Low Emissions Development Strategy and Action Plan: Belize

2021

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Acronyms & Abbreviations

AOSIS	Alliance of Small Island States
BAU	Business As Usual
BCCI	Belize Chamber of Commerce and Industry
BNCCC	Belize National Climate Change Committee
BOD	Organic Water pollutant
BWS	Belize Water Services
BZD	Belize Dollar
CAGR	Compounded Annual Growth Rate
CAPEX	Capital Expenditures
CARDI	Caribbean Agricultural Research and Development Institute
CARIFORUM	Caribbean Forum
CCCCC	Caribbean Community Climate Change Centre
CCTF	Climate Change Trust Fund
CH_4	Methane
CNTMP	Comprehensive National Transportation Master Plan
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
CSA	Climate-Smart Agriculture
CSF	Critical Success Factors
CSIDS	Caribbean Small Island Developing States
CZMAI	Coastal Zone Management Authority and Institute
CZMP	Coastal Zone Management Plan
DDP	Deeper Decarbonization Projections
EE	Energy Efficiency
EIA	Environmental Impact Assessment
EUI	Energy Use Intensity
FAO	Food and Agriculture Organization of the United Nations
FOLU	Forest and Other Land Use
GCF	Global Climate Fund
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gas
GIS	Geographic Information System
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GoB	Government of Belize
GPC	Global Protocol for Community-Scale Greenhouse Gas Emission Inventories
GSDS	Growth and Sustainable Development Strategy
HA	High Ambition

HFO	Heavy Fuel Oil
ICE	Internal Combustion Engine
ICZMP	Belize Integrated Coastal Zone Management Plan
IDB	Inter-American Development Bank
IMF	International Monetary Fund
INC	Initial National Communication
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Producer
IPPU	Industrial Products and Process Use
IRENA	International Renewable Energy Agency
ITC	International Trade Center
LCCA	Levelized Cost of Carbon Abatement
LCD	Low Carbon Development
LEDS	Low Emissions Development Strategy
LPG	Liquefied Petroleum Gas
LTS	Long-Term Strategy
LUCF	Land Use Change and Forestry
MAC	Marginal Abatement Cost
MAFSE	Ministry of Agriculture, Food Security, & Enterprise
MEDI	Ministry of Economic Development & Investment
MESTPU	Ministry of Energy, Science & Technology and Public Utilities
MoF	Ministry of Finance
MFEDI	Ministry of Finance, Economic Development & Investment
MFFESD	Ministry of Fisheries, Forestry, the Environment and Sustainable Development
MSDCCDRM	Ministry of Sustainable Development, Climate Change & Disaster Risk Management
Mha	million hectares
MRV	Measurement, Reporting and Verification
MSW	Municipal Solid Waste
MT	Million Tonnes
MW	Megawatt
MW	Mega Watt
N_2O	Nitrous oxide
NAMA	Nationally Appropriate Mitigation Actions
NCCO	National Climate Change Office
NCCPSAP	National Climate Change Policy, Strategy and Action Plan
NCRIP	National Climate Resilient Investment Plan
NDA	Nationally Designated Authority
NDC	Nationally Determined Contribution
NEMO	National Emergency Management Organization
NFP	National Forest Program
NOAA	National Oceanic and Atmospheric Administration
NREL	US DOE’s National Renewable Energy Laboratory

NSES	National Sustainable Energy Strategy
NSWMSIP	National Solid Waste Management Strategy & Implementation Plan
OPEX	Operation Expenditure
PACT	Protected Areas Conservation Trust
PFES	Payment for Ecosystems Services
PPP	Public-Private Partnerships
PAPU	Policy and Planning Unit
PSIP	Public Sector Investment Programme
PUC	Public Utilities Commission
PV	Photovoltaic
RfP	Request for Proposals
STI	Strategic Options for Implementation
SWMA	Solid Waste Management Authority
TES	Transforming Energy Scenario
TJ	Terajoule
TNA	Technology Needs Assessment
TOE	Tonne of Oil Equivalent
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Program
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollar
VHA	Very High Ambition

Executive Summary

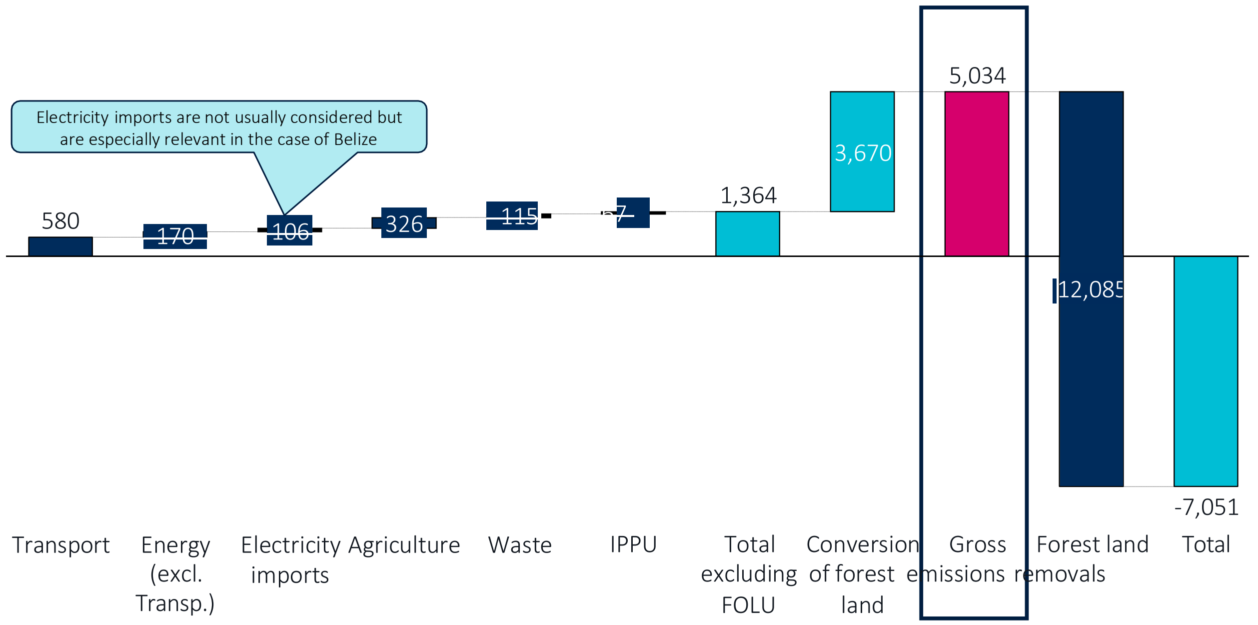
The Belize Low Emission Development Strategy (LEDS) 2020-2050 is a living document compiled to define pathways to achieve low emission development in Belize until 2050. Belize is highly vulnerable to climate change and impacts experienced in the country to date include sustained droughts, floods, increased coastal erosion and changing precipitation patterns; these effects are expected to increase in the future, threatening the physical and social infrastructure in Belize. It is therefore imperative to take ambitious and rapid action to address climate change, through greenhouse gas (GHG) emission reductions. As a member of the High Ambition Coalition[1], Belize has committed to increasing emissions reduction ambition in an updated NDC and developing a long-term strategy aligned with achieving net zero global emissions by 2050. As Belize updates its NDC, raising country ambitions, the country needs to connect its 2050 ambitions to the current policies. The LEDS process, supported by the UNDP, aims to set out the country's long term mitigation ambitions in line with a public commitment to a low emission development pathway.

The GHG emissions of Belize are dominated by the contribution of Forestry and Other Land Use (FOLU). On the one hand, there are emissions from 'conversion of forest land to other uses' (i.e., deforestation) of 3.7 $MtCO_2e$, while the remaining sectors emitted 1.4 $MtCO_2e$. On the other, removals due to the forest's growth at 12.1 $MtCO_2e$ more than offset both emission sources, converting the country to a net sink of GHG emissions, with negative net emissions of 7.1 $MtCO_2e$ (see Figure 1). Apart from the FOLU sector, the main sources of emissions are transport, agriculture, energy, waste and the Industrial Products and Process Use (IPPU).

The LEDS uses gross emissions (total emissions excluding FOLU removals and including electricity imports) as the primary concept for tracking mitigation performance in Belize's case. In order to ascertain the full impact of mitigation options proposed in this LEDS, it is important that their impact is fully reflected in the indicator. First of all, this estimate includes the main cause of GHG emissions in Belize, which is conversion of forest land to other uses, but excludes removals because this is an intrinsic condition and is not directly under control of Belizean decision makers. Second, even though electricity imports are not officially Belizean emissions, not considering them would underestimate the real impact of energy consumption in the countryand would not adequately measure the effect of replacing imports by local renewable generation, for instance. We, therefore, incorporated these two adjustments on the previous emissions indicator. With this definition, GHG emissions would reach 5.0 $MtCO_2e$ (see Figure 1) in the baseline year of 2020.

[1] The High Ambition Coalition (HAC) is a group of 61 countries within the UN Framework Convention on Climate Change (UNFCCC) committed to advancing progressive proposals on climate ambition. The HAC was founded by the Republic of the Marshall Islands in 2014 with the aim of ensuring the Paris Agreement, adopted in 2015, was as ambitious as possible. The group succeeded in securing the Paris Agreement's most ambitious provisions, including the five-year ratchet-up cycles of nationally-determined contributions, as well as language in Article 2, related to pursuing effortsto limit the temperature increase to 1.5 degrees Celsius above pre-industrial levels.

Figure 1 Annual estimated GHG emissions in Belize, 2020, thousands tCO_2e



Source: Vivid Economics and Aether analysis

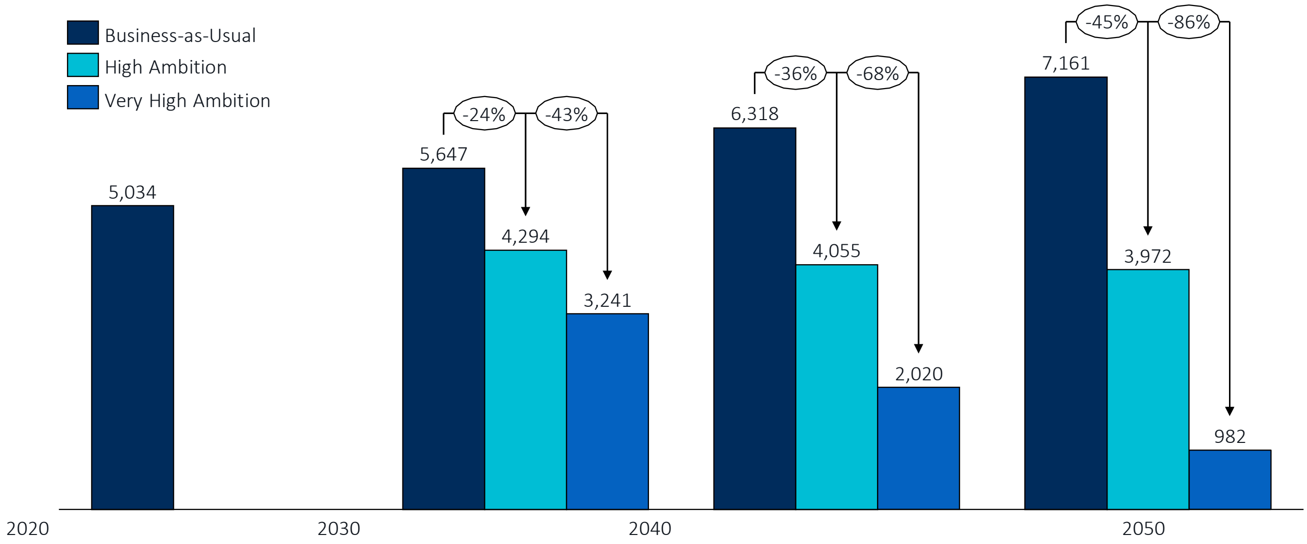
As the central goal of this LEDS, Belize aims to eliminate the majority of its gross carbon emissions by 2050 across all sectors of its economy through pathways defined in this LEDS. To achieve this core objective, the LEDS has elaborated three possible emission scenarios for Belize:

- A "Business-as-Usual (BAU) scenario", which reflects the continuation of existing trends and historical conditions.
- A "High Ambition (HA) scenario" projects ambitions beyond those already specified in policies, relying on the adoption of new, more ambitious policies and technologies and availability of additional financing to implement mitigation actions, and achieve significant emission reductions by 2050 compared with the business-as-usual scenarios.
- A "Very High Ambition (VHA) scenario" projects ambitions well beyond those already specified in policies, thus relying on the adoption of new, significantly more ambitious policies and availability of new technologies and additional financing to implement mitigation actions, and in which most sectors achieve net zero or negative emissions, by 2050.

These scenarios were elaborated for each sector, including: forestry, and other land use (FOLU), electricity and other energy use; transport; agriculture, and waste. Mitigation strategies arising from IPPU have not been included, due to sector's small contribution to Belize's total emissions.

Mitigation options proposed in this LEDS could cut almost 90% of expected emissions by 2050. The LEDS estimates that Belize's gross emissions would grow more than 40% in the 2020-2050 period under BAU scenario to 7.2 $MtCO_2e$. In relation to this scenario, gross emissions could drop by 45% under the High Ambition scenario and could be reduced by 86% under Very High Ambition scenario by mid-century (see Figure 2 below).

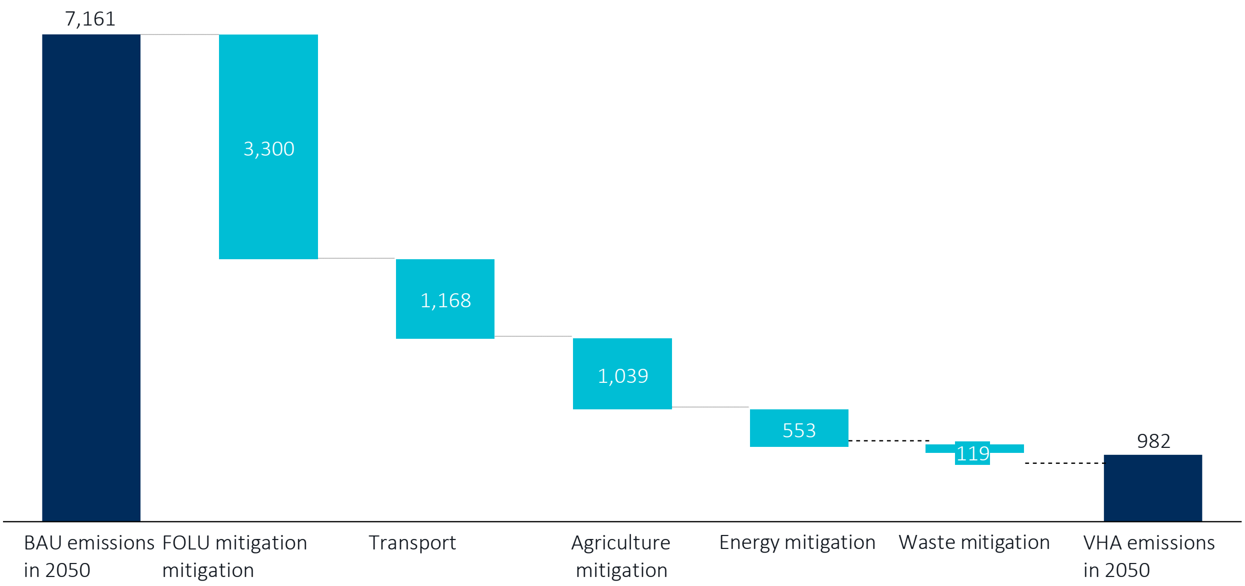
Figure 2 Annual GHG emissions vs. BAU scenario; Gross emissions (incl. Conversion, Imports); thousands tCO_2e



Source: Vivid Economics and Aether analysis

The most significant mitigation of emissions would result from FOLU mitigation, followed by Transport and Agriculture. On FOLU, a combination of reduction of deforestation rates outside current protected areas and a proactive reforestation programme would lead the sector to be virtually GHG emission free by 2050, under the Very High Ambition scenario. A similar transformation could be expected in the Transport sector led by light vehicles, through a combination of accelerated adoption of electrical vehicles and blending ethanol in the regular gasoline for the legacy fleet. The transformation should be a little less radical on Agriculture (reduction of 70% of emissions), but it would be impactful since this sector is expected to be the largest emitter after FOLU under BAU scenario; here, increasing adoption of sustainable livestock management practices should lead the transformation, due to reduction of enteric fermentation emissions and of Belizean lands dedicated to pastures.

Figure 3 Reduction of annual gross emissions from BAU to VHA 2050; impact by sector; thousands of tCO_2e



Source: Vivid Economics and Aether analysis

The implementation of mitigation options could support the creation of more than 30,000 jobs, most of them concentrated within the agriculture and FOLU sectors (see chapter 4). On Agriculture, job creation is led by sustainable livestock and land management, including those in arable and livestock farming and in converting farmland to more appropriate uses. In the FOLU sector, reducing deforestation and increasing reforestation activities support job creation. Many jobs are expected to be created with reforestation, in particular due to the amount of work required to plant trees, mangroves and seagrass meadows.

Each of the emission reduction scenarios detailed for each sector in this LEDS is underpinned by a range of key policies and actions that must be undertaken in each sector to achieve the emission reductions. Some of the priority mitigation options for decarbonization in each sector are given below (see also chapter 5).

For the FOLU sector:

- Reduction of deforestation outside protected areas; and
- Proactive reforestation.

For the agriculture sector:

- Sustainable livestock management practices;
- Restoration of sugar land; and
- Conversion of croplands to agroforestry systems.

For the energy sector:

- Installing utility-scale solar power capacity;
- Installing onshore wind power capacity; and
- Efficiency improvement on water heating.

For the transport sector:

- Accelerated adoption of electrical passenger vehicles;
- Blending ethanol in regular gasoline; and
- Attracting commuters to public transportation.

For the waste sector:

- Flaring methane on National Landfill;
- Using solid waste methane for biogas energy; and
- Installing disposal sites in villages and building a collection network for rural waste.

A list of required interventions to the successful implementation of this mitigation option is explored in chapter 6, with high-level responsibilities and timeline. Finally, chapter 7 explores LEDS role in the context of other climate policy frameworks in Belize, as well as its interactions and alignment with other national policies and strategies.

Achieving Belize's Very High Ambition scenario will be challenging but it is possible with the establishment of a comprehensive enabling environment, sufficient access to technology and climate financing, and extensive capacity building and education programmes. Eliminating the majority of gross emission by 2050 is critical to meeting the Paris Agreement goal to keep the global average temperature increase to below 1.5°C. Belize aims to lead the way with this LEDS, setting the tone for ambition in the region, in the year that the country serves as the Presidency of AOSIS.

