional jobs would be created by 2024. This is 0.5% more than under the BAU Scenario. Under the Zero Carbon3 Scenario 53,959 net additional jobs would be created by 2024, corresponding to 1.8% more than under the BAU Scenario. Following this trend, jobs would increase even higher 3% and 10.1% by 2050, respectively. In net absolute terms, the energy transition would result in 102,098 and 336,373 more jobs economy-wide compared to BAU Scenario. The net additional jobs created by investments in the energy transition under the Zero Carbon3 Scenario more than triple those created in the ETA3 Scenario by 2050. Under the ETA3 and Zero Carbon3 Scenarios, for every million U.S. Dollar that Panama invests in decarbonizing its energy sector 2.95 and 5.33 new additional jobs are created by 2024. Over 2020-2050 period, for every million U.S. Dollar that Panama invests in decarbonizing its energy sector 1.51 and 2.45 new additional jobs are created.

More jobs in the energy sector would be created than are lost in the fossil fuel industry. A transition that leaves no one behind would avoid resistances that could otherwise derail or halt it. As renewables, energy efficiency and other transition-related sectors grow, other energy jobs will decrease, such as those in the fossil fuel industry. However, strategies to ensure a just transition can help to minimize the impacts on labour market.

The energy transition provides ample opportunities to create local value chain in alignment with Panama's strategic industrial goals. Investing in energy transition-related sectors through Panama´s recovery package requires developing industrial policies and training and education programmes aimed at building local supply chains and developing the skills and competences needed across industries to adapt to this transformation. It is essential to consider 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 with supply.



Early action to channel investments, along with policy interventions, in the right energy technologies is critical to reduce energy related CO_2eq emissions. Renewable energy, transport electrification, and energy efficiency are the main pillars of the Panama's energy transition. Accelerated deployment of these clean technologies must start now if Panama´s NDC1 2030 and 2050 targets are to be reached. The ultimate Panama´s climate goal is to reach net-zero emissions by midcentury. The ETA3 scenario achieves compliance with the NDC1 by 2030, while the Zero Carbon3 scenario puts the country on track towards a net-zero trajectory. Under the ETA3 scenario, the energy-related reduction goals defined in the Panama´s NDC1 will be met. Compared to the BAU Scenario, energy related CO_2eq emissions would decrease 14% and 27% by 2030 and 2050. On the other hand, the Zero Carbon3 Scenario would make a larger contribution to Panama´s climate goals. Compared to the BAU Scenario, energy-related CO_2eq emissions would decrease 34% and 58% by 2030 and 2050.

Strong policies, technological leaps and scale up investments needed to reach net-zero emissions. The foreseen cross-sectoral decarbonization measures implemented in energy sector are insufficient to reduce fossil fuel use across all sectors to zero. This last portion of CO_2 emissions - heavy road transport, aviation, shipping, and industrial processes - are the hardest and most expensive part of the economy to decarbonize. It is recommended to develop more ambitious policies underpinning transformative change in Panama´s energy system, increase investments to make the whole power system operate flexibly, and bring other low-carbon incremental technologies to the market, such as next-generation battery, hydrogen and clean and synthetic fuels.

The Panama´s energy transition is more than a transformation of its energy system; it is a paradigm shift of its society and economy. The energy transition can improve Panamanian population´s well-being. Investing in the energy transition agenda has beneficial impacts on air quality beyond the reduction in energy related CO_2eq. This in turn improves human health and minimizes the environmental damage caused by climate change. Under the ETA3 Scenario and the Zero Carbon3 Scenario, decreases in air pollution will reduce in 19,169 and 28,739 people with respiratory illness by 2024. By 2050, this figures would achieve 654,455 and 1,436,442 less people with respiratory illness. The Zero Carbon3 Scenario would achieve greater social and climate benefits than the ETA3 Scenario.

1. Introduction

An assessment to quantify and understand the outcomes of including the energy transition into Panama's post-COVID-19 economic recovery.

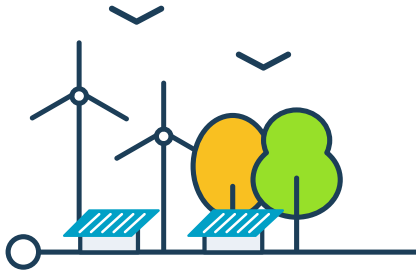
The United Nations Environment Programme (UNEP)´s Latin America and the Caribbean Office has produced a series of studies to quantify and understand the outcomes of including low-carbon climate-resilient strategies into economic recovery packages. This report - The Energy transition as a key driver of the COVID-19 economic recovery in Panama - is the first national study carried out, together with the National Energy Secretariat of Panama and the Ministry of Environment, based on the regional report "Zero Carbon: the opportunity, the cost and the benefits of the combined decarbonization of the energy and transport sectors". "Zero Carbon" was published by UNEP in 2019 and showcases a technically and economically viable path for the transformation of the energy systems of the Latin American and Caribbean region.

This technical assistance in Panama was carried out by the Climate Change Unit of the UNEP´s Latin America and Caribbean Office, as part of the UNEP´s COVID-19 response under the "Programme to support the COVID-19 economic recovery in line with the Paris Agreement on climate change in Latin America and the Caribbean".

In collaboration with the Ministry of Environment and National Energy Secretariat of Panama, a quantitative assessment was performed to comprehensively inform the integration of the Energy Transition Agenda (ETA) into (i) COVID-19 economic recovery and (ii) the first update of the Panama´s NDC1. The energy sector, at the heart of the national economy, plays a crucial role in the COVID-19 crisis. The Government of Panama is promoting the ETA as the cornerstone of an inter-ministerial policy dialogue for the climate, energy, and economic agenda.

This quantitative assessment presents cost-benefit analysis and investment needs of scenarios with different degrees of ambition for the decarbonization of the energy sector, considering the energy transition

The Energy Transition Agenda as the cornerstone of an inter-ministerial policy focus for the energy, climate and economic agenda



at the heart, over a short, medium, and long-term time horizon (2020-2050) carried out with the Green Economy Model (GEM). The GEM-Panama was co-created with local stakeholders under the leadership of the National Energy Secretariat and the Ministry of Environment, and customized to perform an evidence-based analysis demonstrating the impacts of the implementation of the energy transition across economic, social, health and climate dimensions. The GEM analyses the impact of the energy transition on several key performance indicators, such as Gross Domestic Product (GDP), employment, greenhouses gases (GHG) emissions, air quality and health improvement, and other sectorial indicators.

Understanding systemic outcomes of action and inaction is essential to inform policy making since is expected to heavily influence future socio-economic developments. Considering this, the results presented in this Summary for Policymakers focus on two different time horizons along the scenarios:

Short-term (2020-2024)

Includes an assessment of the economic, social, and environmental impacts of Panama´s COVID-19 recovery package. Emphasis is put on the possibility to implement a greener recovery package, in alignment with the energy transition. Although the COVID-19 recovery spending ends in 2025 according to GEM simulations, the short-term results of the analysis are presented for the period 2020-2024 in order to shed light for the Government of Panama on the opportunity of integrating the energy transition into COVID-19 response measures. The overall objective is to demonstrate that policies and investments that boost clean energy transition will encourage higher economic growth and deliver more jobs, while achieving climate goals and social co-benefits in the short-term and beyond (Figure 1).

The energy sector, at the heart of the national economy, plays a crucial role in the COVID-19 crisis

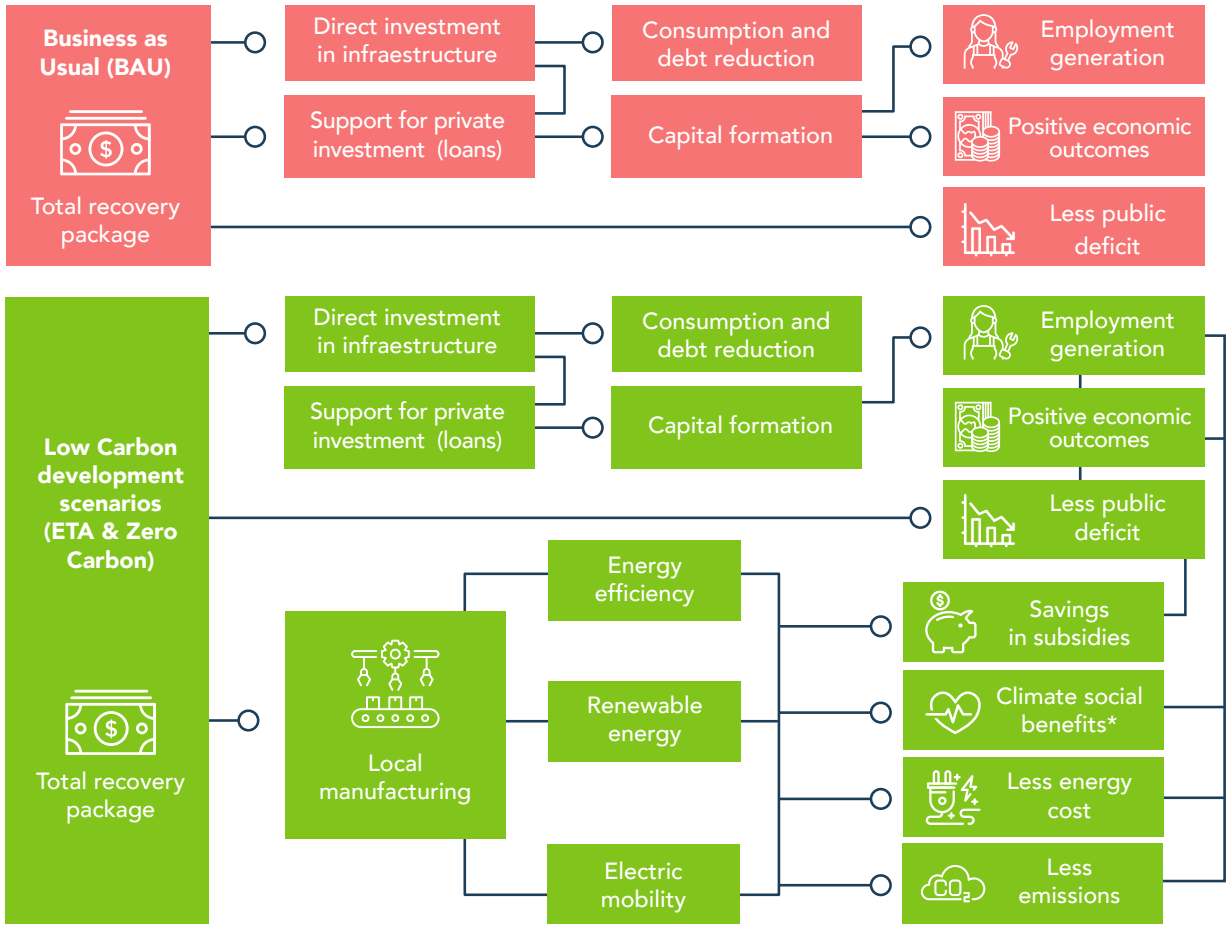
Medium and long-term (2020-2050)

Includes the outcomes of extending the low carbon ambition after 2025, when the COVID-19 recovery spending ends, following the implementation of the energy transition by 2050. For the medium-term, results will cover the period 2020-2030, meeting the completion of the implementation of the ETA and the NDC1´s 2030

energy-related mitigation target. Finally, for the long-term, results will cover the period 2020-2050, corresponding with the period of the long-term low GHG emission development strategy to meet Panama´s Paris Agreement commitment by 2050.

This report considers policy targets and developments until July 2020, including economic impact of COVID-19. Policy changes and targets announced since then are not included in the GEM analysis. All scenarios presented in this document have been validated by government officials from the National Energy Secretariat and the Ministry of Environment of Panama.

Figure 1. Seizing the opportunity of integrating the ETA into Panama´s COVID-19 economic recovery plan.



* Better health &air quality, less traffic accidents and congestion and less coail cost of carbon.

Note: Based on UNEP scenarios (BAU, ETA, and Zero Carbon) for 2020-2050.

2. Scenarios analyzed

The scenarios for the envisaged energy transformation

This report presents an analysis of the cost, benefits and investment needs for low-carbon technologies to achieve the envisaged energy transformation formulated in each scenario. The analysis considers several scenarios and their socio-economic outcomes, estimated using an integrated and science-based modeling approach. The scenarios include the base case (BAU Scenario), which assumes the continuation of existing trends, and two low carbon development pathways. One of these assumes moderate ambition, aligned with the ETA goals (ETA Scenario). The second considers higher ambition, which provides a deeper decarbonization trajectory for the energy sector to 2050 (Zero Carbon Scenario). Despite the level of ambition, each scenario is founded on the main pillars of the energy transition, which are: renewable energy technologies for power and heat generation, electric mobility for passenger transport, and energy efficiency equipment in buildings.

The realization of the ETA and the Zero Carbon ambition requires a joint effort of all economic actors in the country. The interventions considered in this report are many and varied and include (i) investments in public infrastructure (normally the responsibility of the public sector), (ii) investments in appliances, equipment and vehicles (normally the responsibility of the private sector and households), and (iii) behavioral change to reduce energy consumption and use energy more efficiently and more responsibly (primarily implemented by citizens).

Renewable energy, energy efficiency and passenger transport electrification are at the heart of the energy transition and climate goals

The role of each economic actor is fundamental for the achievement of the low carbon ambition of the country. In this respect, the Government of Panama has already designed policies to stimulate the contribution of the private sector and households. Incentives, such as the foregone transmission and distribution cost for renewable energy projects under 10MW, play this role, where an initial contribution of the government leverages more investments by the private sector and households.

In this analysis we consider that investments for the realization of the ETA and Low Carbon scenarios will come from all economic actors (public and private sectors). Specifically, the share of public investment considered is in the range of 60%-78% of the total estimated cost of low carbon interventions. The public investment is calculated by adding the value of projects that are typically the responsibility of the government (e.g. investments in public transport, such as metro lines and Mibus buses, and chargers for electric vehicles and chargers for electric vehicles, plus cost sharing for private vehicles, e.g. via incentives).

However, the Government is in a position to decide what to invest and how over time (e.g. what portion of the investment could be leveraged by public incentives to stimulate private investment), knowing that, as forecasted in this report, low carbon investment are economically viable and generate positive returns. The analysis of these two scenarios highlights the outcomes that emerge from the implementation of all the investment required regardless of the origin of the resources.

Business as Usual (BAU Scenario)

The base case for this report, reflecting a continuation of historical trends. No new policies are introduced under this scenario. In the short-term (2020-2025), it is assumed that the COVID-19 economic recovery plan is implemented as announced, with no particular emphasis on low carbon development. Through the Panama´s economic recovery package USD$8 billion are injected into the economy over the next five-year period. Please see Figure 2 for the main features of the BAU Scenario. Please also refer to the main technical document for more details.

Energy Transition Agenda (ETA Scenario)

Considers the ETA objectives, Government of Panama´s current energy plans and other planned targets and policies, including the first NDC1 update recently submitted under the Paris Agreement. In the short-term (2020-2024), a share of the recovery package is allocated in low carbon investments in alignment with ETA objectives. Specifically, the 39% of the volume of the recovery package (USD$3.14 billion) is being allocated

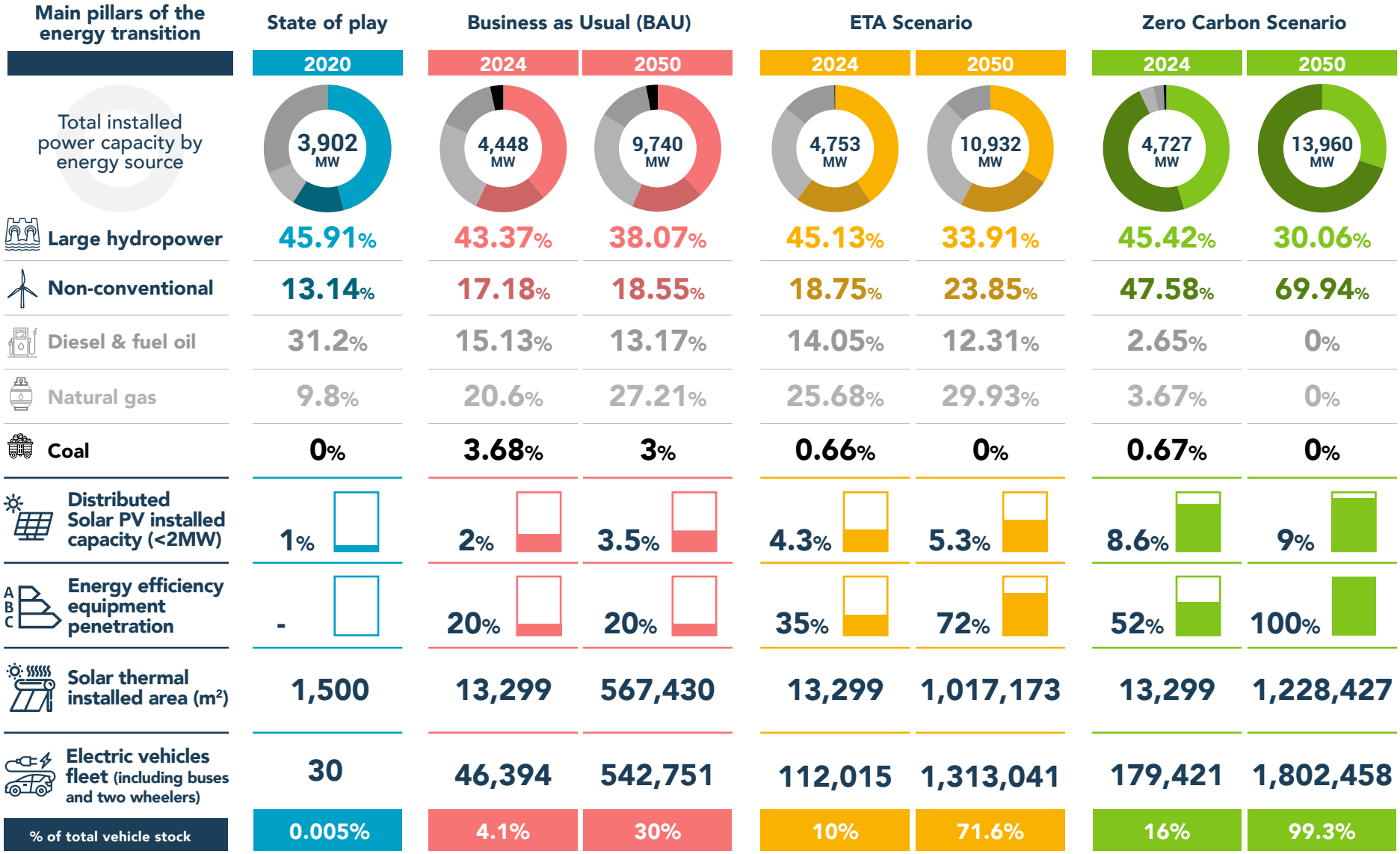
as public investments. The public investments are being allocated towards passenger transport electrification (Metro Lines and MiBus busses), improvement of energy efficiency in public buildings, and solar thermal deployment in governmental buildings and related public infrastructure. Also, that public investment considers that USD 33.5 million out of the USD 150 million credit line for micro, small, and medium enterprises, announced under the recovery package, are allocated to the acquisition of energy efficient equipment, renewable distributed generation systems, solar thermal systems and electric two wheelers with the aim of constituting a specific credit package to promote the private investment in the energy transition. The scenario foresees that starting in 2020 no new fossil fuel-based power units would be commissioned, except for natural gas plants. The existing capacity for coal is decommissioned by 2026. **Energy subsidies to consumers are phased out by 2025.** Includes the expansion of the metro network and passenger transport by train Please see Figure 2 for the main features of the ETA Scenario. Please also refer to the main technical document for more details .

Zero Carbon Scenario

The most ambitious low carbon scenario. The Zero Carbon Scenario will lead to zero emissions from the power and passenger transport sectors by 2050. In the short-term (2020-2024), a share of the recovery package is allocated in low carbon investments in alignment with ETA objectives. Specifically, the 71% of the volume of the recovery package (USD$5.7 billion) is being allocated as public investments. The public investments are being allocated towards passenger transport electrification (Metro Lines and MiBus busses), improvement of energy efficiency in public buildings, and solar thermal deployment in governmental buildings and related public infrastructure. Also, that public investment considers that USD 67 million out of the USD 150 million credit line for micro, small, and medium enterprises, announced under the recovery package, are allocated to the acquisition of energy efficient equipment, renewable distributed generation systems, solar thermal systems and electric two wheelers with the aim of constituting a specific credit package to promote the private investment in the energy transition. This scenario foresees that starting in 2020 no new fossil fuel-based power units would be commissioned. The existing capacity for coal and natural gas is decommissioned by 2026 and by 2030. **Energy subsidies to consumers are phased out by 2025.** Includes the expansion of the metro network and passenger transport by train. Please see Figure 2 for the main features of the Zero Carbon scenario. Please also refer to the main technical document for more details on the Zero Carbon scenario.

Zero Carbon Scenario overall composition shifts away from dependence on fossil fuels

Figure 2. Key indicators for the three scenarios based on the main pillars of the energy transition



Scenarios aligned with the local content goals

In the ETA and Zero Carbon scenarios, two energy transition options were considered. The first assumes that the technology required for the energy transition is 100% imported. The second considers the potential to produce infrastructure and equipment locally, for up to 30% of local value chain creation (the naming convention of scenarios uses "1" for scenarios with imports only and "3" for scenarios with 30% of local manufacturing capacity). These latter scenarios assume a stronger participation of the private sector for the creation of local value chains. As a result, the scenarios are named as follows: (1) BAU, (2) ETA1 and (3) ETA3, and (4) Zero Carbon1 (5) Zero Carbon3.

One of the main goals of the Government of Panama is positioning Panama as a strategic energy hub for Latin America. To achieve this, the Government of Panama has developed a wide range of mechanisms with the aim of encouraging foreign investment and creating new companies in Panama, with a strong focus on promoting Panama´s business environment for manufacturing industries. In line with this national context, the results presented in this Summary for Policymakers will focus on the scenarios that include 30% of local manufacturing, which are the following: (1) BAU, (2) ETA3, and (3) Zero Carbon3. Please refer to the main technical document for more detail on the scenarios with imports only "1".

The energy transition provides ample opportunities to create local value chain in alignment with the country's strategic industrial objectves

Photo: Science in HD, Unsplash.

3. The immediate socio-economic benefits of a green recovery plan

This section presents the inmediate cost and benefits of integrating the energy transition at the heart of the Panama's COVID-19 economic recovery plan.

A green recovery plan embedded in the energy transition calls for a scale-up and shift of investments to clean energy technologies and fossil fuel subsidies removal

The socio-economic analysis presented per scenario shows the economic, social, and environmental impacts that could be achieved if a greener recovery package, aligned with the energy transition, is implemented.

Energy transition investments at the front line of recovery efforts

Investment in the energy transition could become a critical enabler of Panama´s recovery efforts in the next four years. The green recovery plans, formulated in ETA3 and Zero Carbon3 Scenarios, call for a scale up and reallocation of investments to clean energy technologies that are commercially mature, economically competitive, and technically reliable, seek for economies of scale, and availability of access to means of financing. Green recovery plans also considers removal of fossil fuel subsidies.

Overall, total cumulative additional investments in the ETA3 and Zero Carbon3 Scenarios is USD 4.57 and USD 8.81 billion by 2024. The additional investment is equivalent to around 2.55% and 4.91% of average annual GDP over the period, respectively. By 2024, the cumulative additional investment for the sectors considered is 26.19% and 50.84% higher relative to the BAU for the ETA3 and Zero Carbon3 Scenario. Of that total, more than 90% is invested in the passenger transport electrification and renewable energy for power generation. The last one accounts for 75% and 98% of the total investment in power generation in the ETA3 and Zero Carbon3 Scenarios (Figure 3).