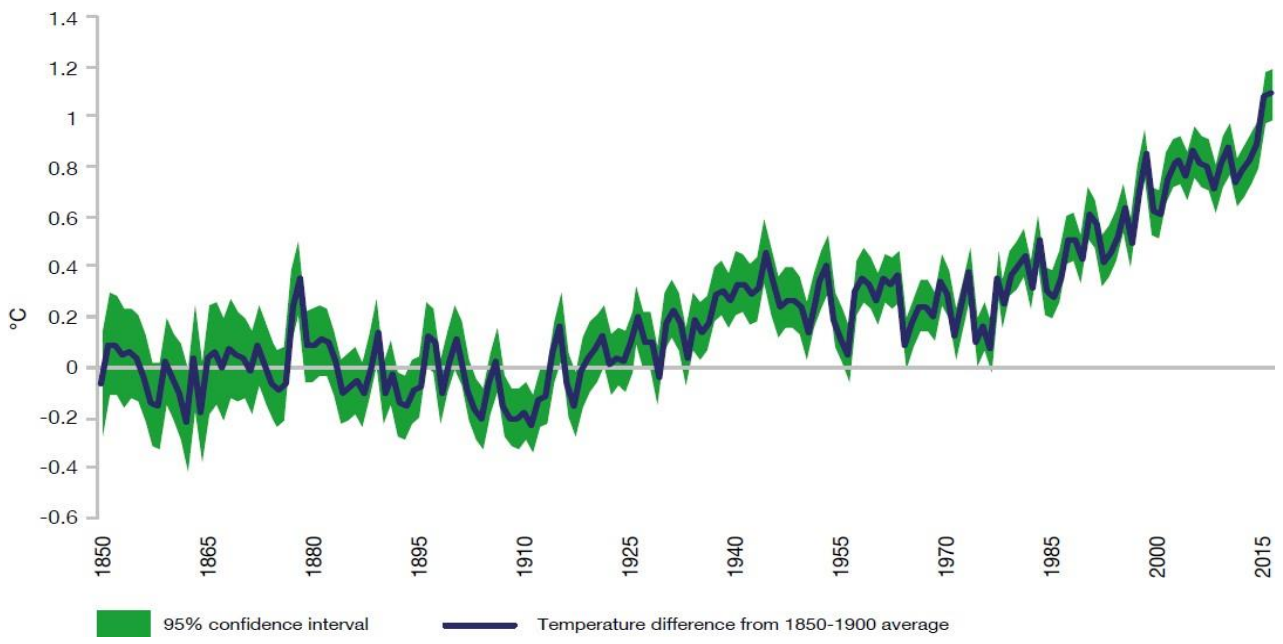
1 Introduction

In the context of global warming and international commitments, this chapter introduces Belize's climate change governance and explains the motivation, approach and process of building a Low Emissions Development Strategy (LEDS) in Belize.

1.1 A Warming Planet and the Paris Agreement

Global surface temperature has been increasing rapidly over the past few decades, having already exceeded 1°C above pre-industrial levels. Multiple independently produced instrumental datasets show that the climate system is warming, with the 2009–2018 decade being 0.93 ± 0.07 °C warmer than the pre-industrial baseline (1850–1900).[2] Currently, surface temperatures are rising by about 0.2 °C per decade,[3] with 2020 reaching a temperature of 1.2 °C above pre-industrial.[4]

Figure 4 Global near-surface annual average temperatures relative to a pre-industrial baseline (1850-1900)

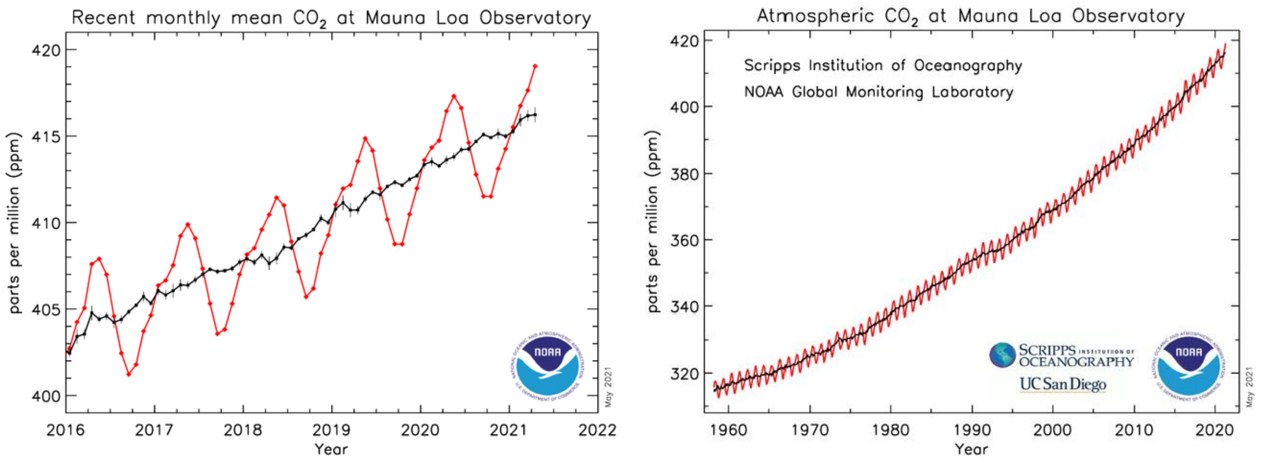


Source: HadCRUT4, Met Office

As shown in Figure 5, in recent years, CO_2 concentrations in the atmosphere have continued to rise and therefore urgent action is required. The earth's temperature has fluctuated over its 4.5 billion years of history, but recent warming is overwhelmingly due to increasing amounts of global greenhouse gas emissions (including CO_2 emissions), which are currently on an unsustainable path. The increasing concentrations of CO_2 in the atmosphere since the 1960s are shown in Figure 5. According to the IPCC's 4th Assessment Report of 2007, limiting GHG to 445 to 490 ppm CO_2e would lead to a global mean temperature increase of 2-2.4°C, in comparison to pre-industrial levels.

[2] https://library.wmo.int/doc_num.php?explnum_id=5789
[3] https://www.ipcc.ch/site/assets/uploads/sites/2/2019/05/SR15_Chapter1_High_Res.pdf
[4] https://public.wmo.int/en/our-mandate/climate/wmo-statement-state-of-global-climate

Figure 5 Carbon dioxide in the atmosphere, 1960-2020, in parts per million at Mauna Loa Observatory, Hawaii



Source: Earth System Research Laboratories, Global Monitoring Laboratory. NOAA Research[5]

Signatories to the Paris Agreement are committed to limiting global warming to well below 2°C and publishing Nationally Determined Contributions (NDCs) to coordinate their efforts.

- The Paris Agreement is a bridge between today's policies and climate-neutrality before the end of the century. It is the first-ever universal, legally binding global climate change agreement, adopted at the Paris Climate Conference (COP21) in December 2015.
- The Paris Agreement sets out a global framework to avoid extreme climate change by limiting global warming to well below 2°C and pursuing efforts to limit it to 1.5°C. It also aims to strengthen countries' ability to deal with the impacts of climate change and support them in their efforts.
- For the agreement to enter into force, at least 55 countries representing at least 55% of global emissions had to deposit their instruments of ratification. This was achieved on November 4th, 2016 and Belize is one of the Parties to the Paris Agreement.

Parties agreed:

- On a long-term goal of keeping the increase in global average temperature to well below 2°C above pre-industrial levels;
- to aim to limit the increase to 1.5°C, since this would significantly reduce risks and the impacts of climate change;
- on the need for global emissions to peak as soon as possible, recognizing that this will take longer for developing countries;
- to undertake rapid reductions thereafter in accordance with the best available science, so as to achieve a balance between emissions and removals in the second half of the century.
- As a contribution to the objectives of the agreement, countries have submitted comprehensive national climate action plans (nationally determined contributions, NDCs). These commitments are

[5] https://gml.noaa.gov/ccgg/trends/

still not enough to reach the agreed temperature objectives, but the agreement traces the way to further action.

1.2 National Climate Change Action and Governance

Global climate change is one of the most serious threats to sustainable development in Belize. Impacts experienced in the country to date include sustained droughts, floods, increased coastal erosion and changing precipitation patterns. Combined, these climate changes and related phenomena are having significant impacts on many environmental, physical, social and economic systems within the country. In the future, these effects are expected to increase, thereby threatening the physical and social infrastructure in Belize.

Belize became a signatory to the United Nations Framework Convention on Climate Change in 1992 (UNFCCC), as a non-Annex 1 country. Belize also joined the Kyoto Protocol in 2003, with the status of Annex B. As a party state to the UNFCCC, Belize submitted its Initial National Communication (INC) to the UNFCCC in 2002, its Second National Communication in the second quarter of 2012 and its Third National Communication in April 2016. By ratifying the UNFCCC, Belize committed itself to developing, adopting and implementing policies and measures to mitigate the adverse effects of Climate Change and adapt to these changes.

Since its ratification of the UNFCCC, Belize has made significant efforts to fulfil the objectives of the Convention, creating an environment which enables GHG emissions abatement and adapting to the negative impacts of Climate Change. To achieve this, Belize has approved the Environmental Protection (Clean Development Mechanism) Regulations in 2011, the National Climate Resilient Investment Plan (NCRIP) in 2013, adopted the National Climate Change Policy, Strategy and Action Plan (NCCPSAP) in 2015, and approved the Growth and Sustainable Development Strategy 2016-2019 (GSDS), along with constituent sectoral plans, which reflect climate change mainstreaming into national policies.

On April 22nd 2016, Belize ratified the Paris Agreement on Climate Change. Belize, as a small country with relatively minor contributions to global greenhouse gas emissions, has limited capacity to contribute to mitigation of global climate change. However, the country is committed to achieving the ultimate objective of the Convention and supports the even more ambitious target to limit the increase in global average temperature to 1.5°C, compared to pre-industrial levels. At the convention's ratification, the country of Belize submitted its Nationally Determined Contribution (NDC), guided by its commitment to strategically transition to low carbon development while strengthening its resilience to the effects of Climate Change.

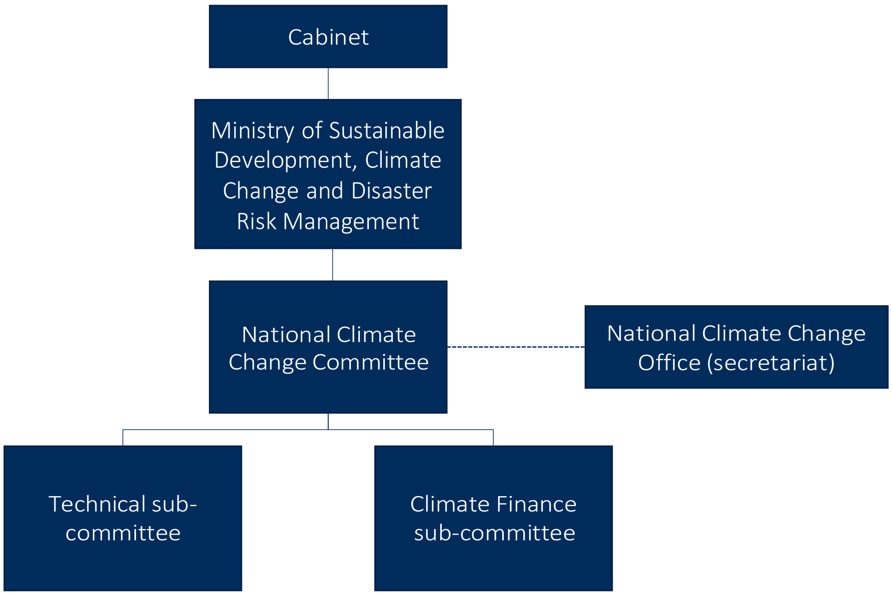
Belize's existing NDC submitted in 2016 builds on national plans but stops short of comprehensively quantifying abatement potential or required investment in mitigation and adaptation measures. The Government of Belize has partnered with the NDC Partnership to develop a new and updated NDC that is more ambitious and accurate with respect to the proposed actions, cost, accounting of GHG emissions and transparency. Belize is submitting an updated version of these commitments for inclusion in the global stock-take planned in conjunction with the 26th Conference of Parties to the United Nations Framework Convention on Climate Change which is to be held November 2021.

1.3 National Climate Change Governance

The National Climate Change Office (NCCO) was established as the national entity with responsibility for the implementation of the NCCPSAP and other climate change policies in Belize. As a complex area affecting multiple sectors and ministries, climate change needs appropriate governance to ensure coordinated mainstreaming of policies and interventions. In this regard, the National Government has sought to establish a coherent, overarching governance structure to coordinate climate change management initiatives at the national level. To this end, the Office is strategically positioned to coordinate the implementation of climate change adaptation and mitigation actions and to implement climate change programmes nationwide. Among other activities, it is responsible for NDC updates/ revisions/ resubmissions, national communications to the United Nations Framework Convention on Climate Change (UNFCCC) and Biennial Update Reports (BURs), among other policy documents.

The Belize National Climate Change Committee (BNCCC) is the leading entity that advises the Government on climate change issues. The main task of the committee is to advise the government of its responsibilities under the UNFCCC and the implementation of appropriate policies and strategies to ensure continued sustainable development. It functions as the main body to monitor implementation of climate change adaptation programmes/projects and identify emerging gaps and opportunities for further action. The BNCCC reports to the Cabinet, providing the necessary guidance and leadership at the political level, including the ratification of international agreements, such as the UNFCCC.

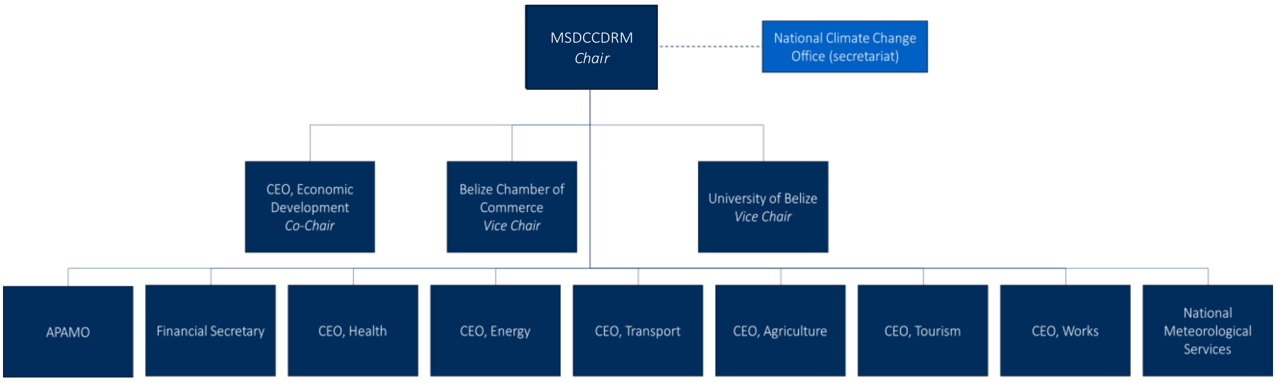
Figure 6 Organizational structure for climate change governance



Source: Vivid Economics based on communication with the National Climate Change Office

The BNCCC is comprised of fourteen members from various government Ministries, non-government organizations and members of the private sector. Ministries represented include those in charge of Infrastructure Development, Transport, National Emergency Management Organization (NEMO), Finance, Economic Development, Sustainable Development, Climate Change, Disaster Risk Management, Blue Economy, Civil Aviation, Natural Resources, Agriculture, Health, Tourism, and Energy. The committee has one representative of the private sector (the Belize Chamber of Commerce) and a recognized non-government organization (currently the Association of Protected Areas Management Organizations). The University of Belize and the National Meteorological Services of Belize, a government entity, also sit on the committee. The Chief Executive Officer of the Ministry of Sustainable Development, Climate Change and Disaster Risk Management (MSDCCDRM) sits as the chair of the BNCCC, whereas the National Climate Change Office (NCCO) functions as the secretariat of the committee.

Figure 7 The current membership of the National Climate Change Committee



Source: Vivid Economics, based on communication with the National Climate Change Office

The BNCCC has the authority to establish sub-committees to assist in the implementation of its terms of reference. Currently, there are two (2) sub-committees existing under the BNCCC: the Climate Finance Sub-Committee and the Technical Sub-Committee. These sub-committees are each made up of seven (7) members, including government Ministries, the Caribbean Community Climate Change Centre (CCCCC), the University of Belize (UB), and Protected Areas Conservation Trust (PACT).

Several Ministries and Departments have functions and ministerial responsibilities that affect the effective development and implementation of climate change action, but three are especially relevant: the MSDCCDRM, the MEDI and the MoF.

The Ministry of Sustainable Development, Climate Change and Disaster Risk Management serves as the lead government organization responsible for coordinating and implementing climate change adaptation and mitigation policies. It is the operational focal point of Belize to the Global Environment Facility (GEF). Government initiatives on climate change are dealt with by the National Climate Change Office established in 2012. Since then, the NCCO has replaced the National Meteorological Service as the government body responsible for providing technical advice to the government relating to climate change, as well as negotiating on the country's behalf at international fora. The NCCPSAP recommended the establishment of the NCCO as a government Department, which has been partially implemented in 2017 with the permanent establishment of a Unit in the public service including four posts within the office: Chief Climate Change Officer, Deputy Chief Climate Change Officer, Climate Change Officer and Project Assistant.

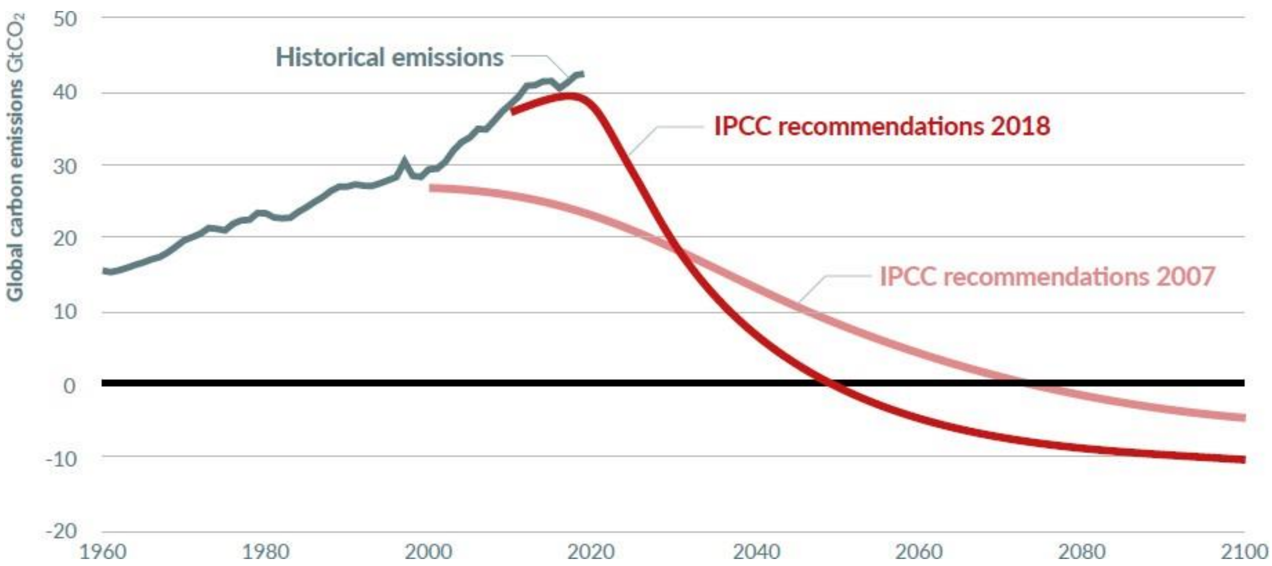
The Ministry of Finance, Economic Development, and Investment (MFEDI) has been appointed by the Cabinet as the responsible organization for coordinating access to international climate finance, with the role of GCF Nationally Designated Authority (NDA) in Belize and political focal point for the GEF. In particular, the Policy and Planning Unit (PPU) within the MFEDI has the following functions: prepare and facilitate national development plans; appraise, monitor, evaluate and report on the Public Sector Investment Programme (PSIP) underpinning the resource planning and mobilization process; coordinate multilateral and bilateral assistance; and act as the focal point for international development partners.