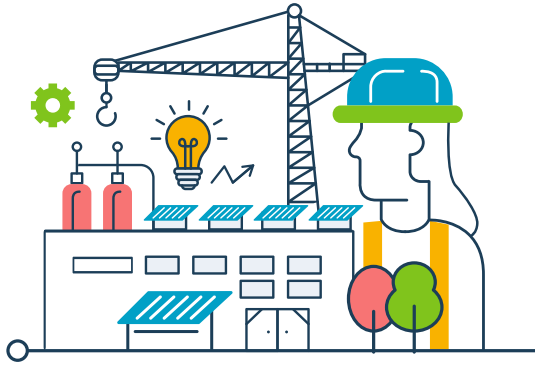
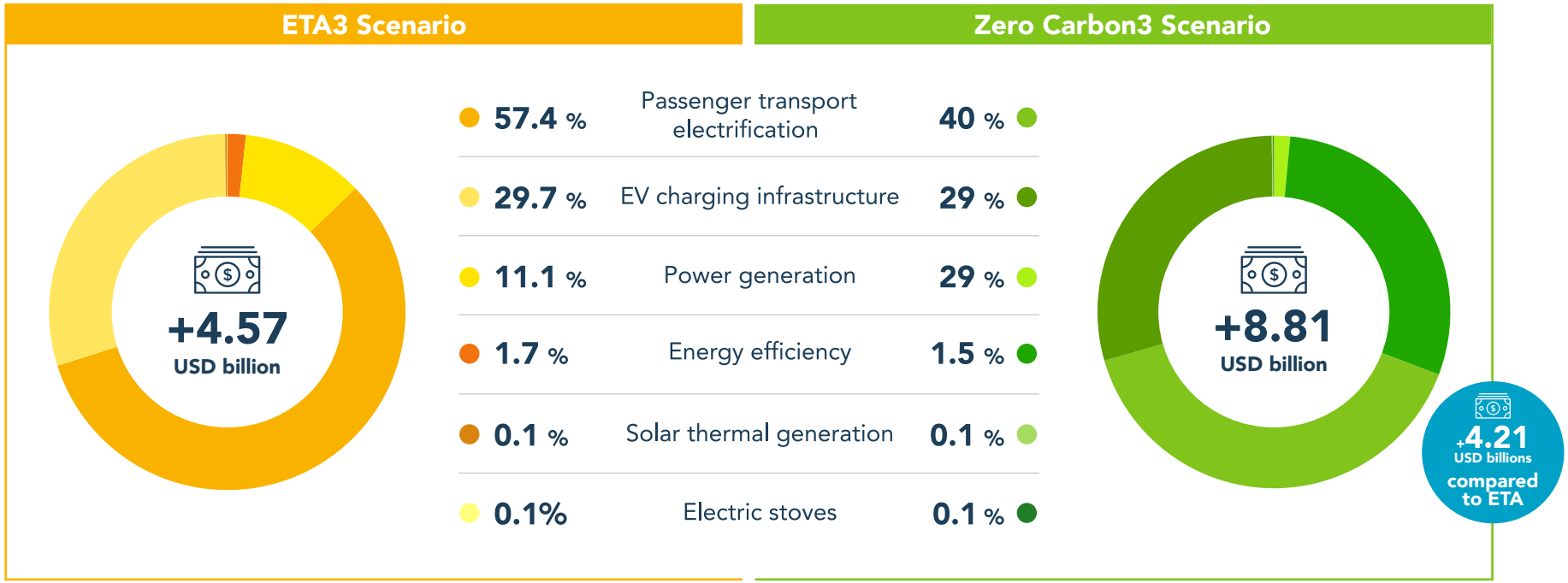


Figure 3. Energy transition investment priorities in renewable energy, energy efficiency and passenger transport electrification.

Discounted additional cumulative investments (USD billion) 2020-2024.
ETA 3 Scenario and Zero Carbon3 Scenario compared to BAU Scenario.
Discounted rate 7.5%.



Immediate economic growth and employment benefits

A recovery package focused on the energy transition can strengthen macroeconomic stability and help Panama to overcome the economic recession, both in the short and long-term:

- **Supportive policies and energy transition investment can greatly 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 0.52% higher in the ETA3 Scenario. When a higher ambition is considered, such as the ZeroCarbon3 scenario, this figure, real GDP, would be multiplied by more than four times (2.35%). In the ETA3 Scenario, the additional cumulative gain through increased real GDP from 2020 until 2024 would amount USD$ 0.48 billion and would generate on average USD$0.12 billion additional real GDP per year over the next 4 years, equivalent to an additional annual average growth rate of 0.11% more than BAU. On the other hand, the Zero Carbon3 Scenario would inject additional USD$ 2.33 billion to the economy through cumulative real GDP growth by 2024. Low carbon interventions would generate on average USD$0.58 billion additional real GDP per year over the next 4 years, equivalent to an additional annual average growth rate by 0.50%.

Investment in the energy transition could become a critical enabler of Panama´s recovery efforts in the next four years

Figure 4. 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 %

GDP would grow more with low carbon development scenarios than in BAU, with Zero Carbon3 Scenario holding a considerable edge

Changing investment focus towards the energy transition can create much needed jobs. Under the ETA3 Scenario 15,687 net additional jobs would be created by 2024. This is 0.5% more than under the BAU Scenario. This would lead to a reduction in the unemployment rate of -0.4% by 2024 compared to BAU approach. Of the total additional jobs created, 15.9% correspond to direct employment in the energy sector – comprising transition-related technologies - the remaining 84,1% are indirect jobs, which are distributed economy-wide. Under the Zero Carbon3 Scenario 53,959 net additional jobs would be created by 2024. This is 1.8% more than under the BAU Scenario. This would lead to a reduction in the unemployment rate of -1.5% by 2024 compared to BAU case. On balance, more jobs in the energy sector would be created than are lost in the fossil fuel industry. Job losses would reach -1,403 in 2024 derived from the thermal power generation. Of the total additional jobs created, 18.6% correspond to direct employment in the energy sector. In both scenarios, direct employment is higher in the short term, when investments are first implemented; indirect employment creation increases steadily as economic gains accumulate over time. In 2024, new jobs created by transition-related technology are highest for charging infrastructure for electric vehicles (EVs), and renewable power generation (Figure 6). These two items together account for more than 80% of the additional direct employment created. 90% of the additional direct jobs created in the renewable energy sector correspond to solar photovoltaic (PV) and wind. Concerning indirect jobs, in both low carbon scenarios, 28% of new jobs are found in industry and the remaining 72% in the services sector. These additional jobs emerge by supporting the creation of the domestic value chain for transition-related technologies.

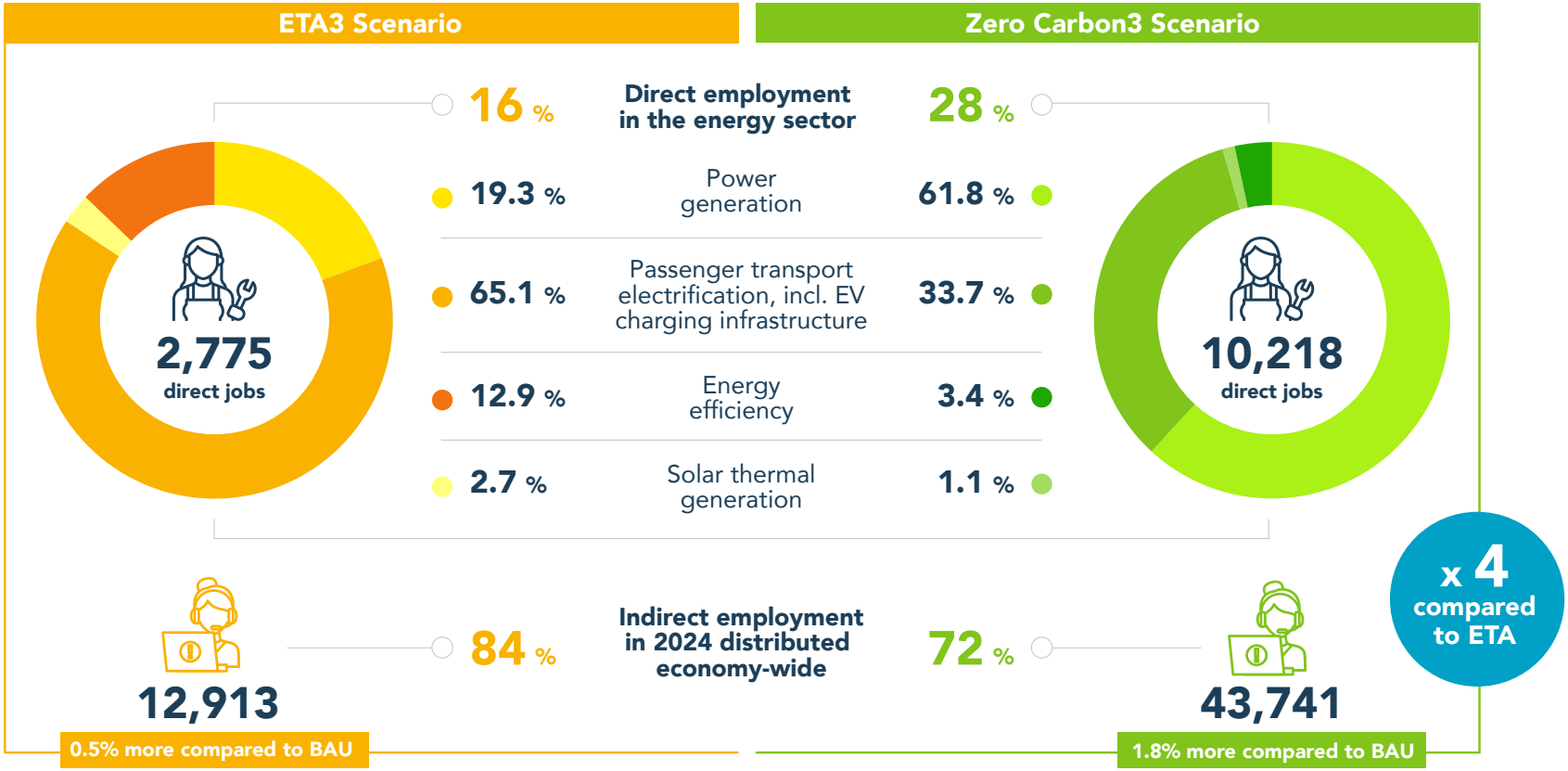
Promoting energy transition-related sectors through Panama´s recovery package would require developing industrial policies and educational programs aimed at building local supply chains and developing the skills and competences needed across industries to adapt to this transformation.

Industrial policies can help to boost higher positive socio-economic benefits

More jobs in the energy sector would be created than are lost in the fossil fuel industry

Figure 5. The net additional jobs created by investments in the energy transition under the Zero Carbon3 Scenario are four times greater than those created in the ETA3 Scenario by 2024.

Net additional employment distribution in the overall energy sector in 2024 (thousand jobs).
ETA3 Scenario and Zero Carbon3 Scenario compared to BAU Scenario.



Jobs in the energy sector and across the economy would grow higher under both scenarios than in BAU, but faster under Zero Carbon3 Scenario

The potential of this transition would lie in enhancing and increasing all links across value chains, making use of training and education programs, as well as the creation and implementation of policies that look at markets with a farsighted view of the future. In addition, it is recommended considering 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 with supply. The industrial policies necessary for the recovery need to integrate the technologies of the transition – renewable energy, energy efficiency and electric mobility – allowing the development of a national industrial and services sector. The prioritization of these green industries will create local value and generate more opportunities for both skilled and unskilled workers, resulting in better sustainable socioeconomic results in the short-terms and beyond.

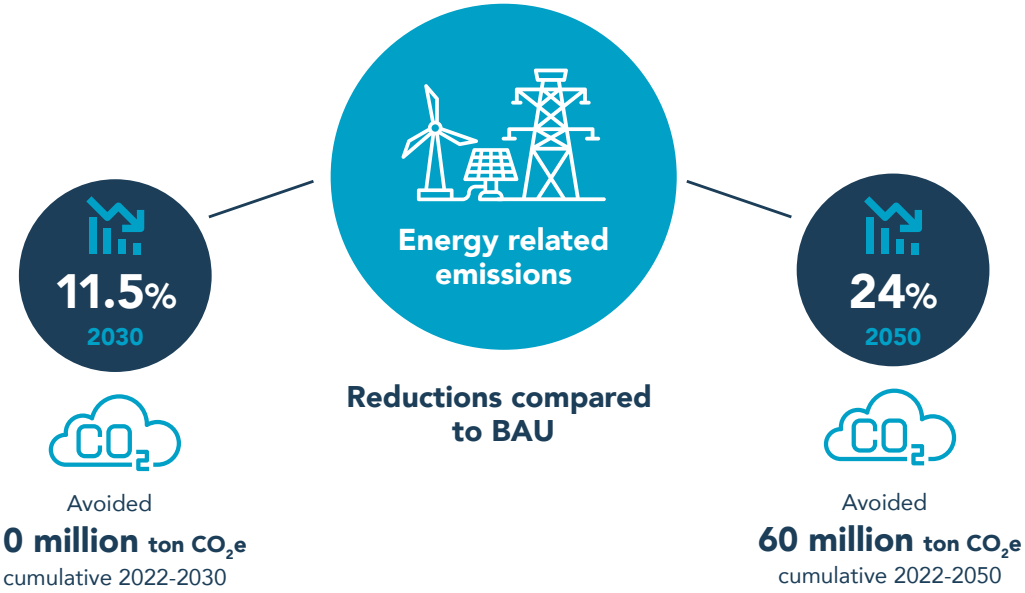
Greater social and climate co-benefits

Early action to channel investments, along with policy interventions, in the right energy technologies is critical to reduce energy related CO_2eq emissions. Renewable energy, transport electrification, and energy efficiency are the main pillars of the energy transition. Accelerated deployment of these clean technologies must start now if Panama´s NDC1 2030 and 2050 targets are to be reached. In fact, the investments made today have a lifetime of 20 to 30 years for most technologies and infrastructure. The ETA3 indicates the projected fall in cumulative energy-related CO_2 emissions as a result of the revised policies and plans, included in the Panama´s first update NDC1.

Accelerated deployment of clean energy technologies must start now if Panama´s NDC1 2030 and 2050 targets are to be reached

Figure 6. Panama´s NDC1´s energy- related CO_2 emission reduction target by 2030 and 2050.

The ETA3 Scenario indicates the projected fall in cumulative energy-related CO_2 emissions included in the Panama´s first update NDC1.



The ETA3 and Zero Carbon3 Scenarios forecast that emissions from the energy sector would decline by 10% and 20.8% in 2024, respectively, compared to BAU, corresponding to 1.4 and 2.6 million tons CO_2eq in avoided emissions. These would be equivalent to 3.3 and 6.5 million tons CO_2eq cumulative by 2024. The ETA3 Scenario would reach NDC1´s 2050 energy-related CO_2 emission reduction target by 2048, whereas in the Zero Carbon3 Scenario this goal would be met by 2025. Under ETA3 Scenario, by 2024 CO_2 emission reduction associated with petroleum and electricity represent 20,9% and 79,5% respectively. Transport and residential sectors are the largest contribution for petroleum emission reductions, constituting 94,3% and 5.6% respectively, being the first one associated to transport electrification and the latter with the replacement of the domestic use of GLP by solar thermal and electric cooking stoves. In the Zero Carbon3 Scenario, by 2024 CO_2 emission reduction associated with petroleum and electricity represent 16,0% and 84,4% respectively. Transport and residential sectors are the largest contribution for petroleum emission reductions, constituting 93,1% and 6,9% respectively.

The Zero Carbon3 Scenario would reach NDC1´s 2050 energy-related CO_2 emission reduction target by 2025, whereas in the ETA3 Scenario this goal would be met by 2048

Figure 7. Renewable energy, energy efficiency and transport electrification all help to further reduce energy sector emissions compared to BAU Scenario.

Indicator	ETA3 Scenario	Zero Carbon3 Scenario
Decline of emissions from the energy sector in 2024	-10 %	-20.8 %
Avoided tons of CO_2eq emissions in 2024	-1.4 million tons	-2.6 million tons
Avoided tons CO_2eq cumulative by 2024	-3.3 million tons	-6.5 million tons

Time for a systemic transformation

The energy transition can be a paradigm shift of Panama´s society and economy. The integration of the energy transition into Panama´s recovery plan presents a low-emission pathway for stable, short-term economic development. Even in the midst of a difficult fiscal situation, as a result of the COVID-19 impacts, investments in the energy transition, as part of the Panama´s COVID-19 economic recovery plan, would generate stronger short-term economic recovery, more jobs, cleaner living environment and improved social well-being over 2020-2024 period and beyond. The energy transition can improve Panamanian population´s well-being. Investing in the energy transition agenda has beneficial impacts on air quality beyond the reduction in energy related CO_2eq. This in turn improves human health and minimizes the environmental and economical damage caused by climate change. For the first, less air polllution means less health costs for the country and for the second, it means more productivity, because less worked days are lost due to air pollution episodes. This productivity enhancement is one of the factors that supports a larger GDP generation. The Zero Carbon3 Scenario would achieve greater social and climate benefits than the ETA3 Scenario (Figure 8).

The integration of the energy transition into Panama's recovery plan presents a low-emission pathway to stability and prosperity.

Figure 8. The immediate additional socio-economic benefits of a green recovery plan based in the energy transition 2020-2024.
ETA3 Scenario and Zero Carbon3 Scenarios compared to BAU Scenario.

Indicators	ETA3	Zero Carbon3
Higer GDP	+0.52 % USD$ 0.49 billion	+2.35 % USD$ 2.33 billion
More job creation	+15,687	+53,959
Improve government finance	USD$ 0.16 billion	USD$ 0.74 billion
Increase in labor Income	USD$ 0.16 billion	USD$ 0.48 billion
Savings in energy subsidy phase-out	USD$ 0.56 billion	USD$ 0.57 billion

Indicators	ETA3	Zero Carbon3
Greater energy-related CO_2 emission reduction	-10 %	-20.8 %
All scenarios improve air quality leading to cleaner cities		
Less people with respiratory diseases	-19,169	-28,739
Savings in health system	USD$ 0.02 billion	USD$ 0.03 billion
Reduced environmental damage – protecting the climate	USD$ 0.11 billion	USD$ 0.22 billion

4. Paving the road for prosperity through the energy transition

What happens after 2025, when COVID-19 recovery spending ends?

This section presents the main macroeconomic and socio-economic outcomes and investment needs for extending the low carbon ambition to 2050 to achieve the envisaged energy transformation, specified in each Low Carbon Development Scenarios - ETA3 and Zero Carbon3.

Substantial scale-up and a shift of investment patterns must happen

- **Substantial scale-up and a shift of investment will be required to enable Panama´s energy transition, while subsidies to fossil fuels must be phased out.** Fossil-fuel investments are increasingly risky. These types of investments will lead to stranded assets and will lock-in energy emissions for decades. While, in both Low Carbon Development Scenarios, the cumulative additional investments would be higher than in the BAU case, the overall energy mix composition will gradually shift away from hydrocarbons. To ensure a climate-safe prospect, investments must be redirected towards a comprehensive energy system

With only 11 billion added to the total investment volume by 2030, the Panama´s energy sector could become more climate resilient, with market-based and cost-effective renewable power generation technologies

transformation that prioritizes renewable energy and energy efficiency, coupled with transport electrification. The ETA3 and Zero Carbon3 Scenarios would require a total cumulative additional investment of USD$9 billion and USD$20.01 billion, respectively, by 2030. This is equivalent to an increase around 30.2% and 67.2%, respectively, by 2030 compared to BAU. Over that period, the Panama´s economy would need to invest each year 2.1% and 4.65% of its annual GDP on average in energy decarbonization solutions. For the longer-term, by 2050, the ETA3 and Zero Carbon3 Scenarios would require a total cumulative additional investment of USD$21.08 billion and USD$47.09 billion, respectively. This is 43% and 83.9% more than in the BAU plan, by 2050. Zero Carbon3 Scenario overall composition would shift decisively away from fossil fuels. Over that period, the Panama´s economy would need to invest each year 2% and 3.82% of its annual GDP on average to achieve the low-carbon energy transformation. For the ETA3 Scenario and Zero Carbon3 Scenario, the electrification of the passenger transport sector and renewable energy for power generation would absorb the bulk of total investments. Solar PV and wind technologies will get the biggest share of total power generation investments (Figure 9).

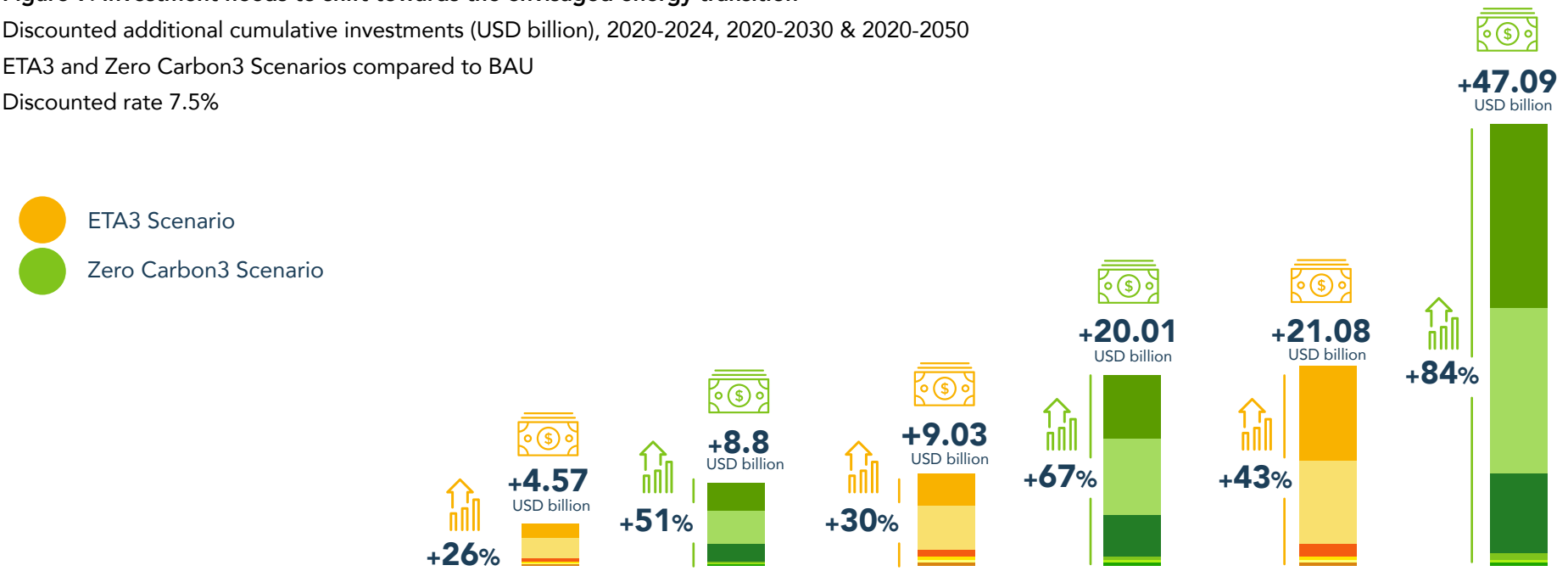
A full decarbonization of the energy system means almost doubling planned investments in the energy transition over the next three decades

Figure 9. Investment needs to shift towards the envisaged energy transition

Discounted additional cumulative investments (USD billion), 2020-2024, 2020-2030 & 2020-2050

ETA3 and Zero Carbon3 Scenarios compared to BAU

Discounted rate 7.5%



USD billion	2024	2024	2030	2030	2050	2050
EV charging infrastructure	1.36	2.58	3.46	6.89	10.37	19.76
Passenger transport electrification	2.62	3.50	4.57	7.98	8.86	17.69
Power generation	0.51	2.58	0.76	4.72	1.26	8.69
Energy efficiency	0.08	0.13	0.18	0.32	0.36	0.60
Solar thermal generation	0.01	0.01	0.06	0.10	0.22	0.33
Electric stoves	0.00	0.01	0.00	0.02	0.01	0.02
Investment per average of annual GDP	**2.55%**	**4.91%**	**2.1%**	**4.65%**	**2%**	**3.82%**

The energy transition pays for itself

The benefits resulted of Panama´s energy transition outweigh the cost. By redirecting investments, Panama would achieve greater gains, even without computing social and climate avoided costs. By 2030, the ETA3 and Zero Carbon3, while costing USD$9.03 billion and USD$ 20.01 billion more than the BAU Scenario, would bring USD$7 billion and USD$26.7 billion in cumulative additional gains, respectively. For every U.S. Dollar that Panama invests in energy transition, USD$ 0.78 and USD$ 1.33 in returns would be achieved by 2030. With a different overall energy mix composition and only 20 billion added to the total investment volume, the Panama´s energy sector could become more climate resilient, with market-based and cost-effective renewable power generation technologies by 2030. For the longer-term, by 2050, the ETA3 and Zero Carbon3, overall incremental investment needs are USD$21 billion and USD$47 billion, which would bring USD$44.5 billion and USD$160.65 billion in cumulative additional gains, greatly exceeding the additional investments needed by 2050. In the ETA3 Scenario, every U.S. Dollar that Panama invests in energy transition can bring returns as high as USD$ 2.11, reaching the payback period in eleven years. On the other hand, in the Zero Carbon3 Scenario, for every U.S. Dollar that Panama invests in decarbonizing its energy sector, USD$ 3.4 of economic benefits are achieved, reaching the payback in six to seven years (Figure 10).

Out of these cumulative additional gains, USD$44.5 billion and USD$ 148.37 billion correspond to added economic benefits, in the ETA3 and Zero Carbon3 Scenarios. These figures would double and more than triple investments, respectively. A total amount of 70% of the added economic benefits corresponds to additional real GDP gains, 26% to additional government revenues, and 4% to additional labor income in both scenarios. In the ETA3 and Zero Carbon3 scenarios, labor productivity per employee is 3.4% and 10% higher in 2050 compared to the BAU scenario.