In addition, the Ministry of Finance (MoF) holds responsibility for coordinating access to reimbursable financing associated with climate change activities; it is also the Adaptation Fund's focal point. Its main role is enforcing the fiscal policy as directed by the Cabinet, by ensuring that revenue collection through the main revenue departments is enough to cover the recurrent and capital expenditure (financed from international sources). It is also responsible for the preparation of annual budgets commencing with a "Budget Call" and ending with the "Appropriation Act" which authorizes the GoB to spend proceeds from the Consolidated Revenue Fund.

1.4 A mid-century Low Emissions Development Strategy for Belize

Carbon emissions pathways recommended by the IPCC imply reaching net zero emissions globally by mid-century. Limiting global warming to 1.5°C will require global emissions to peak by 2020, to reduce by 45% below 2010 levels by 2030 and to reach net zero around mid-century and the upholding of negative emissions thereafter, as shown in Figure 8.

Figure 8 4th Assessment Report of 2007 (2-2.4°C) vs. IPCC special report on 1.5°C in 2018



Source: Making Long-term Low GHG Emissions Development Strategies a Reality, GIZ

In order to guide the pathways towards 2050, the Paris Agreement proposes the formulation of long-term low emissions development strategies.

- Article 4 of the Paris Agreement calls on Parties "to formulate and communicate long-term low greenhouse gas emission development strategies"
- The Katowice Rulebook reiterates the invitation for parties to communicate a long-term strategy by 2020

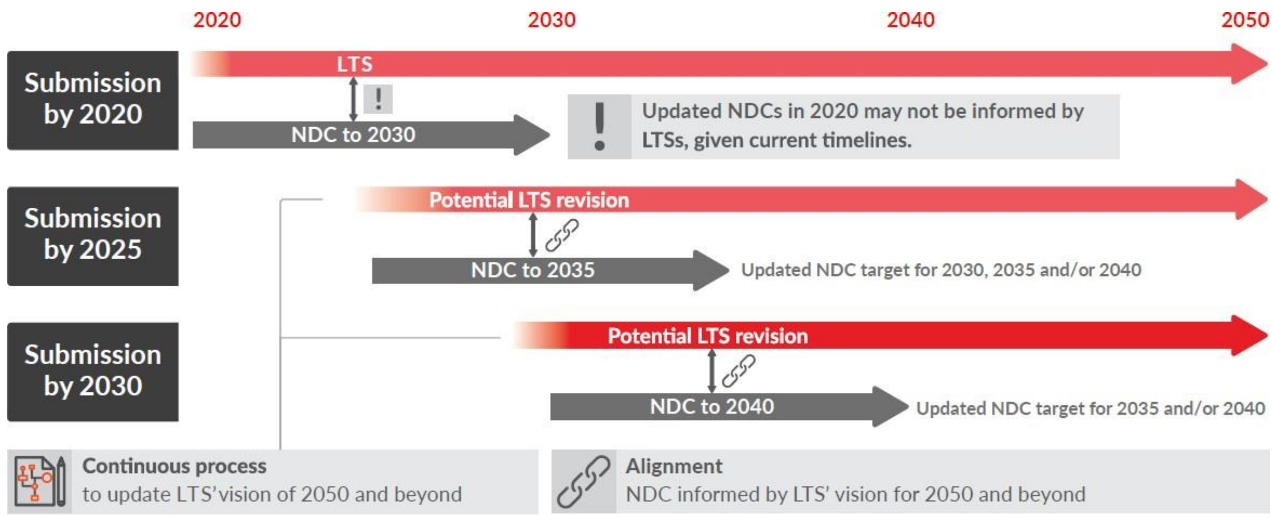
Long-term Low Emissions Development Strategies (LEDS) are generally used to build forward-looking national economic development plans or strategies that encompass low-emission and/or climate-resilient economic growth. LEDS can serve multiple purposes but are primarily intended to help advance national climate change and development policy in a more coordinated, coherent, and strategic manner. "A LEDS may serve a range of domestic purposes for government, the private-sector and the general public as well asother institutions and stakeholders".[6] The adoption of an ambitious LEDS is important as it will help to link the national climate change policy to national development plans and sectoral planning processes, engage stakeholders across the economy to enhance buy-in and ownership of climate mitigation strategies, enable the country to meet international climate change commitments through nationally appropriate actions, and leverage public and private climate finance, both domestically and internationally.

The Belizean Low Emissions Development Strategy and Action Plan (LEDS) is an initiative undertaken on behalf of the United Nations Development Programme (UNDP) and the Belize National Climate Change

[6]Low-Emission Development Strategies (LEDS): Technical, Institutional and Policy Lessons, Clapp, Briner, and Karousais. Nov 2010

Office (NCCO). As a member of the High Ambition Coalition[7], Belize has committed to increasing emissions reduction ambition in an updated NDC and developing a long-term strategy aligned with achieving net zero global emissions by 2050. As Belize updates its NDC, raising country ambition and elaborating a low emission development pathway, the country needs to connect Belize's 2050 net zero ambitions to the current policies, summarized in the 2021 NDC. The LEDS aims to set out the country's long term mitigation ambitions. This process, supported by the UNDP, supports the definition of long-term targets for low carbon and carbon neutral development in line with a public commitment to achieve net zero emissions by 2050.[8]

Figure 9 Relationship between a Long-Term Strategy (LTS) and the NDC



Source: Making Long-term Low GHG Emissions Development Strategies a Reality, GIZ

1.5 The approach and the process for developing Belize's LEDS

The process to develop a Low Emission Development Strategy and Action Plan for Belize for 2020-2050 was organized in two phases: development of the Concept LEDS (Phase I) and drafting of the Action Plan (Phase II). It is important to notice that the LEDS is primarily focused on mitigation, rather than adaptation, which is the primary focus of the NCCPSAP.

Phase I aimed to build an initial consensus among stakeholders on the aspirations for decarbonization of each sector. The LEDS identifies a strategic high-ambition net zero vision for 2050 as established by the High Ambition Coalition. The LEDS then adopts a pragmatic approach to developing sector-by-sector pathways to decarbonization, starting from baseline estimates and Business-As-Usual (BAU) projections, identifying tangible mitigation options to limit the expected growth, and establishing targets for implementing those options through time (see chapter 2). It is interesting to notice that the process of adjusting mitigation options and setting out targets was highly interactive, conducted through sector-specific consultation sessions (further explored in section 1.6).

In line with the 2006 IPCC Guidelines, the sectors covered are:

[7] The High Ambition Coalition (HAC) is a group of 61 countries within the UN Framework Convention on Climate Change (UNFCCC) committed to advancing progressive proposals on climate ambition. The HAC was founded by the Republic of the Marshall Islands in 2014 with the aim of ensuring the Paris Agreement, adopted in 2015, was as ambitious as possible. The group succeeded in securing the Paris Agreement's most ambitious provisions, including the five-year ratchet-up cycles of nationally-determined contributions, as well as language in Article 2, related to pursuing effortsto limit the temperature increase to 1.5 degrees Celsius above pre-industrial levels.

[8] https://sdg.iisd.org/news/15-countries-pledge-to-update-ndcs-by-2020-achieve-net-zero-emissions-by-2050/

- Forestry and Land Use (FOLU)
- Agriculture
- Stationary energy combustion (Energy)
- Mobile energy combustion (Transport)
- Waste

Mitigation strategies to reduce GHG emissions arising from the Industrial Processes and Product Use (IPPU) sector have not been included in the LEDS due to the small contribution that this source makes to Belize's total annual emissions.

Phase I was concluded with the understanding of potential impact in terms of GHG emissions. Each mitigation option was assessed in terms of its potential GHG emissions reduction impact. These combined impacts were then aggregated into High Ambition (HA) and Very High Ambition (VHA) scenarios to achieve decarbonization in each sector from 2030 to 2050 (see chapter 3). Finally, the scenarios of emissions reduction were aggregated for the country as a whole and the overall results were validated in a session with all stakeholders (see section 1.6).

Phase II focused on developing an action plan to support LEDS implementation through time. The development began with identifying and assessing potential wider impacts and challenges to the implementation of each mitigation option, in order to prioritize the most impactful ones. This was done through multi-criteria assessments, conducted in sector-specific consultation sessions (methodology further explored in chapter 5). These sessions – alongside with additional sessions conducted with Vulnerable Groups (see Stakeholder Engagement section) – allowed the identification of potential obstacles and challenges to the implementation. This was the initial input for the development of an initial action plan framework, connecting barriers and associated interventions, and including high-level responsibilities and implementation timeframes (see chapter 6). The phase was completed with an analysis of potential high-level implementation costs, as well as the impact on supporting new jobs in the country (see chapter 4), and an analysis on the alignment between LEDS' proposed strategies and mitigation options with other climate policy frameworks, national development strategies, and sectoral policies and strategies (see chapter 7).

1.6 Stakeholder engagement

As discussed in the previous section, the process of developing the LEDS was highly interactive, with several opportunities for stakeholder engagement. The most relevant ones were:

- Initial engagement with sector principals: the first round of stakeholder engagement consisted of seven one-to-one interviews with sector principals conducted in December 2020. After compiling an initial portfolio of mitigation options based on the review of existing publications/ reports and incorporating NDC-based assessments from institutions such as FAO, IRENA and Fundación Bariloche, we tested and adjusted initial findings with principal/ leads for each sector, validated with NCCO. Prescheduled one-on-one meetings with sector leads were held prior to the plenary workshop. Directors were provided with an overview of the preliminary mitigation actions and targets for their sector and asked to provide high-level input on the status, feasibility, and target ambition levels within the LEDS longer term timeframes.
- Inception Workshop: The formal commencement of the project took place on December 10th, 2020 with a Workshop aimed at presenting main concepts and best practices on NDC and LEDS development, the objectives and the work plan proposed for LEDS construction, current situation of

GHG emissions in the country, and a preliminary set of mitigation actions that would be discussed later with stakeholders of each section.

- Adjustment of mitigation options and definition of implementation targets: Conducted through sector-focused group discussions with critical stakeholders for each sector. The objective of these discussions was to validate the portfolio of mitigation options and to define aspirations for each option, with different levels of ambition for the implementation of these options in Belize (Business-as-Usual, High Ambition and Very High Ambition) in different timeframes (2030, 2040 and 2050). Four sessions (Energy & Transport, Agriculture, FOLU and Waste) were conducted in December 2020.

- Validation of the Concept LEDS: A general stakeholder consultation workshop was held in order to present the development of LEDS to a broad audience of stakeholders. Following an introduction, stakeholders were presented with the main components of LEDS in each sector, including: historical trends on GHG emissions; BAU projections; identification of mitigation options; proposed targets for implementation in the in-coming decades; assessment of GHG mitigation impact; and preliminary prioritization of mitigation options. The conclusion was overall scenario projections for GHG emissions reductions. The consultation was held virtually on February 10th, 2021.

- Prioritization of mitigation options: One of the critical elements of the second round of sector discussions was discussing barriers to implementation. While the first round of sector-focused stakeholder meetings aimed at consolidating the portfolio of mitigation actions, agreeing on target parameters and setting implementation level targets for the High Ambition and Very High Ambition scenarios, the second round focused on prioritizing mitigation options on two dimensions: “impact” and “ease to implement”, based on multi-criteria assessments with 4-5 criteria for each dimension. It is important to note that both scores and factor weights were attributed by critical stakeholders in each sector, through intensive discussions aiming to reach group consensus. The open discussion of “ease to implement” aspects further revealed the critical technical barriers and challenges to successful implementation and supported identification of potential interventions to overcome them. Five independent sessions with all sector groups were conducted during the second half of February 2021.

- Validation with Vulnerable Groups: Our engagement with stakeholders from Vulnerable Groups allowed us to refine the previous interventions, as well as identify additional challenges to be addressed. A literature review was conducted of UNDP and other gender guidelines and policies in order to develop an expanded scoring system for Vulnerable Groups. A preliminary assessment was performed internally by scoring each mitigation option based on the anticipated level of concern as (high, medium or low) across five diverse criteria. Organizational leaders representing a diverse array of vulnerable groups were invited to give feedback to a visual representation of the analyses. Leadership responses not only highlighted the areas of greatest concern, but further clarified barrier origins. The customized forum and open discussion were a first for the country and also resulted in rather insightful proposed solutions, in some cases already being implemented in village level initiatives that could be scaled up and that would have otherwise gone undocumented. In several cases additional challenges were identified and revisions made to accommodate existing and new interventions. There were two sessions with vulnerable groups during the send half of February and beginning of March 2021.

- Validation of the Action Plan: The workshop with technical stakeholders was critical to validate the initial draft of the Action Plan Framework. The validation workshop focused on ensuring that the final LEDS action plan will effectively serve as a high-level roadmap - guiding the development of sector mid-term plans and future NDC revisions - and that the highest priority barriers and correlating interventions were accurately identified for each of the LEDS mitigation actions. The aims of the workshop included: Outline the hierarchical relationships and timeframes of Belize living documents and mitigation goals; Refine sub-action Interventions identified per sector based on participant consensus; Revise responsible leading entities per LEDS interventions if needed based on participant feedback; and Advise participants on process to submit written comments to be incorporated into draft. On Friday May 7th, 2021, the workshop was conducted virtually via zoom due to travel restrictions from COVID-19.

- Interaction between the LEDS and the new NCCPSAP: It was the last stakeholder workshop and was conducted jointly with the team responsible for the revision of the NCCPSAP, a process that was launched in June 2021. It was aimed to introduce the overall LEDS development process to the newly engaged NCCPSAP team and to foster the discussion of interactions and synergies between the two processes. It was held virtually on June 3rd, 2021.

1.7 Overview of this document

This document is structured as follows:

1. *Introduction:* In the context of global warming and international commitments, this chapter introduces Belize's climate change governance and explains the motivation, approach and process of building a Low Emissions Development Strategy (LEDS) in Belize.
2. *Pathways towards low emissions development in Belize:* Starting with current GHG emissions baseline and Business-as-Usual (BAU) projections, this chapter explores pathways towards low emissions development for each critical sector in Belize, including the identification of mitigation options and potential targets for implementation levels in the High Ambition (HA) and Very High Ambition (VHA) scenarios.
3. *Potential impact of mitigation options on GHG emissions:* This chapter focuses on estimating the potential impact of mitigation options in terms of reduction of GHG emissions. In line with the implementation targets discussed in the previous chapter, we build two alternative scenarios for each sector, the High Ambition (HA) and the Very High Ambition (VHA) and, comparing to BAU projections, we estimate potential aggregate reductions for each sector. Finally, considering that the country is a 'net sink', we present overall aggregate impact for the country as a whole, considering different definitions of what the aggregate impact for Belize could be.
4. *Potential impact of mitigation options on costs and jobs:* Drawing on the targets for the Very High Ambition Scenario (VHA) scenario, as well as international data on marginal abatement costs (MAC) and job multipliers, this chapter aims to estimate the accumulated net effect of implementing the mitigation policies on both, costs and job creation.
5. *Prioritization of mitigation options in each sector:* After assessing the impact of mitigations option both in terms of reducing GHG emissions and their net impact in costs and jobs, this chapter focuses on supporting a prioritization of mitigation options.
6. *High-Level Action Plan:* This chapter describes LEDS Action Plan framework and explores obstacles and challenges to the implementation of mitigation options, as well as high-level interventions proposed to address those obstacles and challenges.
7. *Interaction of the LEDS with other policies and strategies:* This chapter explores the interactions of the LEDS with other national policies and strategies, including other climate policy frameworks, national development strategies, sector-specific policies, and strategies. We discuss functions of different instruments, and how they complement and feed upon each other. More importantly, we assess the level of alignment of proposed LEDS options with existing instruments, highlighting aspects to proactively consider in next policy revisions.

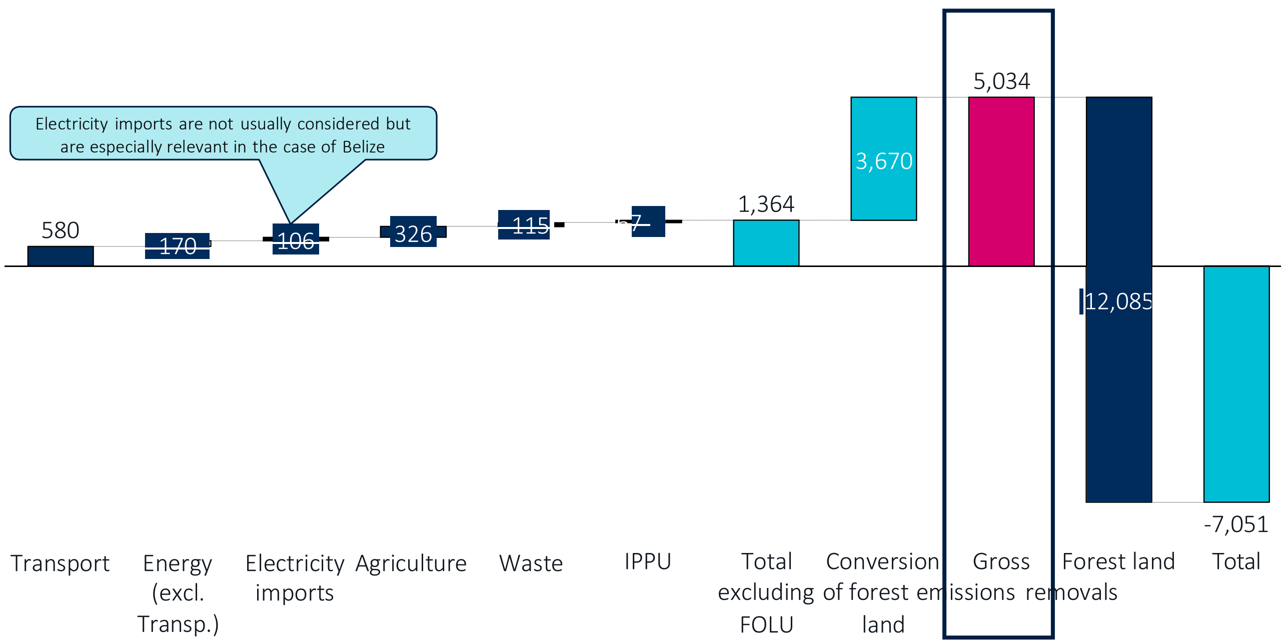
2 Pathways towards low emissions development in Belize

Starting with current GHG emissions baseline and Business-as-Usual (BAU) projections, this chapter explores pathways towards low emissions development for each critical sector in Belize, including the identification of mitigation options and potential targets for implementation levels in the High Ambition (HA) and Very High Ambition (VHA) scenarios.

2.1 Overall emissions baseline and BAU projections

The GHG emissions of Belize are dominated by the contribution of Forestry and Other Land Use (FOLU). In 2020, the emissions from the 'conversion of forest land to other uses' (i.e., deforestation) was estimated to be 3.7 $MtCO_2e$, with the remaining sectors emitting an estimated 1.4 $MtCO_2e$. However, CO_2 removal due to the forest growth in this year was estimated to be 12.1 $MtCO_2e$, which more than offset overall country's emissions, turning Belize into a net sink of GHG emissions, (-7.1 $MtCO_2e$) (see Error! Not a valid bookmark self-reference.). Apart from the FOLU sector, the primary source of GHG emissions is the stationary and mobile energy sector (about 2/3 of the total), followed by agriculture, waste, and IPPU sectors, in this order. In the figure below, the energy sector is split into stationary energy combustion, transport and emissions arising from electricity imports, which are very relevant for the case of Belize, and this will be discussed further in the energy section.

Figure 10 Annual estimated GHG emissions in Belize, 2020, thousands tCO_2e

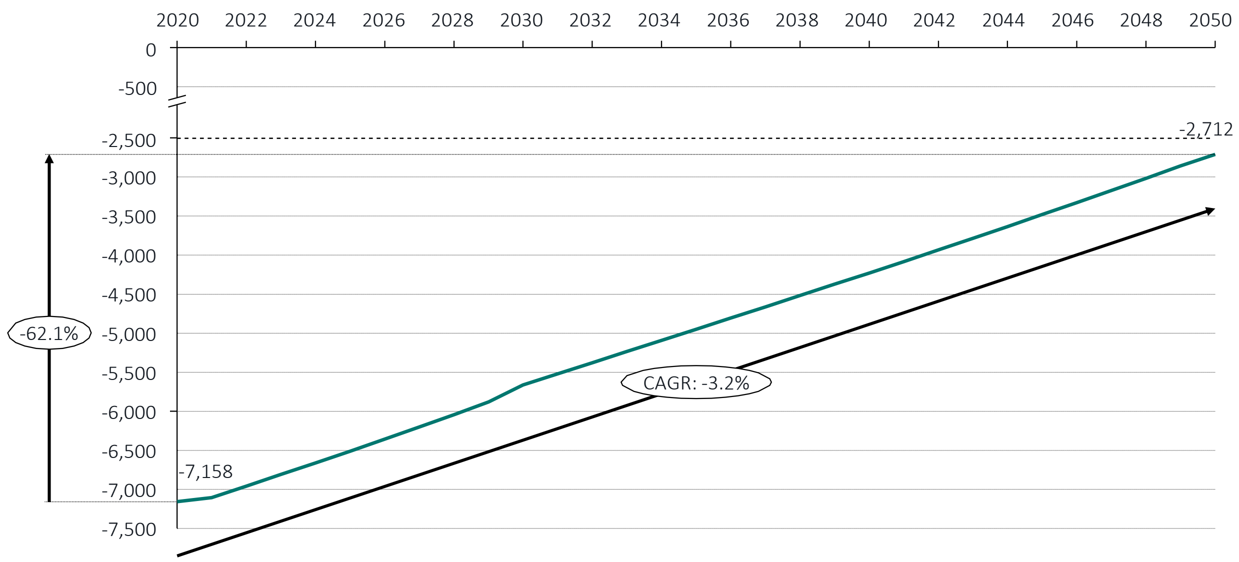


Source: Vivid Economics and Aether analysis

Although Belize is a GHG net sink due to FOLU, Business-as-Usual (BAU) projections lead to a reduction of removals of almost two thirds in the 2020-2050 period. Vivid Economic and Aether analysis indicate that overall country's overall net removals may reduce at a Compounded Annual Growth Rate (CAGR) of 3.2% on in-coming years, leading to an accumulated reduction of over 60% in the next three decades (see Figure 11).

The difference from the baseline above (-7.051 $KtCO_2e$) and the initial data point of the BAU projection below (-7.158 $KtCO_2e$) is due to electricity imports, which are not officially accounted as Belize's GHG emissions.

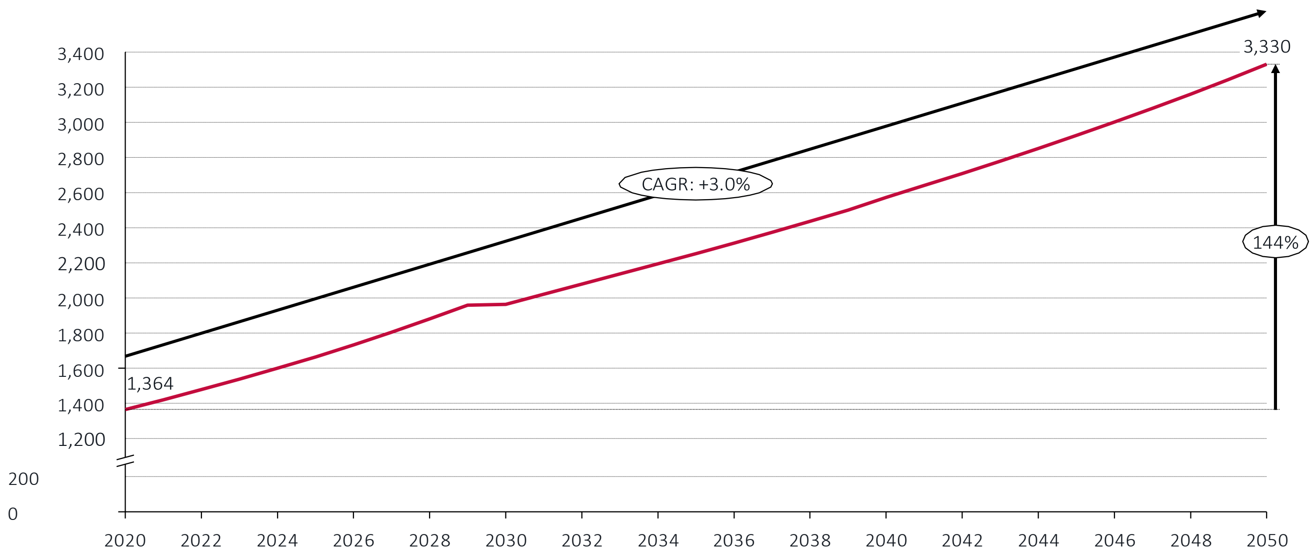
Figure 11 Business-as-Usual projections: Total annual GHG emissions including FOLU; thousands tCO_2e



Source: Vivid Economics and Aether analysis

Excluding FOLU, BAU projects emissions more than double in the 2020-2050 period. As removals from the FOLU sector are so much larger than emissions from other sectors, one simple perspective is to analyze the aggregate evolution of the emissions of all other sectors. As it is possible to see in Figure 12, aggregate emissions excluding FOLU should grow at an annual rate of 3%, from 1,300 to 3,300 $KtCO_2e$ in the period.

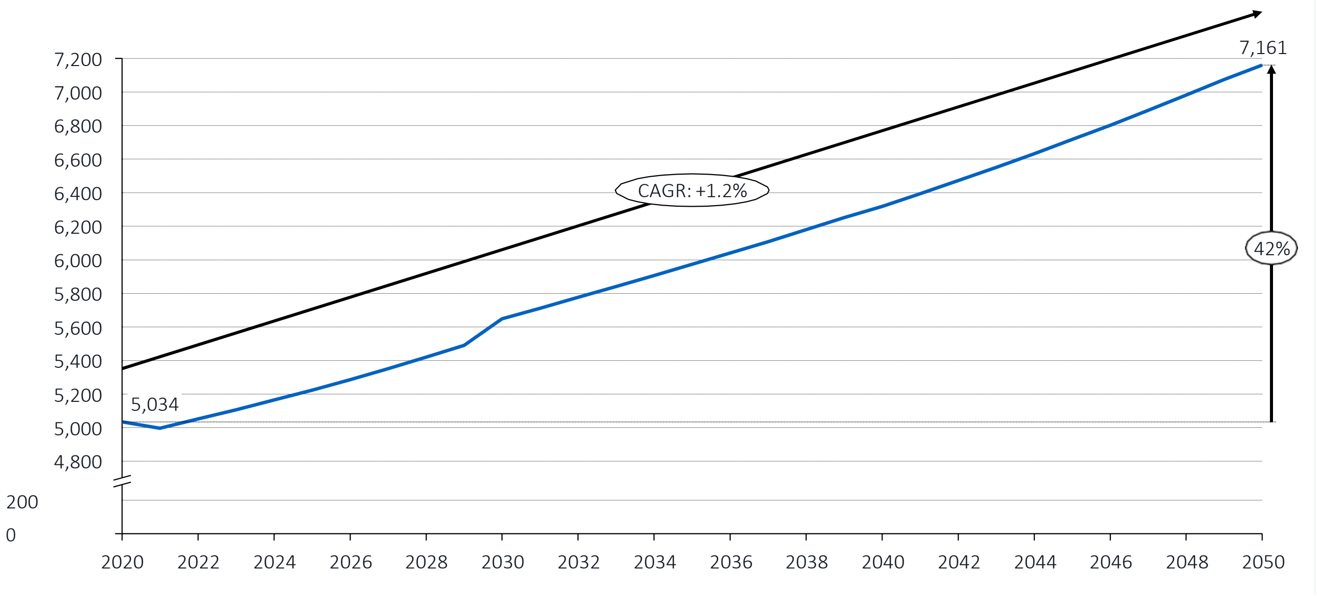
Figure 12 Business-as-Usual projections: Total annual GHG emissions excluding FOLU; thousands tCO_2e



Source: Vivid Economics and Aether analysis

Gross emissions (including conversion of land to other uses and electricity imports) are probably a more appropriate concept for tracking mitigation performance in Belize's case. In order to ascertain the full impact of mitigation options proposed in this LEDS, it is important that their impact be fully reflected in the indicator. First of all, the previous estimate would not include the main cause of GHG emissions in Belize, which is conversion of forest land to other uses. Second, not considering electricity imports it would underestimate the real impact of energy consumption in the country and would not adequately measure the effect of replacing imports by local renewable generation, for instance. We, therefore, incorporated these two adjustments on the previous emissions indicator. With this definition, GHG emissions would reach 5,000 $KtCO_2e$ in the baseline and would grow by more than 40% in the 2020-2050 period (Figure 13).

Figure 13 BAU projections: Annual gross GHG emissions (incl. Conversion, Imports); thousands tCO_2e



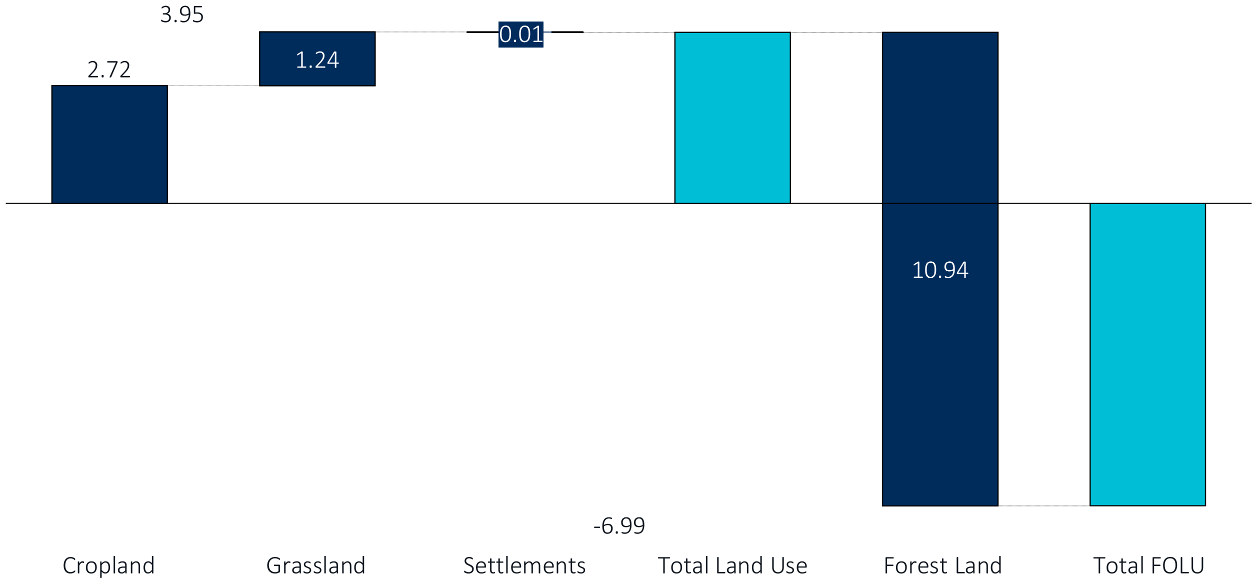
Source: Vivid Economics and Aether analysis)

In the following sections, we explore assumptions, BAU projections and mitigation options available for each sector.

2.2 Forestry and Other Land Use

Forestry and Other Land Use (FOLU) is a sink of GHG emissions due to the removals from the forest's growth, as explained previously. According to the last GHG emissions inventory in Belize (2017), conversion of forest to other uses such as croplands and grasslands was a significant driver of emissions and was estimated to account for almost 4 $MtCO_2e$. However, these emissions were more than compensated by forest growth and recovery, leading to net FOLU emissions of 7$MtCO_2e$ (see Figure 14).

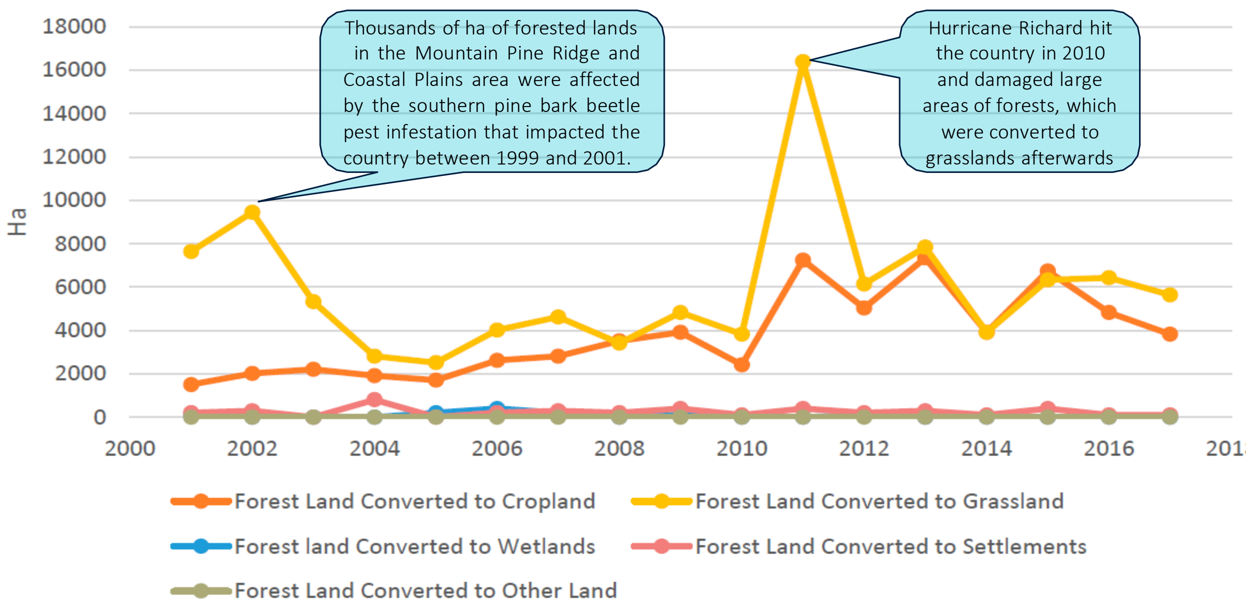
Figure 14 Annual FOLU GHG emissions in Belize, 2017, $MtCO_2e$



Source: Vivid Economics analysis, based on the 4th National GHG Inventory

Excluding natural disasters, the conversion of forests seems to be increasing, despite a small reduction of conversion to croplands recently. While conversion to both, grassland and cropland, were in the range of 2,000 – 3,000 ha/ year each in mid 2000s, they seem to be floating around 4,000 – 6,000 in recent years (Figure 15).

Figure 15 Forest Lands converted to other land uses, 2000-2017



Source: Vivid Economics analysis, based on the 4th National GHG Inventory

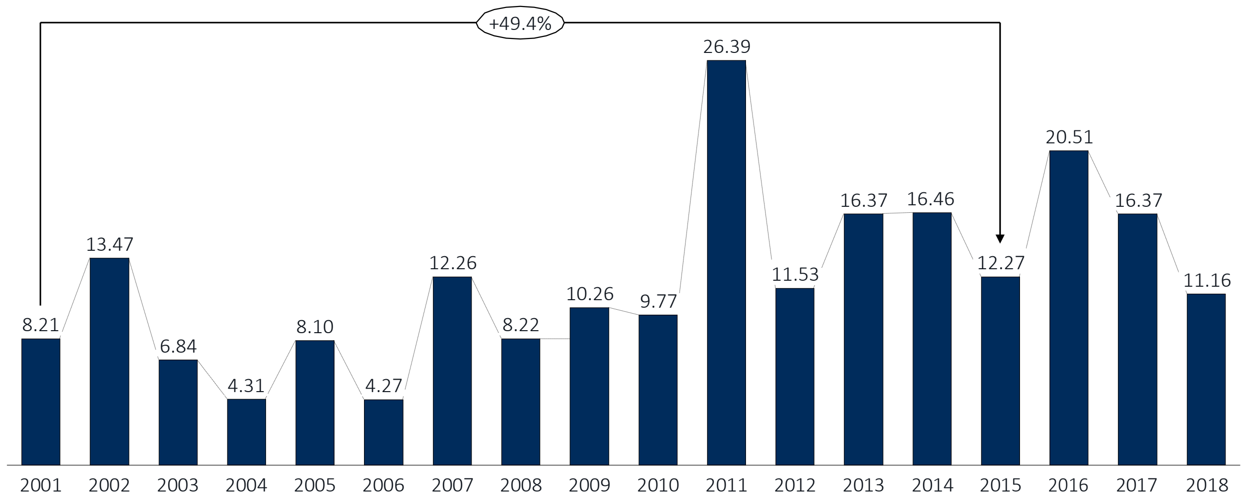
The Forest Watch sees an average deforestation rate of about 0.7% in the last decades, but also points to an increase over recent years. According to the Global Forest Watch,[9] 79.5% of national area was covered by

[9] https://www.globalforestwatch.org/dashboards/(accessed on March 2021)

trees as of 2000: out of 2.2 million hectares (Mha), 1.16Mha (53.0% of total) was primary forest,[10] 0.58 Mha (26.5%) was other tree cover[11] and 0.45 Mha (20.5%) was non-forest. From 2001 to 2018, Belize lost 0.22 Mha of tree cover, equivalent to a 12% decrease in tree cover (10% in total area), or with a deforestation rate of 0.7% per annum. Despite significant fluctuation, it is possible to notice an increase of at least 50% on annual tree cover loss rates, even considering conservative reference years (see Figure 16).