In the ETA3 Scenario, every U.S. Dollar that Panama invests in energy transition can bring returns as high as USD$ 2.11, reaching the payback period in eleven years. In the Zero Carbon3 Scenario, for every U.S. Dollar, USD$ 3.4 of economic benefits are achieved, reaching the payback in six to seven years

In addition to economic benefits, there are considerable cost savings in both Low Carbon Development Scenarios relative to the BAU case, which account for a quarter of the required investment. Avoided costs add up to USD$ 5.4 billion and USD$ 12.3 billion, in the ETA3 and Zero Carbon3. Savings in energy cost, energy subsidies, social cost of carbon and transport-related externalities are considered among the categories of economic avoided cost. The shift in investments towards renewable energy power technologies underpinned with efficiency use and coupled with passenger transport and heat electrification would lead to higher energy cost savings in the Zero Carbon3 Scenario than in the ETA3 Scenario, amounted USD$0.92 billion and USD$5.5 billion.

This is because renewable energy costs will continue to fall rapidly, making non-conventional renewable power a cost-effective investment. Solar photovoltaic (PV) and wind energy will win the race. Non-conventional renewable power will become the default source of least cost new power generation and, in some cases, cheaper than existing fossil fuel-fired plants. In addition, in both Low Carbon Development Scenarios, it is considered a coherent energy policy that not only reflects the supply of affordable and reliable power, but also public health impacts, climate change and environmental degradation. Under this premises, fossil fuel subsidies are difficult to justify. Fossil fuel subsidies are highly costly for the Government of Panama and undermine the decarbonization of the energy sector. 100% fossil fuel subsidy removal from 2025 will free up USD$ 3.5 billion and USD$ 3.7 billion by 2050, contributing to levelling the playing field of non-conventional renewable energy investment for the private sector. Finally, additional social and climate avoided cost would be estimated to be reduce in USD$ 2 billion and USD$ 3 billion, in the ETA3 and Zero Carbon3 Scenarios (Figure 10).

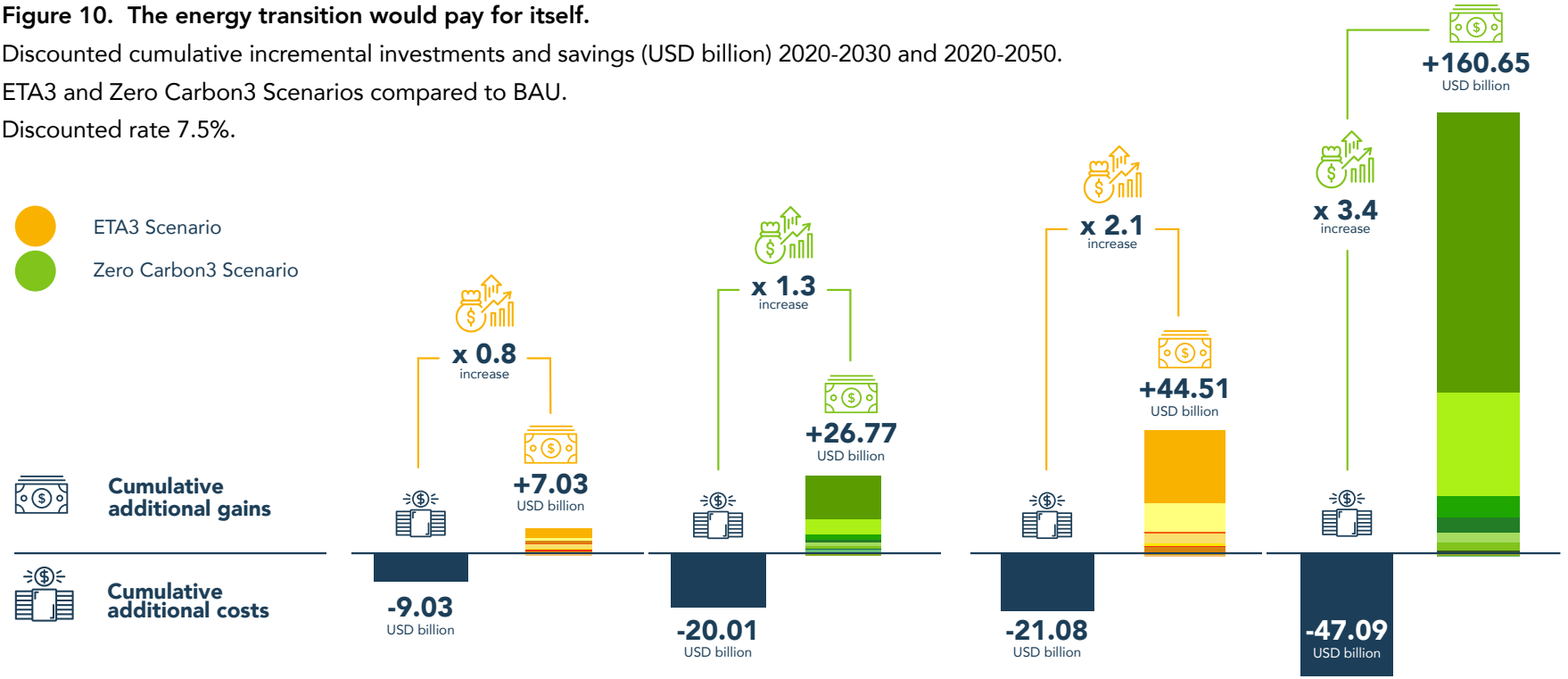
Fossil fuel subsidy removal will free up to USD$ 3.7 billion by 2050, contributing to levelling the playing field of non-conventional renewable energy investment for the private sector

Figure 10. The energy transition would pay for itself.

Discounted cumulative incremental investments and savings (USD billion) 2020-2030 and 2020-2050.

ETA3 and Zero Carbon3 Scenarios compared to BAU.

Discounted rate 7.5%.



Cumulative additional gains		2030	2030	2050	2050
Added benefits	Real GDP	3.69	16.09	26.98	102.32
	Government revenue	1.23	5.35	10.15	38.22
	Labor income	0.54	2.04	1.99	7.83
Avoided costs	Energy subsidy	1.55	1.60	3.46	3.70
	Energy cost	-0.39	0.95	0.93	5.55
	Climatic costs (SCC)	0.36	0.82	1.24	2.94
	Cost of air pollution from transport	0.06	0.10	0.20	0.44
	Other related transport externalities	0.01	-0.04	-0.07	-0.04
	Value of time lost due to congestion	-0.02	-0.01	-0.35	-0.28

GDP and employment on the rise

Supportive policies and investments in the Panama´s energy system transformation would bring higher economic yield in the medium and longer-term than historical trends: Panama´s real GDP increases over the next three decades in all Scenarios. However, investments in the energy transition stimulates economic activity further to the growth that could be expected to reach under current plans. The Zero Carbon3 Scenario has consistently higher positive effect on real GDP over time, compared to the ETA3 Scenario. This is due to a net investment stimulus in renewable power and heat, energy efficiency and passenger transport and heat electrification, along with the phase-out of fossil fuel subsidies. Over time, the relative contribution of investments to real GDP growth declines. Under both Low Carbon Development Scenarios, investments in the energy transition are mostly allocated in the first 10-year period. In addition, in the first 10-year period, existing fossil fuel installed capacity is retired and replaced with additional investment in renewables. Over the period 2020-2030, real GDP average annual growth rate would be 0.2% and 0.8% higher under the ETA3 Scenario and Zero Carbon3 Scenario, respectively, than under the BAU tendency. By 2030, the cumulative gain through increased real GDP would amount to USD 4.8 billion and USD 27.27 billion. The higher annual growth rate of GDP accumulates over time, resulting in GDP being by 2% and 8.5% higher in 2030. Considering the long-term, period 2020-2050, real GDP average annual growth rate would be 0.2% and 0.6% higher under the ETA3 Scenario and Zero Carbon3 Scenario, respectively, than under the BAU tendency. By 2050, the cumulative gain through increased real GDP would amount to USD 125.7 billion and USD 455.22 billion. The higher annual growth rate of GDP accumulates over time, resulting in GDP being by 6.5% and 21% higher in 2050 (Figure 11).

Investments in the energy transition stimulates economic activity further to the growth that could be expected to reach under current plans.

Deeper decarbonization scenario has consistently higher positive effect on real GDP over time

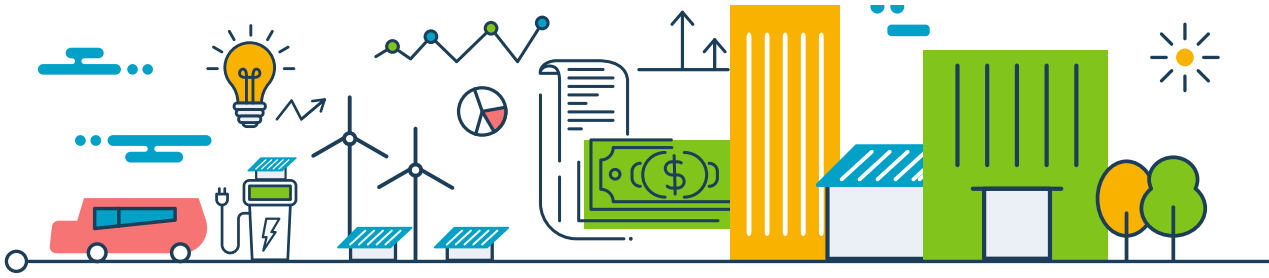
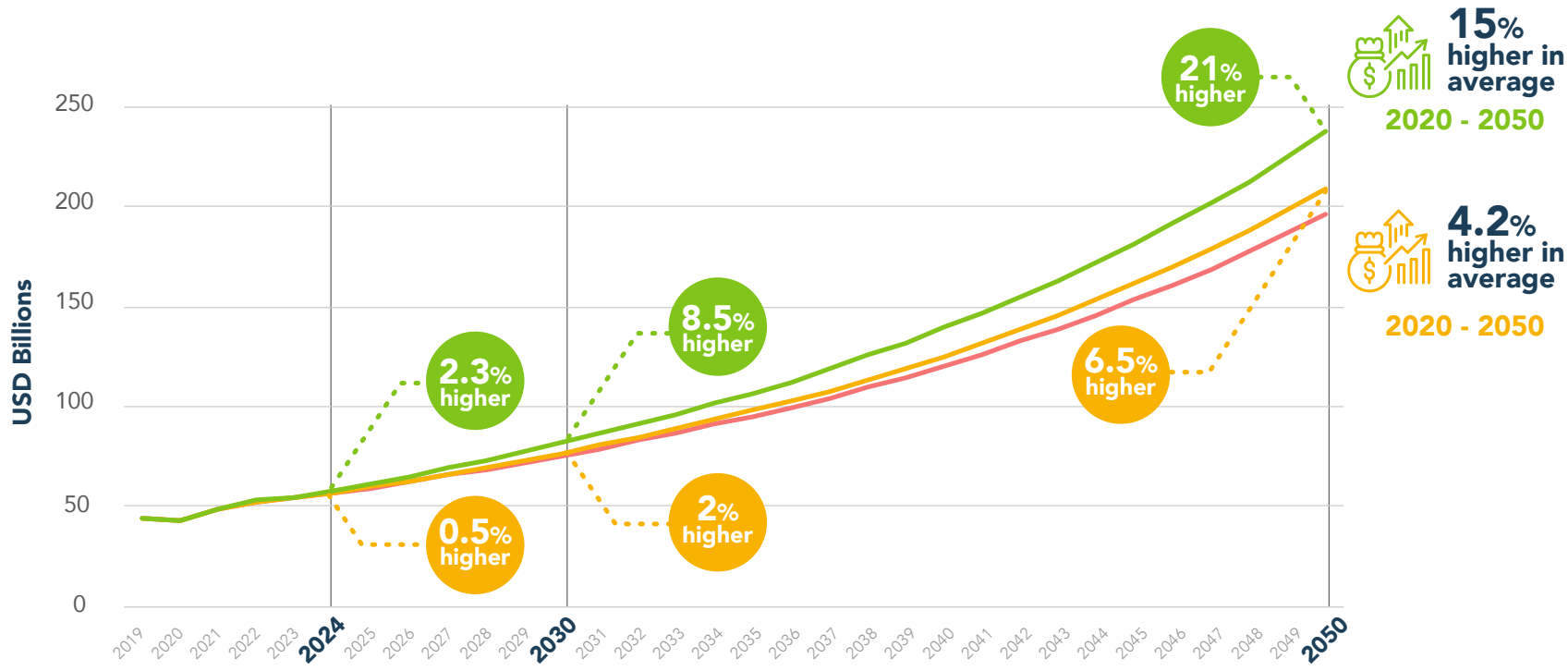


Figure 11. The energy transition results in GDP growth higher than the BAU Scenario 2020-2050.
Total Real GDP 2019-2050 (USD billion).
BAU Scenario, ETA3 Scenario and Zero Carbon3 Scenario.