The National LDN Targets and Measures report (Ministry of Natural Resources, 2020) identifies an even greater process of land degradation in the country since 2000. The UNCCD suggests that the principal indicators of land degradation are negative land cover conversions, declining land productivity and loss in total organic carbon (for which soil organic carbon content is used as the main indicator). Negative land cover conversions include from cropland, wetland, or grassland to artificial areas (settlement), from grassland or wetland to cropland, or from forest to any other land cover class. Including all forms of degradation, the report estimates that, from a total of 2.21 Mha of national land area, 0.48 Mha (21.7%) were degraded in the period 2000 – 2015.

Figure 16 Land Use Change and Forestry: tree cover loss, millions Ha



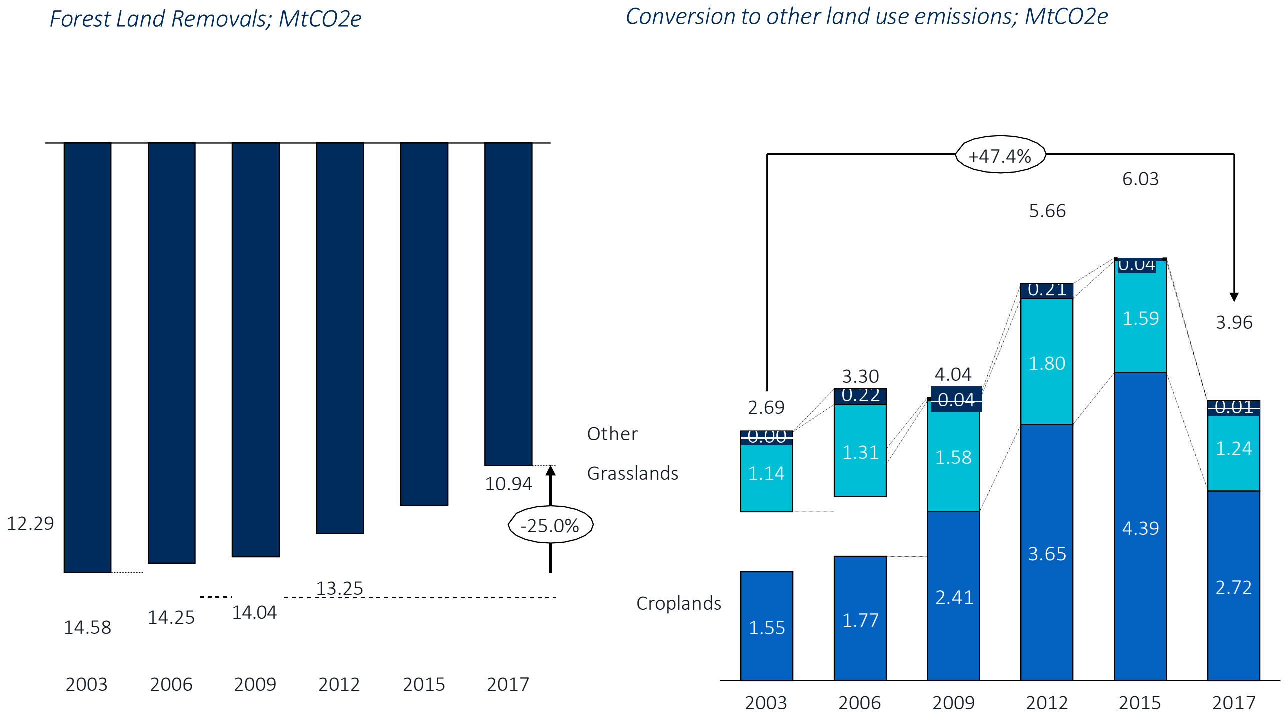
Source: Vivid Economics, based on Global Forest Watch

The 4th GHG inventory also sees a reduction on removals from Forest Land in parallel to an increase of emissions from deforestation. From 2003 to 2017, forest land removals were reduced 25% (from 14.6 to 10.9 $MtCO_2e$), while emissions due to conversion to other land uses increased almost 50% (from 2.7 to 4.0 $MtCO_2e$), as shown in Figure 17.

[10] Primary forests are among the most biodiverse forests, providing a multitude of ecosystem services, making them crucial to monitor national land use planning and carbon accounting. This data set defines primary forests as "mature natural humid tropical forest cover that has not been completely cleared and regrown in recent history".

[11] Tree cover is defined as all vegetation taller than 5 meters in height as of 2000. The tree cover data set uses Landsat satellite images to map tree cover globally at 30-metre resolution. Note that "tree cover" is the biophysical presence of trees and may take the form of natural forests or plantations existing over a range of canopy densities.

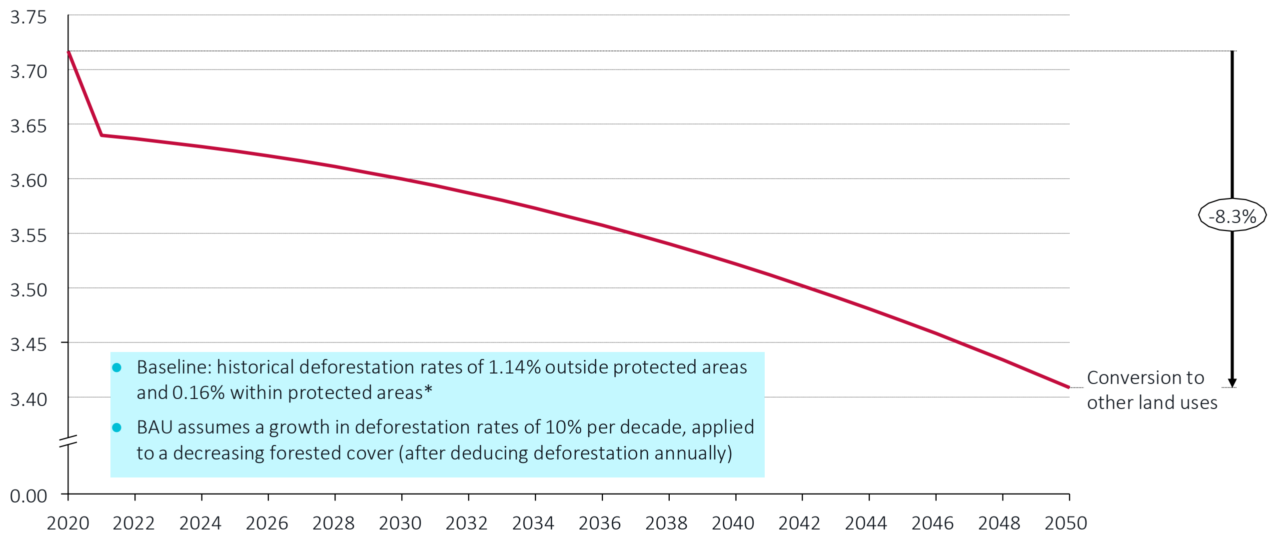
Figure 17 Evolution of Forest Land Removals and conversion emissions in Belize, $MtCO_2e$



Source: Vivid Economics analysis, based on the 4th National GHG Inventory

For future years, the BAU projections assume a gradually decreasing level of emissions from deforestation. BAU assumes a growing rate (deforestation) applied to a reducing base (forest cover), resulting in a small reduction of emissions in the 2020-2050 period. Over the period, the analysis projects a level of 3.4 $MtCO_2e$ (see Figure 18) for 2050, approximately 8% lower than the 3.7 $MtCO_2e$ registered for the baseline.

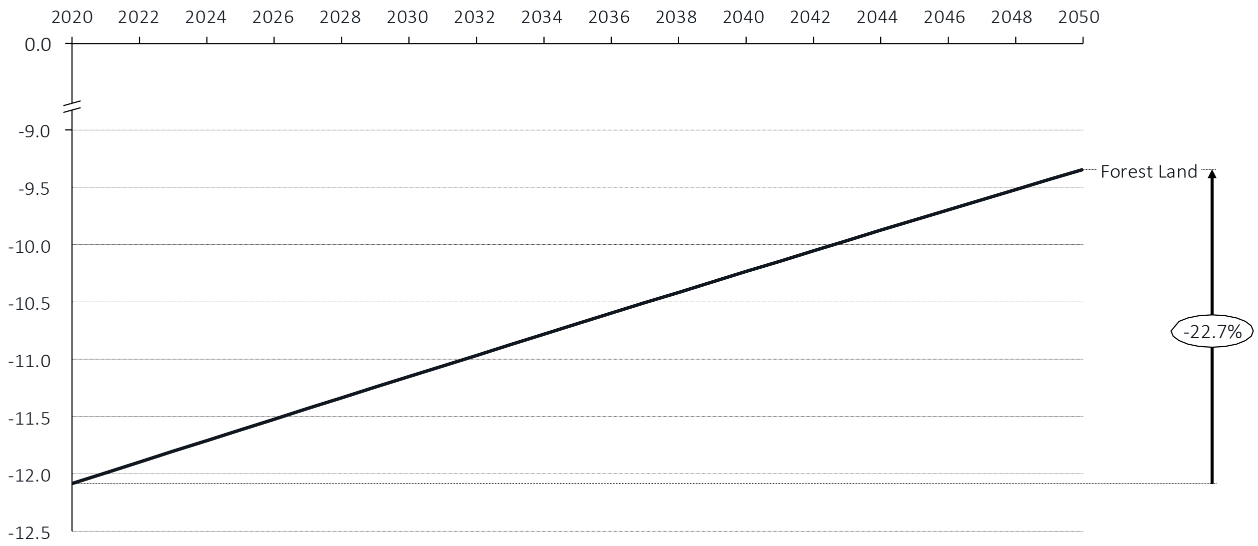
Figure 18 Business-as-Usual projections: Conversion to other land use emissions; $MtCO_2e$



Source: Vivid Economics and Aether analysis

As country's forest area is gradually reduced over the years, BAU projects a significant reduction of Forest Land negative emissions. BAU deforestation assumptions led to a reduction of annual forest land removals of 2.7 $MtCO_2e$ (from 12.1 to 9.3 $MtCO_2e$), i.e., 23% of the 2020 baseline (Figure 19).

Figure 19 Business-as-Usual projections: Forest Land Removals; $MtCO_2e$



Source: Vivid Economics and Aether analysis

Mitigation pathways and targets

The analysis and stakeholder engagement in the Forestry and Land Use sector resulted in six actions with twelve targets spread among them as shown below.

1. Reduction of deforestation rate
   1.1. Reduction of deforestation rate outside Natural Protected Areas System
   1.2. Reduction of deforestation rate in areas within Natural Protected Areas System
2. Restoration of forests in key watersheds
   2.1. Restoration of riparian forests
3. Avoided extraction of mangroves and seagrass meadows
   3.1 Reduction of mangrove extraction rate
   3.2 Reduction seagrass meadow extraction rate
4. Restoration of mangroves and seagrass meadows
   4.1. Restoration of mangroves from rewetting (with saline water)
   4.2. Restoration of seagrass meadows from rewetting (with saline water)
5. Improved prevention and control of forest fires
   5.1. Reduced forest area consumed by fire through prevention and control
6. Reforestation (secondary broad-leaf forests) inside and outside protected areas
   6.1. Reforestation of areas from annual cropland
   6.2. Reforestation of areas from grassland

6.3. Reforestation of areas from set-aside land

6.4. Reforestation of areas from degraded cropland

In the remainder of this section, we will further explore context, targets by scenario with associated assumptions, potential impacts, and implementation feasibility of each of these mitigation options.

2.2.1 Reduction of deforestation rate[12]

		Targets 2030			Targets 2040			Targets 2050		
Sub-action	Target parameter	BAU	HA	VHA	BAU	HA	VHA	BAU	HA	VHA
1.1. Reduction of deforestation rate outside Natural Protected Areas System	Annual deforestation rate outside Natural Protected Areas System (% forested area)	1.25%	1.13%	1.00%	1.39%	1.04%	0.70%	1.52%	0.96%	0.40%
1.2. Reduction of deforestation rate in areas within Natural Protected Areas System	Annual deforestation rate within Natural Protected Areas System (% forested area)	0.18%	0.13%	0.09%	0.19%	0.12%	0.04%	0.22%	0.11%	0.00%

The 2019 Mitigation Strategy report estimates deforestation rate in forest outside conservation areas as 1.14% per year and inside conservation areas as 0.16%, during the period 2001-2015.[13] FAO, in its analysis supporting Belize's NDC revision, proposed an action focused exclusively on areas outside the Natural Protected Areas System, with a target of reducing the deforestation rate by almost half (from 1.14% to 0.6%) by 2030. This level of reduction was considered too aggressive for one decade (2030), but feasible for two decades (2040). Officials from the Ministry of Natural Resources also pointed out that, given recent trend of increasing deforestation, the rates may be even higher in subsequent decades, if no action is taken. Stakeholders then agreed to consider a limited deforestation rate growth for the BAU scenario, and a 10% growth for each decade was agreed upon among the focus group participants, if no actions are taken.

There was a robust discussion among the group supporting the target of achieving zero deforestation (considering only anthropogenic impacts) by 2050 within protected areas, which also influenced the VHA target for other areas. Leadership from the University of Belize, TASA, and the GOB Energy Unit and Natural Resources also indicated that Chiquibul and areas along the Guatemala border are of special concern in moving towards a net zero impact within protected areas. In addition, the group suggested the action be split into targets for both protected and unprotected land areas for execution and monitoring. The VHA scenario follows the pattern of deforestation reduction presented in the 2019 Mitigation Strategy, reaching 0% in 2050 in protected areas and a rate approaching net zero for unprotected areas, when other actions ofAgriculture and FOLU are considered. In the scope of this action in isolation, a target of 0.4% was adopted for VHA 2050 in unprotected areas.

[12] BAU: Business-as-Usual; HA: High ambition target; VHA: Very High Ambition target

[13] This estimation is based on the information provided by Belize in the REDD+ Strategy and the Protected area shapefile 2015.

2.2.2 Restoration of forests in key watersheds

		Targets 2030			Targets 2040			Targets 2050		
Sub-action	Target parameter	BAU	HA	VHA	BAU	HA	VHA	BAU	HA	VHA
2.1. Restoration of riparian forests	Area of riparian forests restored (ha)	-	1,500	3,000	-	2,250	4,500	-	3,000	6,000

This action was also initially proposed by FAO in its analysis supporting Belize's NDC revision, which estimated an opportunity for 750 ha of riparian forest restoration in 2030.

When discussing this target, there was some questioning among FOLU stakeholders on whether the proposed targets may be too conservative. Leadership from the University of Belize, TASA, and Natural Resources discussed the need to include several other watershed areas within the activity, primarily but not limited to Belize River, New River, Mopan River, and Sittee River. There was some inquiry regarding the source of the target activity, and it was suggested that the data and action was extracted from the LDN and GEF projects. The group acknowledged that there are no active projects for the restoration of riparian forest along rivers, which have been impacted by flooding and hurricane activity in recent years.

In this context, the 2030 target was increased to 3,000 ha in the VHA scenario and focus group participants agreed it was reasonable to assume half of that rate for the VHA for the subsequent two decades.

2.2.3 Avoided extraction of mangroves and seagrass meadows

		Targets 2030			Targets 2040			Targets 2050		
Sub-action	Target parameter	BAU	HA	VHA	BAU	HA	VHA	BAU	HA	VHA
3.1 Reduction of mangrove extraction rate	Annual mangrove extraction rate (% of total mangrove area)	0.10%	0.08%	0.05%	0.10%	0.063%	0.03%	0.10%	0.056%	0.01%
3.2 Reduction of seagrass meadow extraction rate	Annual seagrass meadow extraction rate (% of total mangrove area)	0.05%	0.038 %	0.025 %	0.05%	0.031%	0.013%	0.05%	0.028%	0.01%

The Belize National Action Plan estimates seagrass area of 379,130 ha and mangrove area of 72,169 ha in Belize (2017). FAO estimates that the mangrove extraction rate was 0.69% over 7 years (from 2010 to 2017) and assumes seagrass meadow extraction rate of 0.49% in a decade.

Protection of mangroves is an action included in Belize's 2020 NDC and it is currently supported by Forest Department studies of above and underground carbon assessments. A representative from the Coastal Zone Management Authority and Institute (CZMAI) confirmed that the organization had been working on the restoration and protection of mangroves and riparian forests. There was a group consensus regarding the BAU scenario as the historical annual extraction rate (0.1% for mangroves and 0.05% for seagrass meadows) and targets proposed by FAO of a 50% reduction in one decade were considered reasonable for the VHA.

The FAO estimate of a 50% reduction in one decade was also applied to the VHA in subsequent decades as well, although the group considered that additional information may be needed.

2.2.4 Restoration of mangroves and seagrass meadows

		Targets 2030			Targets 2040			Targets 2050		
Sub-action	Target parameter	BAU	HA	VHA	BAU	HA	VHA	BAU	HA	VHA
4.1. Restoration of mangroves from rewetting (w/ saline water)	Area of mangroves restored from rewetting (ha)	-	250	500	-	375	750	-	500	1,000
4.2. Restoration of seagrass meadows from rewetting (w/ saline water)	Area of seagrass meadows restored from rewetting (ha)	-	750	1,500	-	1,125	2,250	-	1,500	3,000

This action was also initially proposed by FAO in its analysis supporting Belize's NDC revision, with a target of 354 ha of mangrove and 929 ha of seagrass meadows restored by 2030. There was a group consensus that the targets proposed were conservative, and the group raised them for 500 ha of mangroves and 1,500 ha of seagrass meadows in one decade. For the subsequent decades, the VHA assumes half of this rate.

Stakeholders confirmed that no prior restoration projects had been undertaken for seagrass meadows to date. An inquiry was made regarding the source of the data, and a representative from the CZMAI confirmed that the organization had been working on the restoration and protection of mangroves and riparian forests but had no previous experience on seagrass restoration. There was a group consensus that additional information may be needed – including scientific studies and concrete experiences and techniques for seagrass restoration – but the proposed targets were considered reasonable for the time being.

2.2.5 Improved prevention and control of forest fires

		Targets 2030			Targets 2040			Targets 2050		
Sub-action	Target parameter	BAU	HA	VHA	BAU	HA	VHA	BAU	HA	VHA
5.1. Reduced forest area consumed by fire through prevention and control	Reduction of forest fires (% of 2020 level)	0%	25%	50%	0%	38%	75%	0%	44%	87.5%

According to the 2019 Mitigation Strategy Report, the average annual emission estimates for forest fires are 119.59 Gg CO2e. The study proposed a complete elimination of forest fires in a decade, which was considered unreasonable by stakeholders. There was a consensus among stakeholders to move forward with a less ambitious target of 50% reduction until 2030 for the VHA scenario, with the acknowledgement that additional information is needed, specifically regarding the target areas. The 50% reduction target was replicated in the following two decades as well.

2.2.6 Reforestation (secondary broad-leaf forests) inside and outside protected areas

		Targets 2030			Targets 2040			Targets 2050		
Sub-action	Target parameter	BAU	HA	VHA	BAU	HA	VHA	BAU	HA	VHA
6.1. Reforestation of areas from annual cropland	Area reforested (ha) from annual cropland	-	5,500	11,000	-	11,000	22,000	-	16,500	33,000
6.2. Reforestation of areas from grassland	Area reforested (ha) from grassland	-	5,500	11,000	-	11,000	22,000	-	16,500	33,000
6.3. Reforestation of areas from set-aside land	Area reforested (ha) from set-aside land	-	5,500	11,000	-	11,000	22,000	-	16,500	33,000
6.4. Reforestation of areas from degraded cropland	Area reforested (ha) from degraded land	-	5,500	11,000	-	11,000	22,000	-	16,500	33,000

This action was also initially proposed by FAO in its analysis supporting Belize's NDC revision. FAO mentions Belize Forest Department Strategic Objective 4 of "Maintain no net loss in forest cover in priority areas" and a prioritization of about 130,000 ha among the activities under the Restoration Opportunities Assessment Methodology (ROAM) Initiative (and to be included within Belize's pledge to the Bonn Challenge). In this context, FAO proposed the reforestation of 44,000 ha in four different categories, which is about a third of the total.

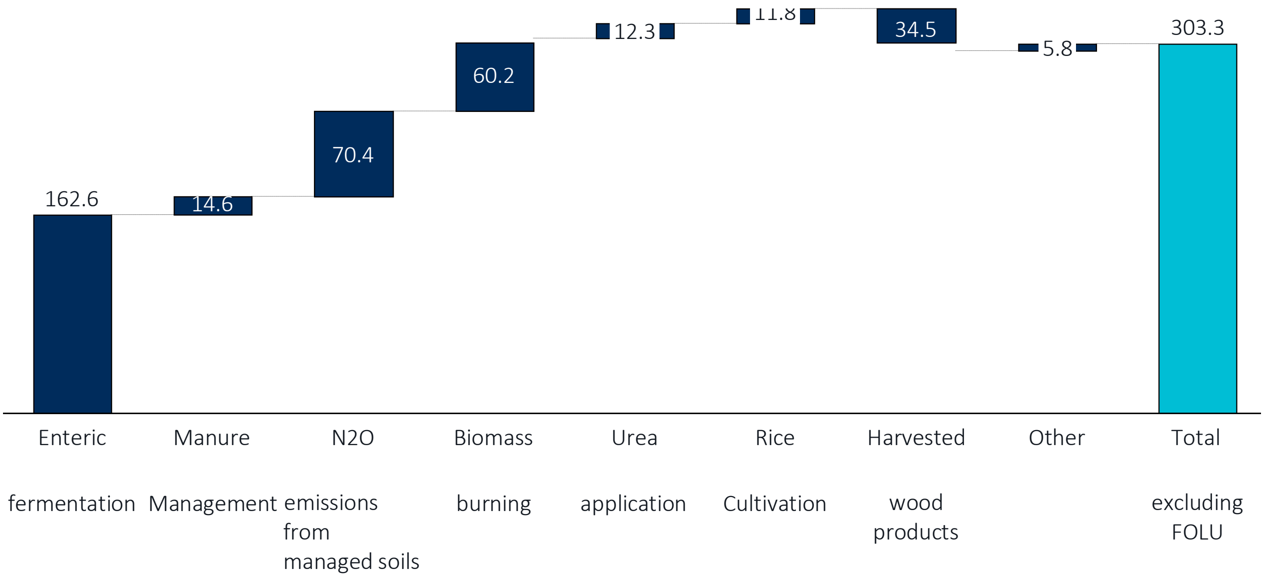
This measure was initially applied to tropical nurseries. Sector leads for forestry and Natural Resources both indicated that the action required additional clarification regarding the target's unique intent for measurement and verification. The action was also further defined based on focus group feedback to include targets for reforestation both within and outside of protected areas. It was noted and agreed that Belize's "secondary forest" may require 18-20 years to recover, and additional information is needed to set ambition targets.

Preliminarily, the target was set maintaining FAO's target in the following two decades as well, approximately reaching FAO's overall prioritized areas (130,000 ha) by mid-century.

2.3 Agriculture

About 60% of Agricultural emissions come from livestock, followed by aggregated sources on land. Figure 20 presents data from the latest GHG inventory, indicating that livestock combined emissions (from manure management and enteric fermentation) were 0.18 $MtCO_2e$, from a total of 0.30 $MtCO_2e$ for Agriculture as a whole (including removals due to harvested wood products). This is followed by aggregated sources on land, especially nitrogen fertilization and biomass burning.

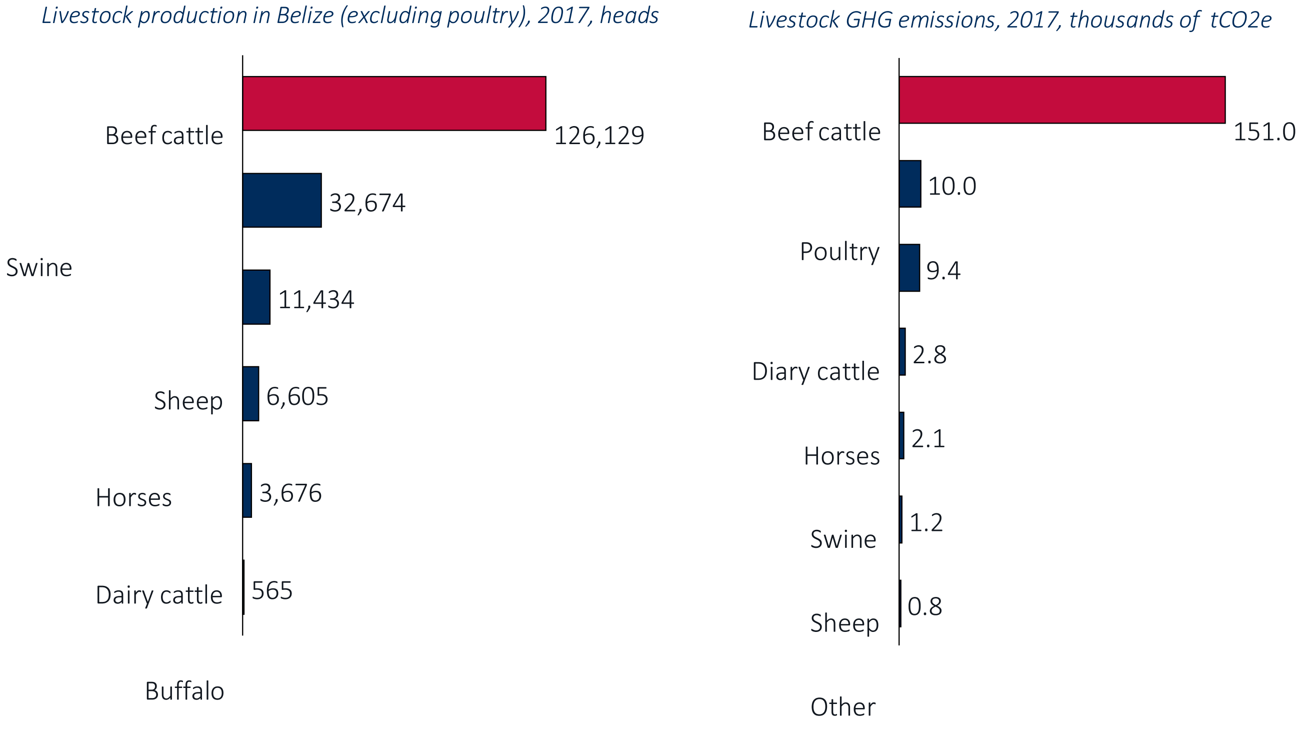
Figure 20 Annual Agriculture GHG emissions in Belize, 2017, thousands tCO_2e



Source: Vivid Economic analysis, based on 4th National GHG Inventory

Beef cattle make up the largest proportion of livestock production (except for poultry) and are responsible for the bulk of livestock GHG emissions in Belize. As shown below, GHG beef cattle are responsible for more than 0.15 out of the 0.18 $MtCO_2e$ of total livestock GHG emissions (Figure 21).

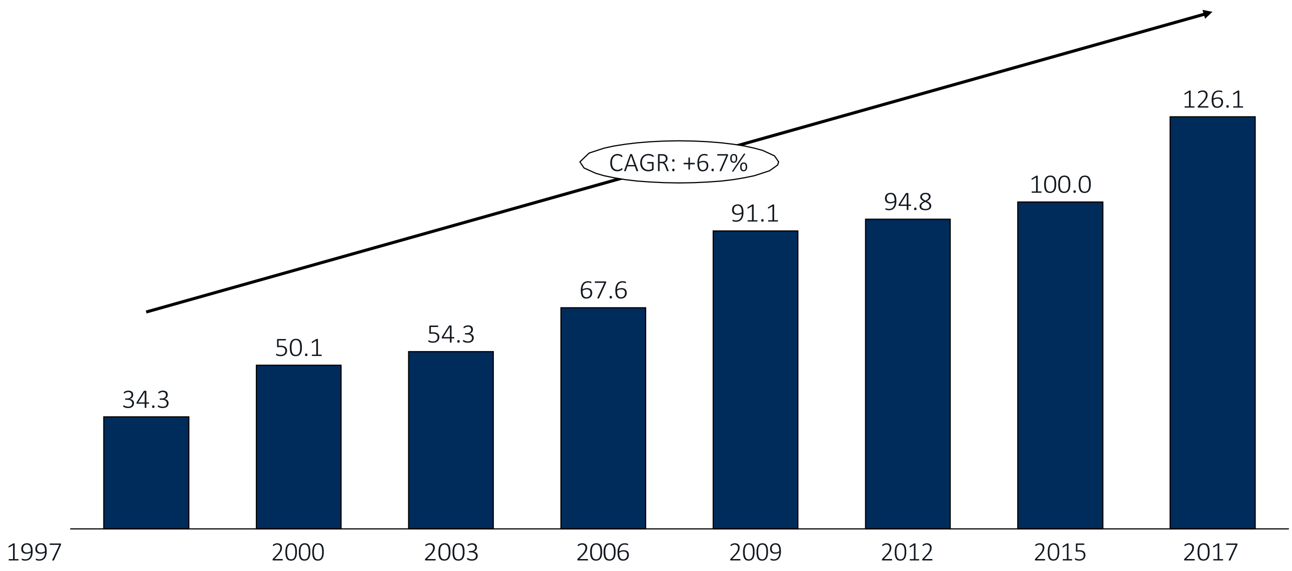
Figure 21 Livestock production and emissions by category, 2017



Source: Vivid Economic analysis, based on 4th National GHG Inventory

Beef cattle production was growing steadily over the last two decades. Figure 22 shows a compounded annual growth rate of 6.7% over two decades.

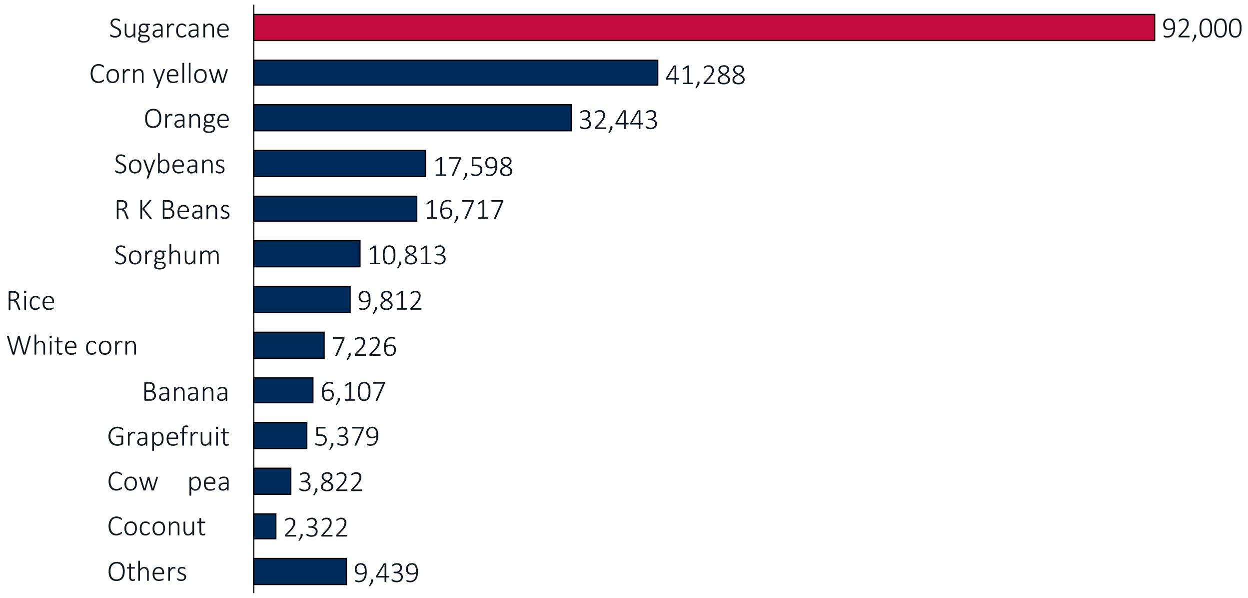
Figure 22 Beef cattle production in Belize, thousands of cattle heads



Source: Vivid Economic analysis based on FAO data within the 4th National GHG Inventory

Agricultural production systems operate on 7% of total land area and croplands are led by sugarcane. Belize comprises an area of 5,676,011 acres, with approximately 1,977,000 acres (about 38% of the land area) suitable for agriculture; only 390,427 acres (7% of the total land area) are actively being used for agriculture. Of the total land area, 1.4% is planted to permanent crops, 2.2% consists of permanent meadows, and 3.3% is arable land.[14] Sugarcane production is the largest crop in terms of land use (27% of total harvested area), followed by Corn (21%), Citrus (16%), Beans (10%), Rice (4%) and Bananas (3%). Additionally, 351,700 acres in pastures are grazed by approximately 135,400 head of cattle.

Figure 23 Area of main crops/ plantations in Belize, 2017, acres

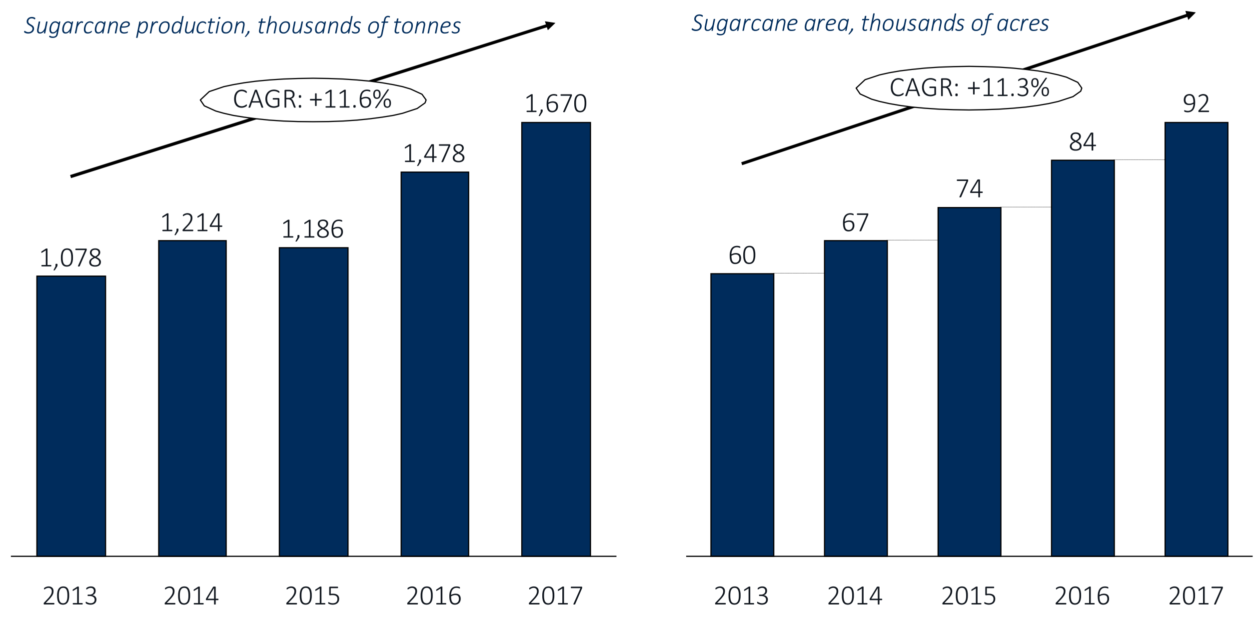


Source: Vivid Economic analysis, based on 4th National GHG Inventory

[14]FAOSTAT. 2018. Available at: www.fao.org/faostat/en/#data/RL

After some fluctuation, sugarcane production has been growing rapidly in recent years. Although production was not increasing strongly in mid-2010s, it has been catching up lately and overall growth has been aligned with harvested area. Overall growth has exceeded 11% annually over the last few years (Figure 24).