Both Low Carbon Development Scenarios raise higher employment across the economy than the BAU approach, with faster tendency under the deeper energy decarbonization scenario. Compared to BAU Scenario, jobs would increase 1.1% and 4.5% by 2030, in the ETA3 and Zero Carbon3 Scenarios. Following this trend, jobs would increase even higher 3% and 10.1% by 2050, respectively. In net absolute terms, the energy transition would create 35,805 and 141,951 more jobs by 2030. These figures would be almost triple and more than double by 2050, reaching 102,098 and 336,373 of new additional jobs, respectively. By 2050, of the total additional net jobs created 10% and 7% correspond to direct employment, in the ETA3 and Zero Carbon3. In both scenarios, direct employment is higher in the short

The net additional jobs created by investments in the energy transition under the Zero Carbon3 Scenario are four times greater than those created in the ETA3 Scenario by 2030 and triple by 2050

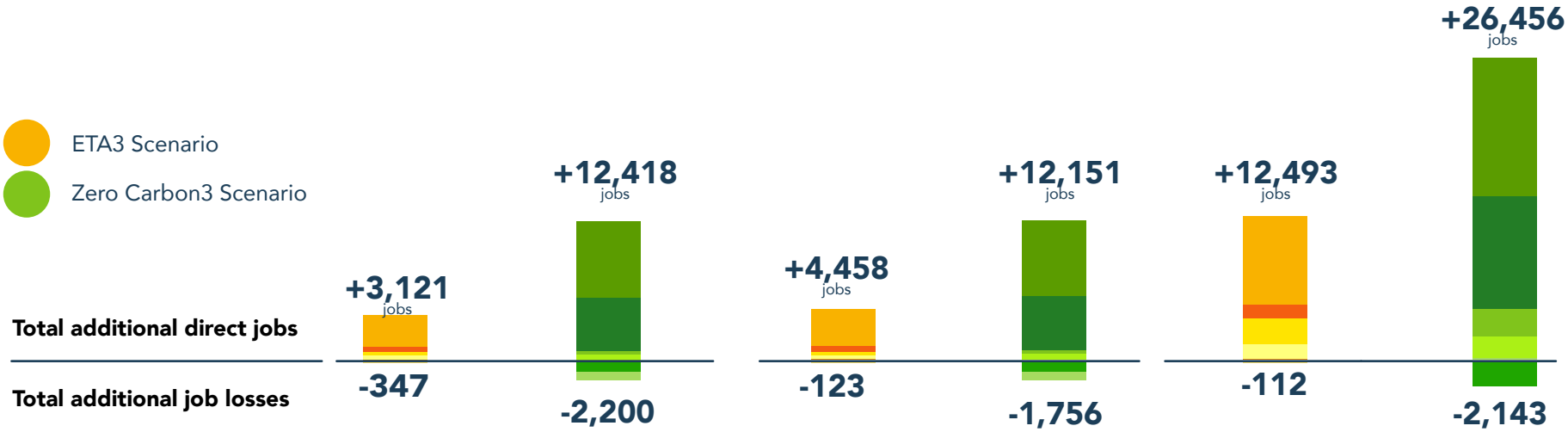
term, when investments are first implemented. The highest number of jobs is generated from the transition to renewable power generation and EV charging infrastructure, followed by energy efficiency. Overall, the first two interventions make up approximately 80% and 70% of additional direct jobs in the ETA3 Scenario and Zero Carbon3 Scenario, respectively (Figure 15). Solar PV and wind are the renewable technologies with higher employment creation rate. Concerning indirect jobs, in both Low Carbon Development Scenarios, 28% of new jobs are found in industry and the remaining 72% in the services sector. These additional jobs emerge by supporting the creation of the domestic value chain for transition-related technologies, such as construction and installation, manufacturing, operation and maintenance (O&M). Indirect employment creation increases steadily as economic gains accumulate over time. This highlights how the positive outcomes of low carbon investment add up over time, creating synergies and spillovers in many other sectors.

A transition that leaves no one behind would avoid resistances that could otherwise derail or halt it. To maximize local value, education and training policies should be in place to meet the forecasting skill needs for renewable energy, energy efficiency and electric mobility disruptive deployment. As renewables, energy efficiency and other transition-related sectors grow, other energy jobs will decrease, such as those in the fossil fuel industry. However, strategies to ensure a just transition could help to minimize the impacts on labour-market. New additional jobs would outweigh the loss of fossil fuel jobs by 2030 and 2050 (Figure 15). Under the Zero Carbon3 Scenario, 2,144 direct jobs would be lost derived from the thermal power generation.

Under the ETA3 Scenario, for every million U.S. Dollar that Panama invests in decarbonizing its energy sector 2.73 and 1.51 new additional jobs are created in total by 2030 and 2050.

Under the Zero Carbon3 Scenario, for every million U.S. Dollar that Panama invests in decarbonizing its energy sector 4.90 and 2.45 new additional jobs are created in total by 2030 and 2050

Figure 12. Investments in the energy transformation would create more green jobs than current plans in 2030 and 2050.
Net Employment distribution in the overall energy sector (thousand jobs) in 2024, 2030 and 2050.
ETA3 Scenario and Zero Carbon3 Scenario compared to 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**

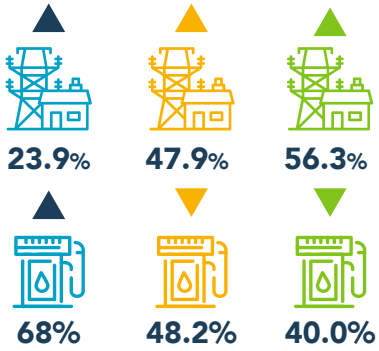
Higher benefits through sector coupling

The electrification of more areas of the economy – sector coupling – would enable Panama to make significant progress toward reaching zero emissions by 2050. Transformational change needed to meet the Paris Agreement and reach net zero emissions by midcentury can be critically supported by coupling the power and transport and heat sectors. Sector coupling would enable these sectors to shift away from dependence on fossil fuels and toward the power system. Realizing synergies and interlinkages between sectors of the economy derive potentially in higher economic benefits and greater mitigation impact.

In the ETA3 Scenario, while the penetration of EVs increases up to 72% by 2050, along with other investments in rail-based transport, energy efficiency measures, and other low carbon technologies, such as solar thermal systems and electric stoves, 40% of the total power installed capacity will be provided by fossil fuel energy sources. On the other hand, by 2050, the Zero Carbon3 Scenario assumes 100% electrification of the passenger transport sector coupled with a fully renewable power sector. Embarking on the road to electrify the passenger transport sectors coupled with the transition towards a fully renewable power sector would contribute to a more cost-efficient decarbonization thanks to cheap renewable and a growing cost competitiveness of EVs.

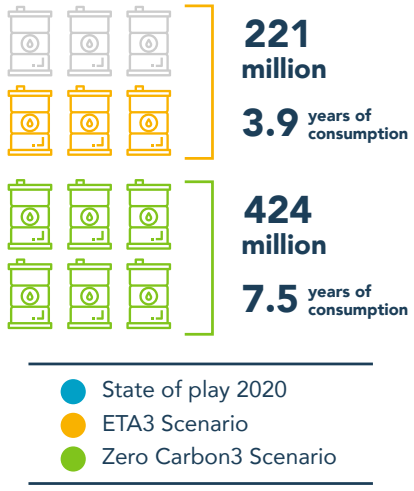
Under the energy transition scenarios, the Panama´s energy system will become increasingly electric and digitalized. Electricity will play a central role in Panama´s decarbonization strategy since is one of the lowest-cost means of low-carbon energy across many different sectors and applications, and it can be gradually decarbonized thanks to the roll-out of the growing cost-competitiveness zero-carbon technologies. Sector coupling pathways established in the ETA3 and Zero Carbon3 Scenarios would enable Panama´s power demand to account to 47.9% and 56.3% of the final energy consumed by 2050, compared to just 23.9% today. The share of fossil fuels drops from 68% in 2020 to 48.2% and 40.0% in 2050 in the ETA3 and Zero Carbon3 Scenarios. These reductions in fossil fuel consumption are equivalent to 4.3 million barrels of crude oil and 7.3 million of barrels of crude oil in the year 2050 alone, or cumulatively close to 3.9 years and 7.5 of consumption in the year 2020. At macroeconomic level, reducing the country´s dependence on

Power demand and fossil fuel as share of final energy consumed by 2050



Reducing dependency on imported energy results in reduced exposure to price volatility and greater energy security.

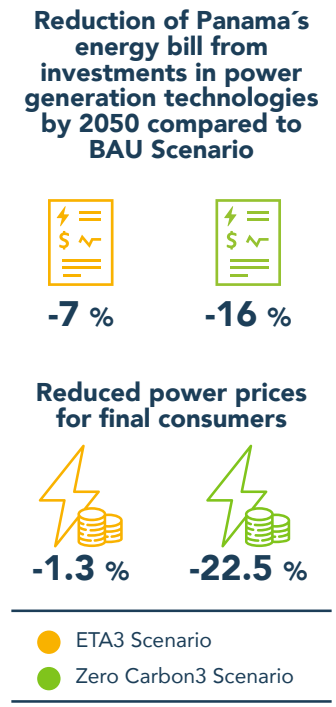
Cumulative barrels of crude oil reduced 2020 - 2050



imported energy means an improvement to the balance of trade an GDP, reduced exposure to price volatility and greater energy security.

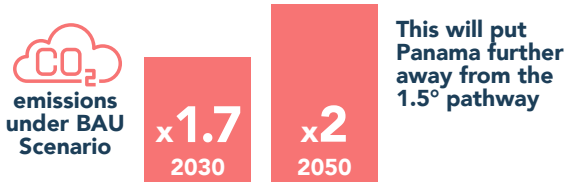
The transition to electric passenger transport sectors, along with the implementation of other energy efficiency measures across sectors, has the net effect of reducing Panama´s total energy demand while increasing future power requirements. As the energy efficiency of EVs is three times higher than for internal combustion engines, the energy demand of the transport sector under the Low Carbon Development Scenarios is much lower compared to the BAU scenario. In 2050, in the ETA3 Scenario and Zero Carbon3 Scenario, Panama´s total energy demand will be reduced by 10% and 8.1%. In contrast, electricity demand in Panama will be 0.8% and 20.7% higher what it would be without sector coupling, respectively. The installed capacity needed to meet the additional power demand should increase in 12% and 42% by 2050 compared to the baseline. Under the Zero Carbon3 Scenario, the additional capacity needed will be comprised with low-cost wind and solar photovoltaic (PV) plants. Renewable power replaces fossil fuels as main source of energy before 2040. The cost of the additional capacity to meet this power demand is lower under the Zero Carbon3 Scenario than in the ETA3 Scenario since the capital investment associated with power generation under a fully renewable power matrix is lower. By 2050, due to changes in energy demand, along with investments in power generation technologies with lower levelized cost of electricity generation, the ETA3 and Zero Carbon3 Scenarios would positively impact Panama´s energy bill with a 7% and 16% reduction compared to the BAU Scenario. Which, in turn, would reduce power prices for final consumers in 1.3% and 22.5% compared to BAU tendency, even considering the phased-out of fossil fuel subsidies. Through the implementation of the Zero Carbon3 Scenario, businesses would become more competitive and households would face lower energy bills.

Sector coupling contributes to a more cost-efficient decarbonization thanks to cheap renewable and a growing cost competitiveness of EVs.



Electrification key for decarbonization

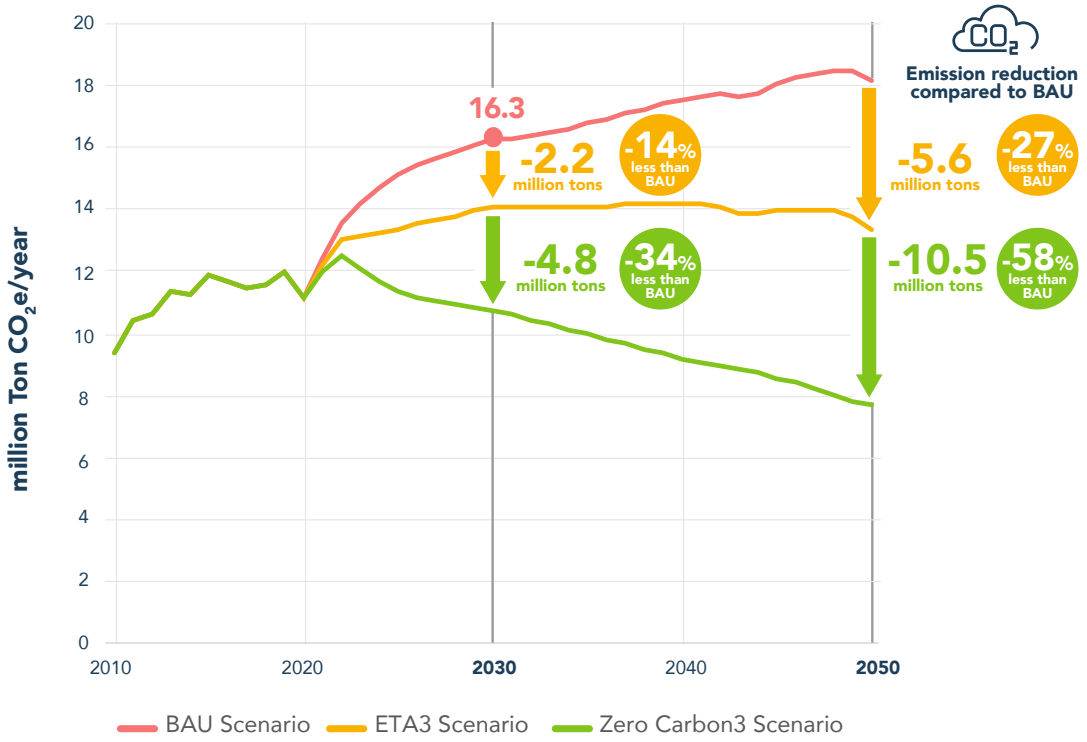
Panama has a significant and growing carbon footprint in its transport and power generation sectors that together are responsible almost for two thirds of GHG emissions in 2020. The country´s energy system is transforming slowly, current progress lags country climate ambition. Under the BAU Scenario, energy-related emissions are expected to increase by a factor of 1.73-fold by 2030 and duplicate by 2050, mainly due to the transport and power generation sectors (Figure 13). This will put Panama further away from the 1.5° pathway.