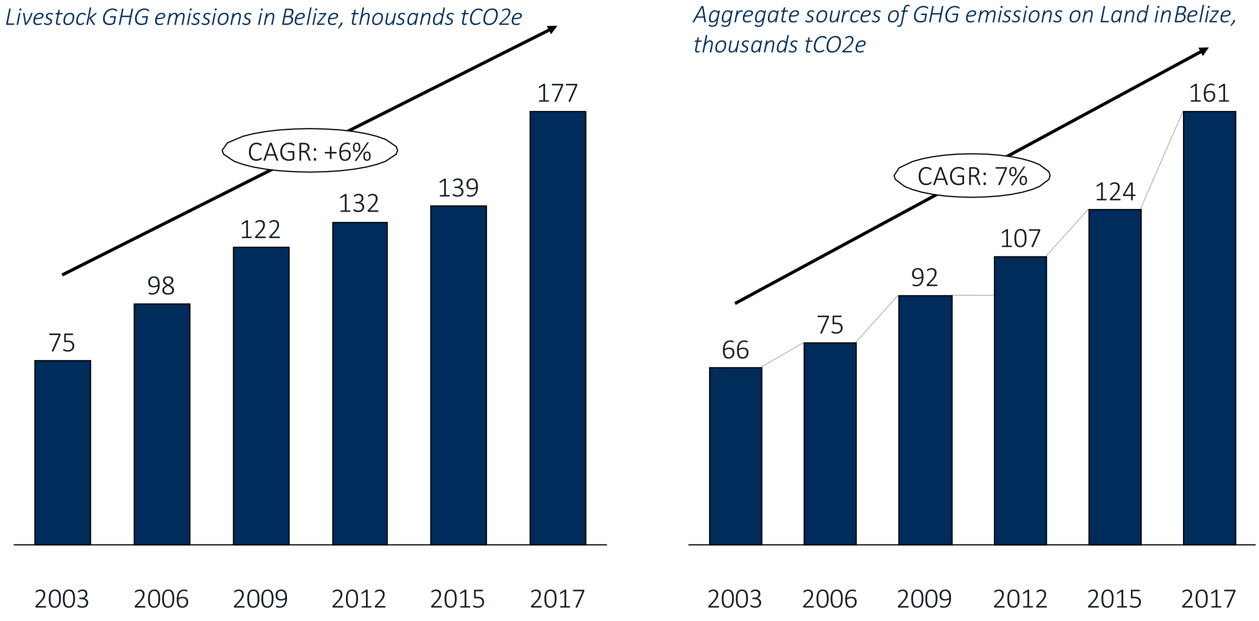
Figure 24 Evolution of sugarcane production and area



Source: Vivid Economic analysis, based on 4th National GHG Inventory

GHG emissions from livestock and crops have been growing at similar rates in this century. While livestock emissions grew from 0.08 to 0.18 $MtCO_2e$ (6%/ year), aggregate sources grew from 0.07 to 0.16 $MtCO_2e$ (7%/ year), as shown in Figure 25.

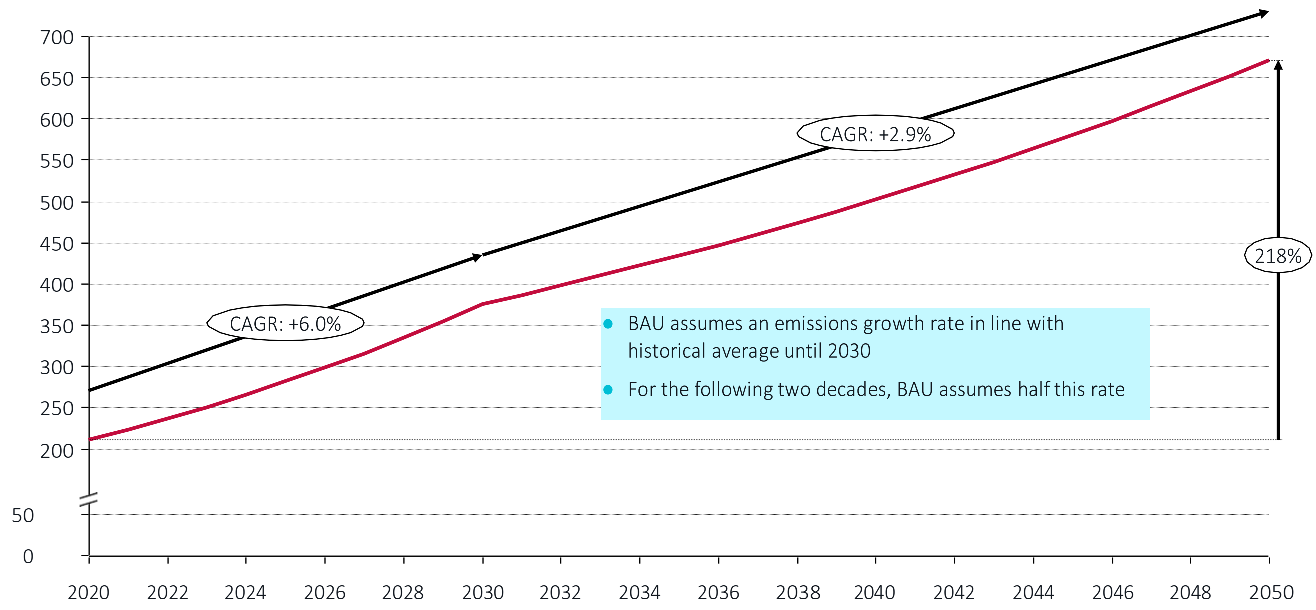
Figure 25 Evolution of emissions from livestock and croplands since 2003



Source: Vivid Economic analysis, based on 4th National GHG Inventory

For Livestock, BAU projections led to an increase of emissions of 218% in the 2020-2050 period. BAU assumes an emissions growth rate in line with historical average until 2030, followed by a substantial reduction, as shown in Figure 26.

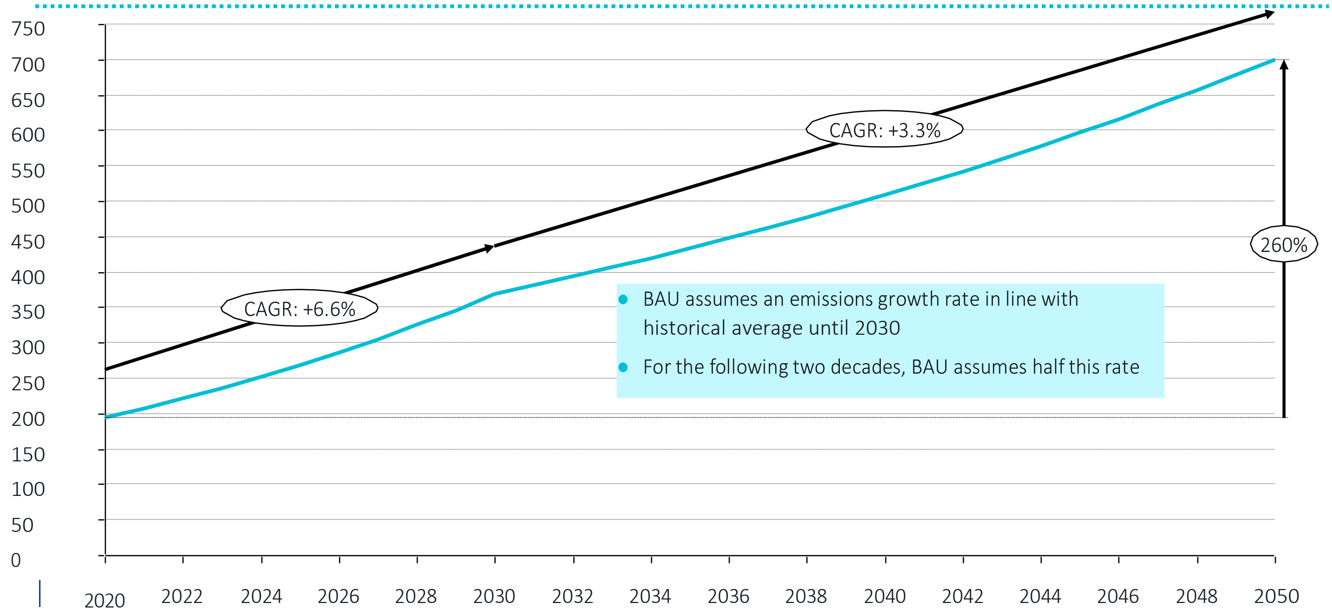
Figure 26 Business-as-Usual projections: Livestock GHG emissions; thousands tCO_2e



Source: Vivid Economics and Aether analysis

For croplands, BAU projections led to an increase of emissions of 260% in the 2020-2050 period. BAU assumes an emissions growth rate in line with historical average until 2030, followed by a substantial reduction, as shown in Figure 27.

Figure 27 Business-as-Usual projections: Aggregate sources of GHG emissions on Land, thousands tCO_2e



Source: Vivid Economics and Aether analysis

Mitigation pathways and targets

The analysis and stakeholder engagement in the agriculture sector resulted in 9 actions with a total of 17 sub-actions with associated targets:

1. Increasing sustainable livestock management
   1.1. Reduction of land dedicated to pastures
   1.2. Reduction of time required to cattle maturity
   1.3. Reduction of emissions from enteric fermentation due to improved cattle feeding and probiotics
   1.4. Capture, store and treat animal manures sustainably, including probiotics
2. Encouraging intercropping of annual cropland with agroforestry
   2.1. Cover crop/ Intercropping in the coconut industry
   2.2. Agroforestry systems (hedgerows) introduced to another conventional annual cropland
3. Introduction of improved agronomic practices to annual croplands, including soil analysis, water/ nutrient management and fertilization (e.g., biofertilizers)
   3.1. Improved agronomic practices on crops (corn, RK beans and soybeans)
   3.2. Improved agronomic practices on vegetables and potatoes
   3.3. Improved agronomic practices on sugarcane
4. Promotion of green mechanical harvesting in northern Belize
   4.1. Conversion of residue burning to retention of sugarcane cropland
5. Restoration of degraded sugar land

5.1. Restoration of arable sugar land

6. Improvement to flooded rice
   6.1. Conversion of irrigated rice from continuously flooded to intermittently flooded single aeration
7. Integrated landscape forest management
   7.1. Conversion of annual croplands into multi-strata agroforestry systems
8. Introduction of sustainable land management in production systems
   8.1. Silvopasture systems introduced to non-degraded grasslands
   8.2. Restoration of moderately degraded grasslands
   8.3. Introduction of silvoarable agroforestry systems on set aside land
9. Sustainable practices in coconut production
   9.1. Coconut waste management (biochar, composting, biofabrics)

In the remainder of this section, we will further explore context, targets by scenario with associated assumptions, potential impacts, and implementation feasibility of each of these mitigation options.

2.3.1 Increasing sustainable livestock management

		Targets 2030			Targets 2040			Targets 2050		
Sub-action	Target parameter	BAU	HA	VHA	BAU	HA	VHA	BAU	HA	VHA
1.1 Reduction of land dedicated to pastures	Average cattle stocking rate (heads/ ha)	1.00	1.50	2.00	1.50	2.25	3.00	2.00	3.00	4.00
1.2 Reduction of time required to cattle maturity	Average cattle slaughtering age (months)	60	57	55	60	52	44	60	52	44
1.3 Reduction of emissions from enteric fermentation due to improved cattle feeding and probiotics	Reduction of emissions from enteric fermentation (% of total)	0%	5%	10%	0	10%	20%	0	15%	30%
1.4 Capture, store and treat animal manures sustainably, including probiotics	Reduction of emissions from manure (% 2020 level)	0%	5%	10%	0%	10%	20%	0%	13%	25%

Livestock emissions (especially from enteric fermentation) are the main source of emissions in the agriculture sector with almost all those emissions coming from beef cattle. In addition, the beef cattle herd is growing rapidly and, due to the low stocking rate in Belize, this expansion occupies a significant extension of land and puts increasing pressure on country's forest cover.

Recognizing this challenge, the Food and Agriculture Organization of the United Nations (FAO) included in its projections for the NDC actions to limit this growth and to diversify it towards other ruminants, which have much lower emission factors. The agriculture sector leads, along with several other cross-cutting representatives, highlighting that Belize has recently experienced economic growth due to an increase in demand for cattle exports, and the Government plans to further increase cattle herd for this purpose. Concurrently, Belize would also have limited potential for accelerating growth for goat and sheep herds. This measure, therefore, was removed from the mitigation options portfolio by consensus of sector stakeholders.

This option was, nevertheless, replaced by a measure to increase the stocking rate, with varied target proposals among stakeholders (between two and five heads per hectare). The latter is currently set as the VHA target for 2050, assuming a gradual progression from the current level (estimated at one head per hectare) by mid-century.

There was a positive consensus across the group regarding the reduced timeframe to cattle maturity and the reduction of emissions from enteric fermentation, due to improved cattle feeding and probiotics. The group agreed on a gradual implementation process VHA targets for 2050 of 44 months for cattle maturity (from current levels estimated at 60 months) and an overall 30% reduction of methane emissions within the same time frame. This is aligned with the 2019 Mitigation Strategy, which proposed a reduction of CH_4 emissions from enteric fermentation of about 20% until 2030.

Manure management makes up historically 10% of the livestock emissions inventory and a measure to treat cattle manure mores sustainably was discussed, with a VHA target of 25% of emissions reduction until mid-century and a gradual progression until that point. The discussion then evolved into a proposal to add a measure to capture biogas from pigs and other livestock under sustainable livestock management. It was noted that the sector had piloted an effort to utilize pig manure for bio-generation previously, and that collection efficiency is presently higher for pigs due to improved practices and more feasible volumes. The sector had been considering expanding this measure as some activity is already taking place. A 2050 target for reducing emissions from pig manure by 33% was discussed but, as the current volume was considered negligible, the target was not adopted.

2.3.2 Encouraging intercropping of annual cropland with agroforestry

		Targets 2030			Targets 2040			Targets 2050		
Sub-action	Target parameter	BAU	HA	VHA	BAU	HA	VHA	BAU	HA	VHA
2.1. Cover crop/ Intercropping in the coconut industry	Area of cover crop/ intercropping within coconut production (ha)	-	2,500	5,000	-	2,500	5,000	-	2,500	5,000
2.2. Agroforestry systems (hedgerows) introduced to another conventional annual cropland	Area of intercropping (hedgerows) within annual cropland (ha)	-	4,000	8,000	-	6,000	12,000	-	8,000	16,000

Intercropping consists of growing two or more different crops together at the same time in the same space in a beneficial manner. Row intercropping involves at least one of the components being planted in rows. Similarly, agroforestry integrates the planting of crops with perennials, such as trees or palms.

The proposal to institute intercropping was aimed initially at Belize's annual crops and FAO estimated that 8,000ha of hedgerows could be introduced until 2030. This value was considered as VHA target for 2030, slowing to half this pace in the next 2 decades, leading to a higher ambition of impacting 16,000 ha of annual croplands by 2050.

An additional target was added to this action, as stakeholders noted the potential for agroforestry that integrated coconut farming, a primary cultivar in Stann Creek, Orange Walk, and Cayo. Stakeholders reported that an area of coconut plantation of 10,000 ha should grow to 20,000 ha in 3 decades if this measure is applied mainly to young coconut plantations. The group agreed that, given the current area and implementation time, this is a relatively short-term action maximizing 50% of the crops by 2030, leading to a VHA assumption of 5,000 hectares.

2.3.3 Introduction of improved agronomic practices to annual croplands, including soil analysis, water/ nutrient management and fertilization (e.g., biofertilizers)

		Targets 2030			Targets 2040			Targets 2050		
Sub-action	Target parameter	BAU	HA	VHA	BAU	HA	VHA	BAU	HA	VHA
3.1. Improved agronomic practices on crops (corn, RK beans and soybeans)	Area of crops with improved soil and water practices (ha)	-	5,000	10,000	-	7,500	15,000	-	12,500	25,000
3.2. Improved agronomic practices on	Area of vegetables with improved soil	-	320	640	-	320	640	-	320	640

		Targets 2030			Targets 2040			Targets 2050		
Sub-action	Target parameter	BAU	HA	VHA	BAU	HA	VHA	BAU	HA	VHA
vegetables and potatoes	and water practices (ha)									
3.3. Improved agronomic practices on sugarcane	Area of sugar land with improved soil and water practices (ha)	-	10,000	20,000	-	21,250	42,500	-	32,500	65,000

This action was initially proposed by FAO in its analysis supporting Belize's NDC revision, focusing on crops, vegetable and potatoes. For crops, FAO considers this could be applied to an area of 17,664 ha of corn, 450 ha of RK beans, 1,420 ha of soybeans (about 20,000 ha in 2020, 25,000ha in 2050). For vegetables and potatoes, FAO considers this could be applied to an Area of 230 ha of conventional vegetables and 140 ha of potatoes (about 400 ha in 2020, 800ha in 2030).

Based on stakeholder feedback, this action was refined regarding targets for grains and vegetables and its scope enhanced to accommodate targets for sugarcane as well. Based on group consensus, the estimated area of land impacted was set to 20,000 hectares of annual grain crops by mid-century; for vegetables, the impact is expected mostly in the short-term, reaching 640 ha by 2030 and not growing further after that.

On sugar, stakeholders reported an estimated area of 35,000ha in Northern Belize (already mature) and 12,000ha in Western Belize (which is growing rapidly and should reach 30,000 ha by 2040). Stakeholders believe that the totality of expanded sugar land (65,000 ha) could be reached until mid-century in the VHA scenario.

It is estimated that a 30-40% reduction in nitrogen emissions will result from this action for all cultures.

2.3.4 Promotion of green mechanical harvesting in northern Belize

		Targets 2030			Targets 2040			Targets 2050		
Sub-action	Target parameter	BAU	HA	VHA	BAU	HA	VHA	BAU	HA	VHA
4.1. Conversion of residue burning to retention of sugarcane cropland	Area with residue retention on sugar cropland - elimination of 2nd burning (ha)	-	10,000	20,000	-	21,250	42,500	-	32,500	65,000

This action was initially proposed by FAO in its analysis supporting Belize's NDC revision, estimating a conversion of 40,157 ha until 2030. Within the mechanical harvesting measure, stakeholders described a recent effort to educate and support small farmers in eliminating the usual practice of second crop burning as part of the harvest process, and suggested the effort be considered within the action. As with other measures impacting sugarcane crops, sector stakeholders expect that this could be applied to 100% of sugar cropland, covering a maximum of 65,000 hectares by mid-century in the VHA scenario.

2.3.5 Restoration of degraded sugar land

		Targets 2030			Targets 2040			Targets 2050		
Sub-action	Target parameter	BAU	HA	VHA	BAU	HA	VHA	BAU	HA	VHA
5.1. Restoration of arable sugar land	Area of sugar land restored (ha)	-	10,000	20,000	-	21,250	42,500	-	32,500	65,000

This action was initially proposed by FAO based on the CSIDS-SOILCARE initiative, with a very limited target: only 200 ha of arable sugar land restored from 2021 to 2030. Nevertheless, as with other measures impacting sugarcane crops, sector stakeholders expect that this could be applied to 100% of sugar cropland,covering a maximum of 65,000 hectares by mid-century in the VHA scenario.

2.3.6 Improvement to flooded rice

		Targets 2030			Targets 2040			Targets 2050		
Sub-action	Target parameter	BAU	HA	VHA	BAU	HA	VHA	BAU	HA	VHA
6.1. Conversion of irrigated rice from continuously flooded to intermittently flooded single aeration	Area of rice converted from continuously to intermittently flooded (ha)	-	600	1,200	-	1,200	2,400	-	1,800	3,600

This action was also initially proposed by FAO in its analysis supporting Belize's NDC revision, considering a cultivation period of 120 days, and straw incorporated long (>30d) before cultivation. FAO estimated a conversion of 1,205 ha until 2025 and a round target of 1,200 ha was set as VHA target for 2030. Targets for the subsequent decades were then extrapolated to 2,400 (2040) and 3,600 ha (2050), as the VHA.