Power installed capacity for non-conventional renewable energy needs to be scaled up at least by five-fold by 2030 to meet the energy-related emission reduction targets set out in Panama´s NDC1. However, renewable energy technologies alone are not enough to achieve a fully decarbonization trajectory. Transforming the energy system encompasses additional key pillars: renewable power and heat, energy efficiency and electrification of other areas of the economy. The ultimate Panama´s

Figure 13. The majority of emission reductions: Renewable power and passenger transport electrification.

Annual energy-related CO_2 emissions and reductions (million Ton CO_2e/year) 2010–2050.



The ETA3 Scenario meets energy-related reduction goals defined in the NDC1.

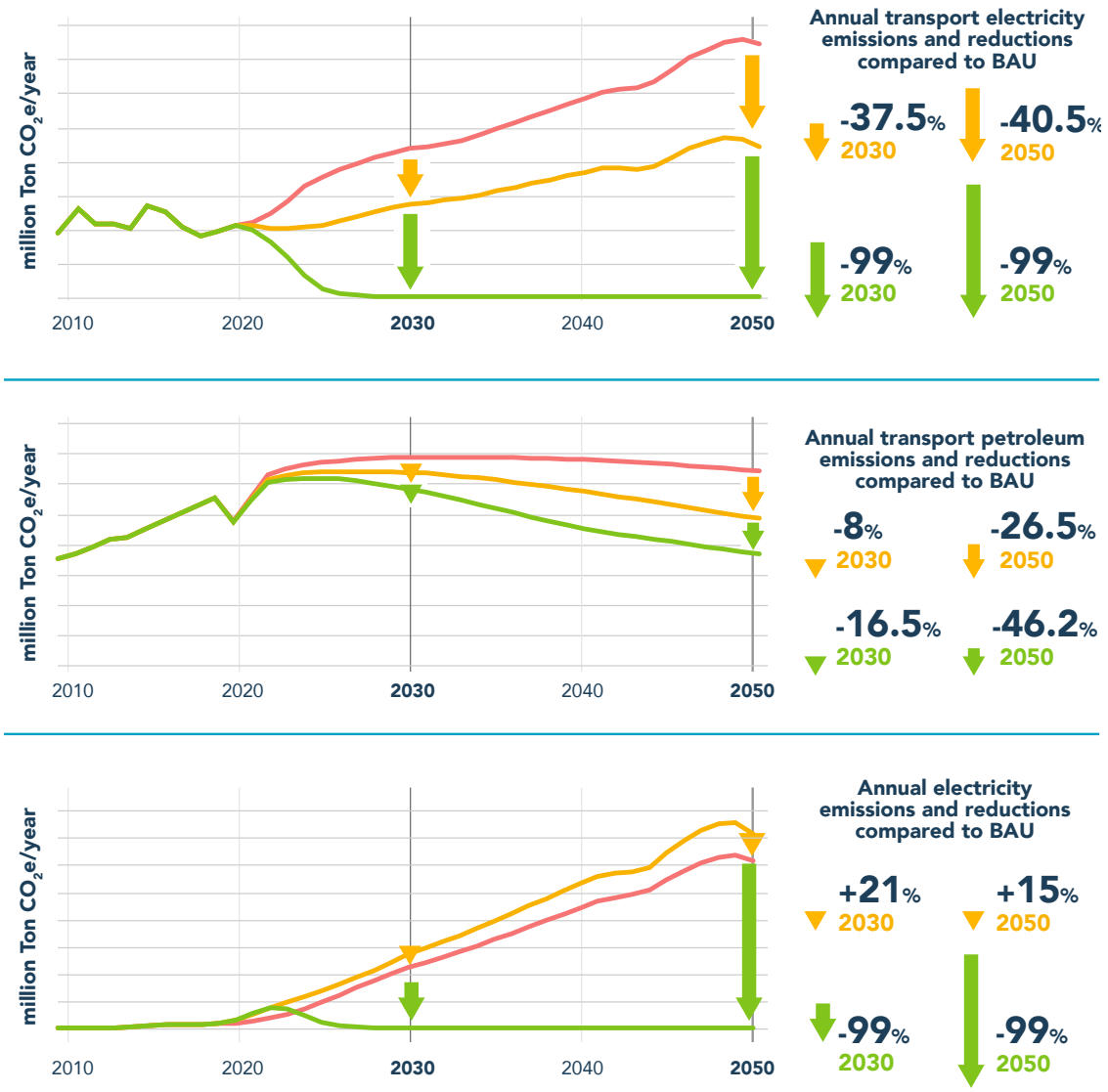
The Zero Carbon3 Scenario sets Panama on track towards a net-zero trajectory

climate goal would be to reach net-zero emissions by midcentury. The Zero Carbon3 Scenario sets Panama on track towards a net-zero trajectory.

Under the ETA3 scenario, the energy-related reduction goals defined in the Panama´s NDC1 will be met. Compared to the BAU Scenario, energy related CO_2eq emissions would decrease 14% and 27% by 2030 and 2050. However, total energy related CO_2eq emissions will be slightly higher than today due to some fossil fuel technology still remain in the energy matrix, both in transport and power sectors.

On the other hand, the Zero Carbon3 Scenario would make a larger contribution to Panama´s climate goals. By 2030, coupled sectors with electricity would sharply cut emissions to 4% below today´s levels. This reduction would extend to 31% by 2050 below today´s levels. Compared to the BAU Scenario, energy-related CO_2eq emissions would decrease 34% and 58% by 2030 and 2050. In both Low Carbon Development Scenarios, renewable power and passenger transport electrification together would provide over 95% of the energy-related CO_2eq emission reductions compared to BAU, presenting the greatest opportunity to

Figure 14. Electrification key for decarbonization (million Ton CO2e/year), 2010-2050.
BAU Scenario, ETA3 Scenario & Zero Carbon3 Scenario.



accelerate Panama´s energy transition towards a net-zero goal (Figure 14). Under ETA3 Scenario, by 2030 CO_2 emission reduction associated with petroleum and electricity represent 27,3% and 72,7% and 38.3% and 61.7% by 2050. Transport is the largest contribution for petroleum emission reductions, constituting 91,3% and 90% for 2030 and 2050. As mentioned earlier, this fact is related to transport electrification. The remaining reductions are associated with the replacement of the use of GLP by solar thermal systems and electric cooking stoves and energy efficiency interventions. In the Zero Carbon3 Scenario, by 2030, CO_2 emission reduction associated with petroleum and electricity represent 21.7% and 78.3% respectively while being 29.7% and 70,3% for 2050. Transport and residential sectors are the largest contribution for petroleum emission reductions, constituting 88.1% and 11.8% respectively for 2030 and 88.3% and 11,6% for 2050.

Strong policies, technological leaps and scale up investments needed to reach net-zero emissions

The foreseen cross-sectoral decarbonization measures implemented in energy sector in the Zero Carbon3 Scenario contribute to significant reductions of energy-related emissions compared to the baseline. However, the efforts envisaged are insufficient to reduce fossil fuel use across all sectors to zero, leading to residual use of fossil fuels, which prevents achieving net-zero emissions by 2050. This last portion of CO_2 emissions - heavy road transport, aviation, shipping, and industrial processes - are the hardest and most expensive part of the economy to decarbonize. To further reduce energy-related emissions to net-zero, the Government of Panama needs to develop more ambitious policies underpinning transformative change in Panama´s energy system, increase investments to make the whole power system operate flexibly, and bring other low-carbon incremental

Strengthen policy frameworks that enable market conditions and send the appropriate signals to the financial community is crucial to achieve energy transformation

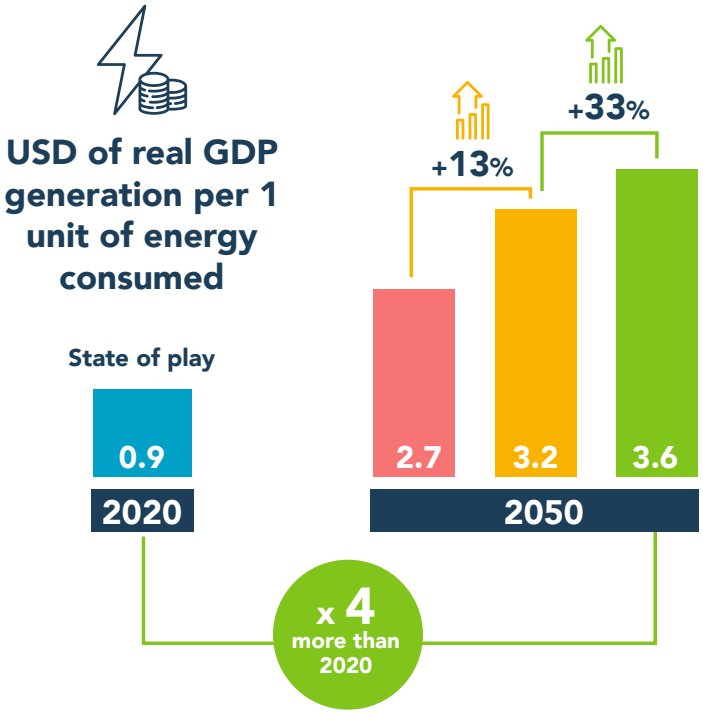
technologies to the market, such as next-generation battery, hydrogen and clean and synthetic fuels. It is necessary to strengthen policy frameworks that enable market conditions and send the appropriate signals to the financial community, including private investors, who more and more are announcing climate considerations to be their investment core motive. Panama will require strong policies, technological leaps and a scaling up of investments to move the needle towards a net-zero trajectory.

Decoupling GDP from energy demand

The energy transition increases Panama´s economic competitiveness and energy security through accelerating the decoupling of the energy demand and economic growth.

Investments in energy transformation in the ETA3 Scenario and the Zero Carbon3 Scenario would increase country´s energy productivity of economic activities, equivalent to using in 2050 three times less energy than in 2020 to produce 1 USD of real GDP. Under the Zero Carbon3 Scenario, in 2050, one unit of energy (kWh) consumed would generate 3.6 USD of real GDP, almost four times more than the GDP generated in 2020, 33% and 13% higher than the GDP generated in 2050 under the BAU Scenario and ETA3 Scenario, respectively. (Figure 15 and 17)

Figure 15. Under the Zero Carbon3 Scenario, energy productivity in 2050 would quadruple.

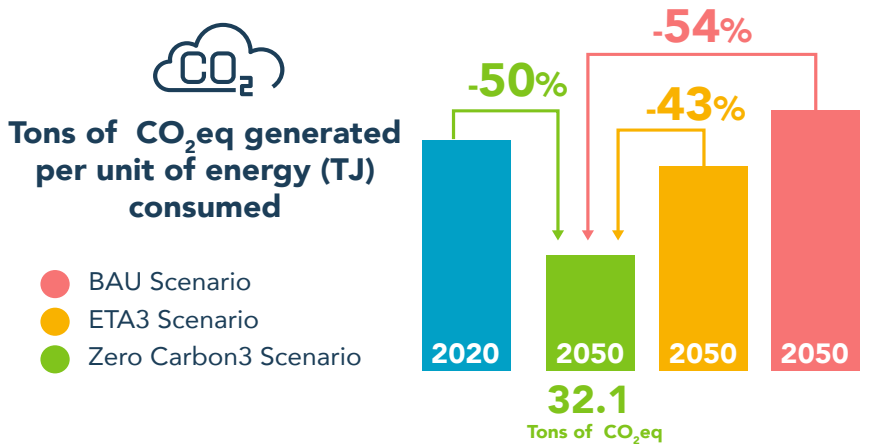


In addition, the energy transition would foster Panama´s decarbonization pathway through improving energy carbon intensity. The Zero Carbon3 Scenario indicates higher progress towards decarbonization. Under the Zero Carbon3 Scenario, in 2050, one unit of energy (TJ) consumed would generate 32.1 ton CO_2eq, half of the CO_2eq emissions generated in 2020, 43% and 54% less of CO_2eq emissions than those generated in 2050 under the ETA3 and BAU Scenarios (Figure 16 and 17).

A paradigm shift for Panama's society and economy

The Panama´s energy transition is more than a transformation of its energy system; it is a paradigm shift of its society and economy. The analysis demonstrates that policies and investments that boost energy transition will encourage higher economic growth and deliver more jobs, while generating a cleaner living environment and improving social well-being in the short, medium and long-term (Figure 11 and 21).

Figure 16. The Zero Carbon3 scenario would reduce energy carbon intensity by half in 2050.



The energy transformation under the deeper decarbonization scenario would triple energy productivity and reduced by half energy carbon intensity by 2050

Figure 17. The energy transition a key driver for Panama´s economic competitiveness and energy security

Real GDP, energy demand and energy-related CO_2eq emission growth rate 2020-2050

BAU Scenario, ETA3 Scenario, and Zero Carbon3 Scenario

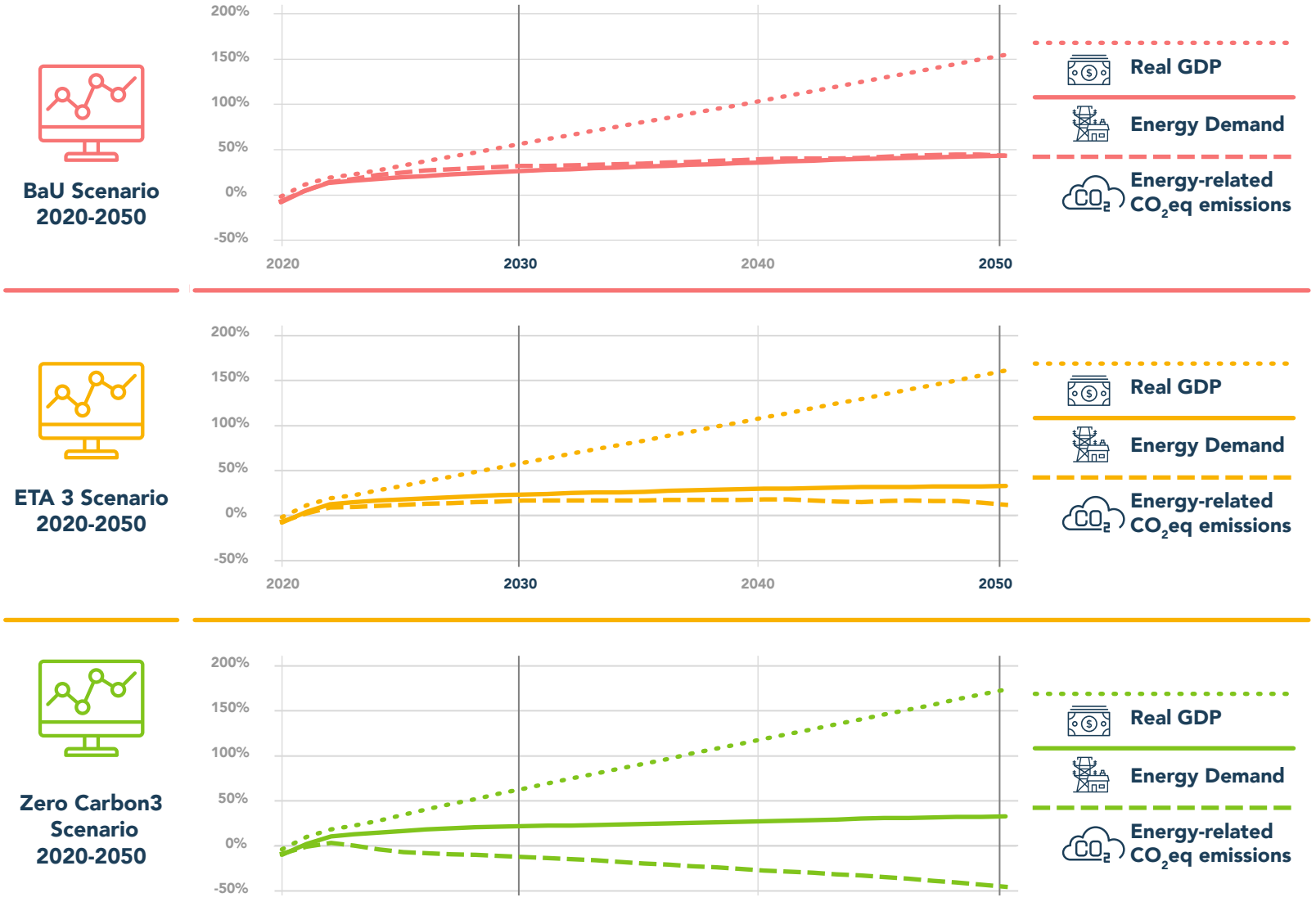


Figure 18. The socio-economic opportunity resulted from the Panama´s energy transformation

ETA3 Scenario and Zero Carbon3 Scenario compared to BAU Scenario, 2020-2050

5. Recommendations and next steps

Going forward, an effective response to the COVID-19 health, social, and economic crisis requires political leadership through a decisive and ambitious policy making, accompanied by significant recovery investments. The mobilization of vast public resources represents a unique occasion to boost economic output and seed employment opportunities, while setting a prosperous economic development path for the next decade. The Government of Panama can leverage today´s recovery efforts to guide sustainable development that stimulates economic growth, creates employment opportunities, ensures competitiveness, and promotes innovation towards the imminent fourth industrial revolution in the short, medium, and long-term.

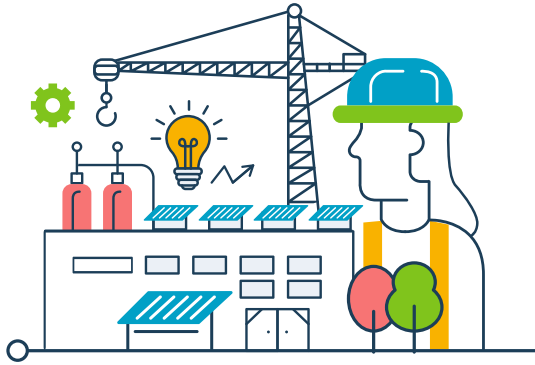
Even in the midst of a difficult fiscal situation, as a result of the COVID-19 impacts, investments in the energy transition, as part of the Panama´s COVID-19 economic recovery plan, could become a critical enabler of Panama´s recovery efforts over 2020-2024 period and beyond. The analysis performed shows that investing in energy transformation can heavily influence future socio-economic development through creating synergies across social, economic, and environmental indicators in Panama. The return on investment is higher compared to current plans, both considering the avoided costs and added benefits generated by low carbon interventions.

While the energy transition described in this report is technically feasible and economically beneficial, it will not happen by itself. Policy action is urgently needed to steer the national energy system towards a sustainable pathway. This report identifies the following focus areas where policy and decision makers need to act. It is therefore recommended to:

1 Include low-carbon investments in the post-COVID-19 economic recovery package, focusing on creating the necessary market conditions to grant certainty to the private sector and, thus, lay the foundations for investments in the main pillars of the energy transition for the coming years (for example, charging infrastructure for electric vehicles, electric buses and railways, incorporating solar thermal energy, distributed PV and the use of LED luminaires in the refurbishing of schools, homes, public buildings and road infrastructure).

2 Design incentives to stimulate private investment, both for households and business sector, towards clean technologies of the energy transition (for example, solar PV generation systems, solar thermal systems, electric vehicles, efficient air conditioners and refrigerators). This can be implemented through credits with specific characteristics. Several countries have associated the inclusion of renewable and energy efficiency technologies in mortgage loans in such a way that the mortgage is only granted if it contemplates a technological replacement for the home to be purchased. In the case of companies, an interesting option would be to aim the credit lines provided in the post-COVID-19 recovery package towards investment in clean technologies in specific sectors such as commercial or industrial, including also additional measures such as tax rebate.

3 Design incentives and programs to stimulate the creation of local supply chains, to benefit more fully from the demand that will be generated through the fulfillment of the emission reduction targets in the energy transition agenda (for example, electric vehicles, efficient appliances, renewable energy technologies). In this sense, Panama has already given the first steps,[1] and it is necessary to continue encouraging the local production of technologies for the transition. An action for the short term would be to cover all or a percentage of the state's purchases with the supply of national producers. The local production of equipment for the energy transition not only generates more employment and income, but also minimizes the



1. Law 45, Law 159 and Law of Multinational Companies for the Provision of Services Related to Manufacturing (EMMA Law)

emissions related to the transport of merchandise and the import of emissions associated with the product manufacturing. Solar thermal energy represents one of the clearest opportunities to be developed locally. The successful solar thermal markets in Latin America and the world are based on local production to supply the national market. Such successful market stories are Barbados, Mexico, and Brazil.

4 Eliminate subsidies for fossil fuels that free up public resources to support low-carbon investments in the medium and long term, as well as laying the way for private investments to be more economically viable. Today Panama partially subsidizes the electricity tariff. This fact does not allow for an equal competition of renewable energy in the market and sends a distorted signal to electricity consumers. Additionally, the fuel used by generators and the industry does not have a tax burden, that is, it is sold almost at the price of an international commodity. This fact represents a barrier to renewable technologies that are capital intensive. An additional alternative to the elimination of subsidies could be to tax the fossil fuel used by industries and generators and create a fund for the implementation of the energy transition, ensuring that funds are available to fully implement the ETA, once the allocation of the announced economic recovery package has been finalized. The fund for the rational use of energy (UREE Fund) could act as financial tool for the implementation of the energy transition. Several alternatives would be possible for its capitalization. One of them is the elimination of fossil fuel subsidies and their reinvestment in the energy transition through the UREE fund. Another alternative would be a tax rate on the use of fossil fuels at the industrial level and electricity generation for collection purposes for the UREE Fund.

5 Develop industrial policies, training and education programs to meet the skills required in all energy transformation industries. To enhance and maximize local value and promote equal opportunities for all workers it is recommended to develop educational programs at all levels. Schools, universities and professional associations should incorporate new contents referred to the energy transition that will take place in Panama.

6 Develop a strategy to ensure a just transition in the energy sector that helps minimize the impacts on the labor market caused by the loss of employment in the fossil fuel industry. To do so it is essential to maintain coordination with the Ministry of Employment and Labor Development and the Ministry of Commerce and Industry of Panama.

7 Establish a monitoring system to evaluate the volume and performance of low-carbon investments. Gather data on air quality, health costs related to pollution of air and traffic congestion. In addition, oversee job creation and the registration of new companies related to the energy transition sectors. Monitoring the evolution of the energy transition agenda is crucial to define the next steps. It is therefore necessary to strengthen all about monitoring the progress, and even create an energy transition committee assessing the evolution of ETA through predefined indicators.

8 Establish annual or biannual assessment on the roadmap path to zero net emissions in energy, possibly through increasing the ambition for ETA. For this objective, it may be useful to carry out an inventory of emissions from the energy sector every year and eventually, with this data, complete the updates of the GHG reports. The verification of the evolution of the ETA in terms of emissions will allow us to identify new interventions not contemplated initially.

9 Reduce totally the emissions related to the energy sector. It is recommended to design more ambitious policies that underpin the transformation of the country energy system and increase investment for the electrical system to work flexibly and promote other technologies low in carbon on the market such as next-generation battery, hydrogen and clean synthetic fuels . A revision of Law 6 that governs the purchase and sale of energy in the electricity market is recommended. It is necessary to consider the consumption and the needs of the future electric mobility and the whole new market that can originate in the purchase and sale of energy for the recharging of electric vehicles.

10 Reinforce policy frameworks that improve market conditions and send appropriate signals to the financial community, including private investors. Move the needle toward a path of zero net emissions in Panama will require solid technological policies, disruptive technologies, and increased investment.

11 The ETA can position Panama as a clean technology energy HUB at the forefront of the Latin American and Caribbean region. Panama's location and logistics conditions are unbeatable for the establishment of regionally integrated local value chain production centers.

The ETA can position Panama as a clean technology energy HUB at the forefront of the Latin American and Caribbean region.