2.3.7 Integrated landscape forest management

		Targets 2030			Targets 2040			Targets 2050		
Sub-action	Target parameter	BAU	HA	VHA	BAU	HA	VHA	BAU	HA	VHA
7.1. Conversion of annual croplands into multi-strata agroforestry systems	Area of annual croplands converted into multi-strata agroforestry systems (ha)	-	2,250	4,500	-	4,500	9,000	-	6,750	13,500

This action was also initially proposed by FAO in its analysis supporting Belize's NDC revision, focusing on the conversion of conventional annual croplands into multi-strata agroforestry systems. Stakeholders agreed to utilize FAO's initial assessment, which estimates 4,500 hectares in 2030, as the target for the VHA scenario across all three decades.

2.3.8 Introduction of sustainable land management in production systems

		Targets 2030			Targets 2040			Targets 2050		
Sub-action	Target parameter	BAU	HA	VHA	BAU	HA	VHA	BAU	HA	VHA
8.1. Silvopasture systems introduced to non-degraded grasslands	Area of non-degraded grasslands converted to silvopasture (ha)	-	2,500	5,000	-	3,750	7,500	-	5,000	10,000
8.2. Restoration of moderately degraded grasslands	Area of moderately degraded grasslands converted to silvopasture (ha)	-	2,500	5,000	-	3,750	7,500	-	5,000	10,000
8.3. Introduction of silvoarable agroforestry systems on set aside land	Area of set aside land converted to silvoarable agroforestry (ha)	-	2,500	5,000	-	3,750	7,500	-	5,000	10,000

This action was also initially proposed by FAO in its analysis supporting Belize's NDC revision, including the introduction of silvopasture systems and agroforestry to non-degraded grasslands and protected areas and to convert areas of moderately degraded grasslands. Stakeholders agreed to utilize the initial assessment from FAO, which estimates 5,000 ha in each of the three modalities by 2030, as a basis to extrapolate VHA targets, but considered a 50% reduced implementation pace across the subsequent two decades.

2.3.9 Sustainable practices in coconut production

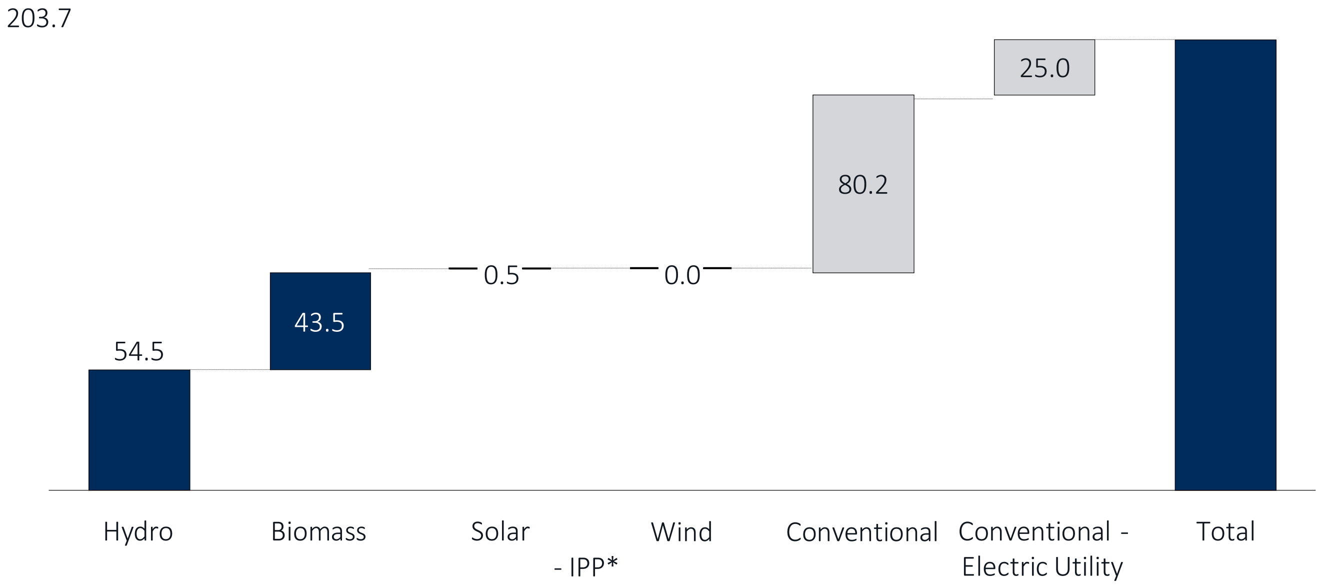
		Targets 2030			Targets 2040			Targets 2050		
Sub-action	Target parameter	BAU	HA	VHA	BAU	HA	VHA	BAU	HA	VHA
9.1. Coconut waste management (biochar, composting, biofabrics)	Volume of coconut waste managed sustainably (tonnes)	-	200,000	400,000	-	300,000	600,000	-	400,000	800,000

This is a new measure that has been added based on stakeholder feedback, during the last round of engagement. It was agreed that the volume of coconut waste is consequential, and this action may be among the low hanging fruit for emissions reductions. A request for information was made during the focus group discussion, to which stakeholders reported that the CARDI/ITC Coconut Development project for the Caribbean estimates 15,000 ha of coconut plantations by 2030, with each hectare producing an average of 68 tonnes of waste ha/year from cut nuts when crop is in full production. This would lead to over 1 million tonnes waste/year and confirmed that the long-term target set by stakeholders of reaching 800,000 tonnes by 2050 is reasonable. These targets and projections need further validation from stakeholders at a later stage.

2.4 Energy

A significant share of Belizean electricity capacity is renewable. Figure 28 shows that, in 2017, Belize had almost 100MW of renewable capacity, which is almost half of the country's installed capacity. There are indications of significant untapped potential as well: US NREA, for instance, indicated Belize has a potential for increasing Hydro capacity from 54 to 84MW, and to add 42 MW of Solar and 20 MW of Wind generation (US National Renewable Energy Laboratory, 2015). Achieving this potential would nearly double current renewable generation.

Figure 28 Belize: Installed generation capacity, MW, 2017

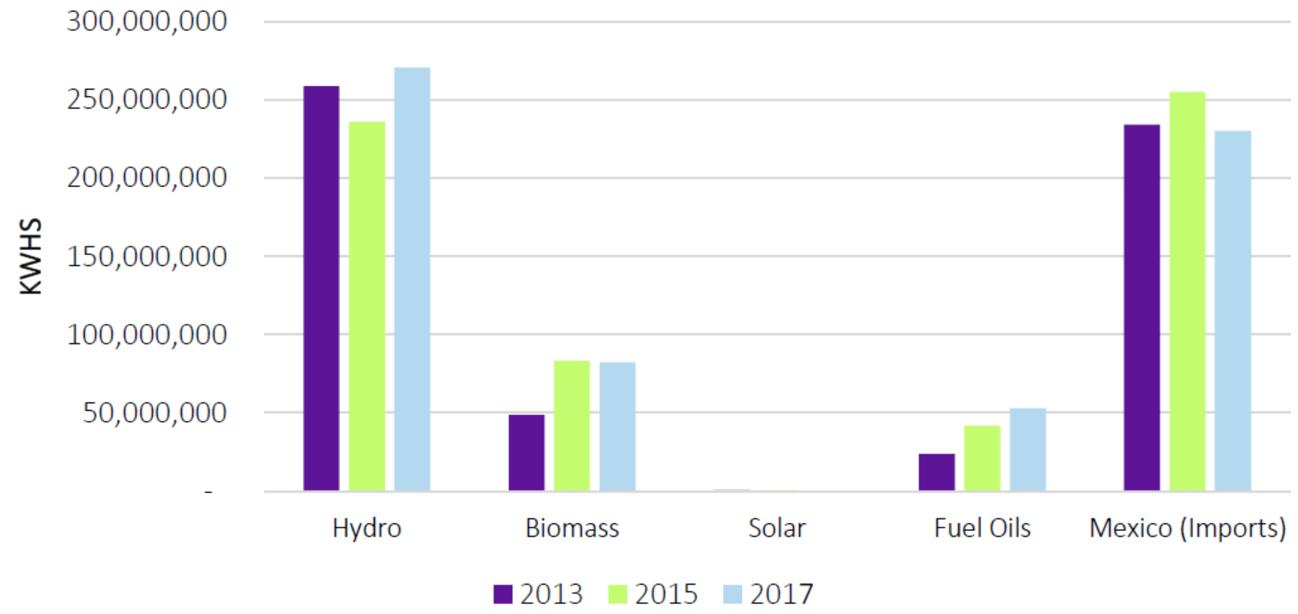


Note: *IPP: Independent Power Producers.

Source: Ministry of Finance, Public Service, Energy and Public Utilities, CARIFORUM Energy Report Card Input Data 2017, 2018 (completed for Belize)

Even though substantial amounts of the current generation are from renewable sources, demand is much larger than current supply. As shown in Figure 29, electricity generated in Belize is mostly from renewable sources (about 250 GWh of hydro and 80 GWh of biomass). Belize Electricity Limited (BEL), which distributes electricity throughout the country, also generates a smaller share from fossil fuel (diesel, HFO, natural gas and crude oil) generators that it owns to meet peak demand. Nevertheless, the country regularly imports a significant share of its needs (this amounted to 40%, or 230-250 GWh in 2017) from Mexico.

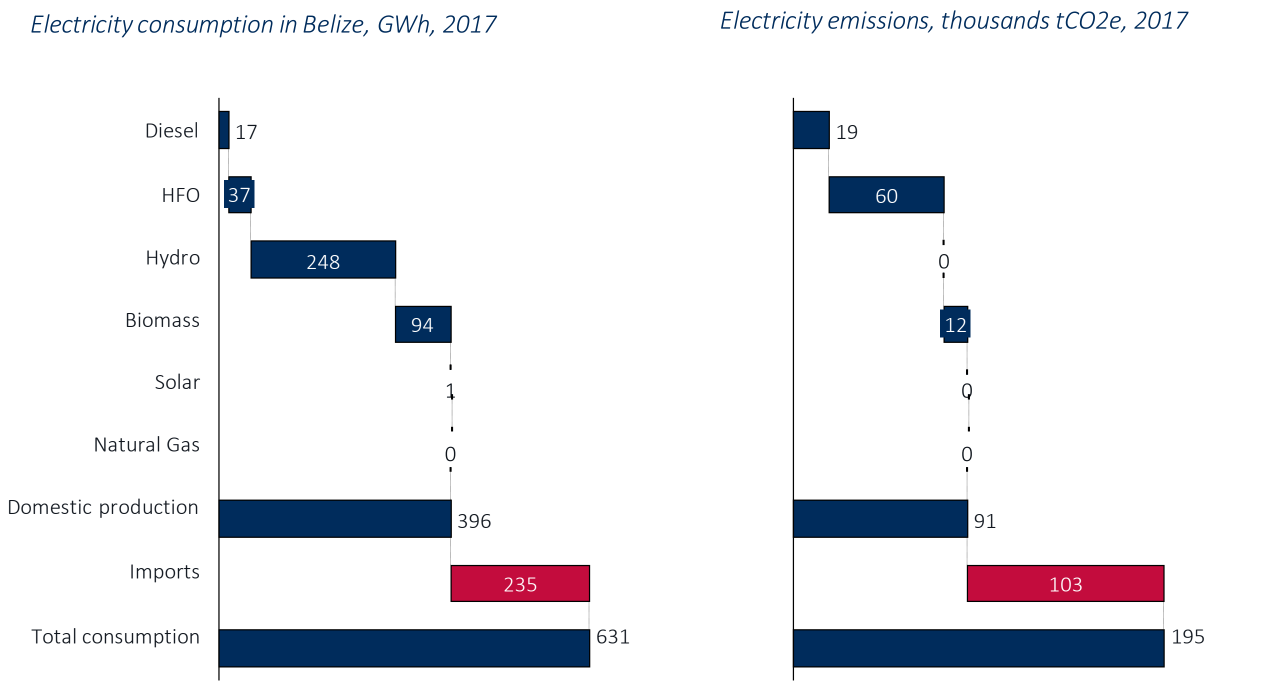
Figure 29 Electricity Generation Output by source, KWh



Source: 4th National GHG Inventory

The majority of GHG emissions associated with the country's electricity consumption is from electricity imports. In contrast to Belize, in which the bulk of generation is renewable, Mexico's electricity generation is much more dependent on fossil fuels. As a result, imports are responsible for more than half of GHG emissions associated with electricity consumed in the country, as shown in Figure 30.

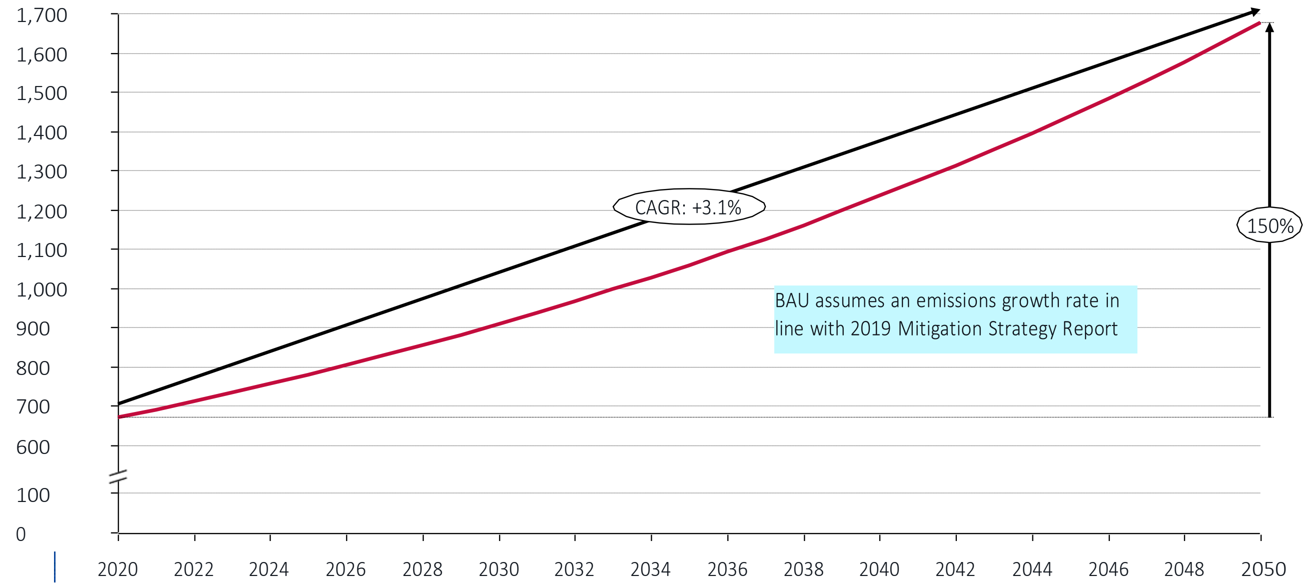
Figure 30 Electricity consumption and emissions by source, 2017



Source: Vivid Economics and Aether, based on activity data from BEL Annual Report 2018

The first step to build BAU emissions projections is to estimate evolution of electricity consumption. For estimating electricity consumption, we used as a reference the 2019 Mitigation Assessment and Strategy report (Gauss International Consulting S.L., 2019), which indicated annual growth of about 3%. Based on these assumptions, BAU projections consider an increase of 150% in the 2020-2050 period (Figure 31).

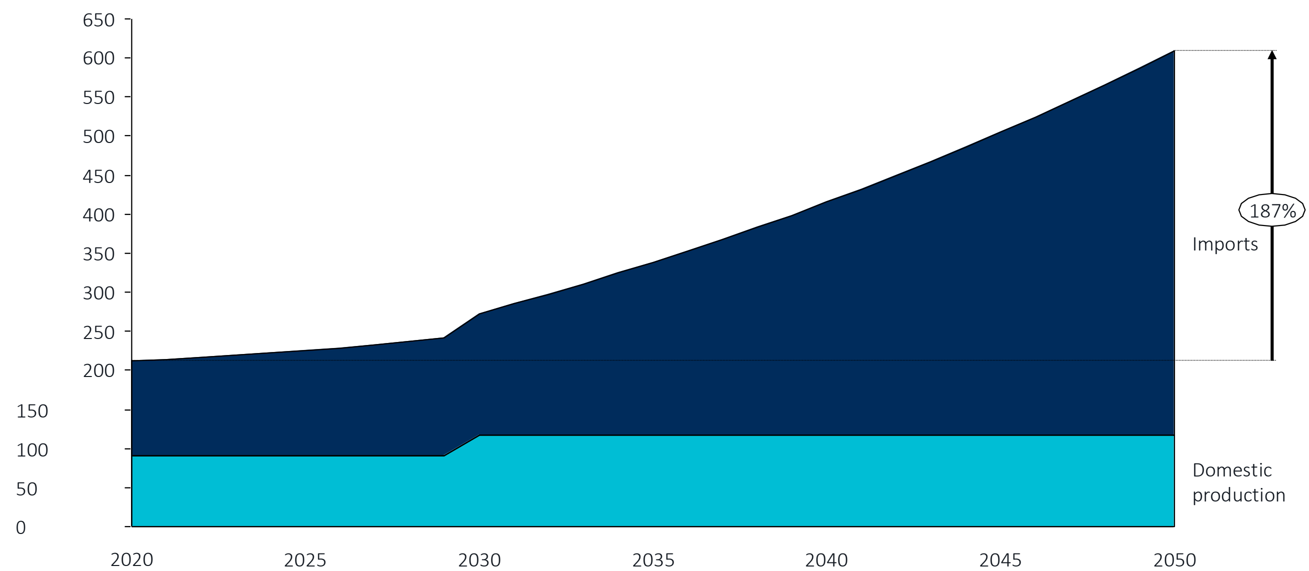
Figure 31 Business-as-Usual projections: Electricity consumption; GWh



Source: Vivid Economics and Aether analysis

BAU projections reinforces that emissions from imported electricity should be actively considered. In line with the dialogue of IRENA with sector stakeholders, the BAU scenario assumes limited growth of the country's installed capacity. In this scenario, most of the 150% electricity consumption increase would be supplied by imports. As Mexico's generation profile is significantly different from Belize's – and assuming this profile is maintained in the future - the bulk of GHG emissions growth of almost 190% in the 2020-50 period would come from imports, as shown in Figure 32.

Figure 32 Business-as-Usual projections: Annual Electricity GHG emissions; thousands tCO_2e



Source: Vivid Economics and Aether analysis

Mitigation pathways and targets

The analysis in the Energy sector resulted in 12 actions with 22 targets spread among them as shown below.

1. Expansion of hydropower capacity
   1.1. Installing new hydropower capacity
2. Expansion of grid solar power (utility-scale)
   2.1. Installing utility-scale solar power capacity
3. Expansion of distributed solar power generation
   3.1. Deploying off-grid solar PV and battery storage in rural villages without access to the national grid
   3.2. Installing residential/ commercial solar panels, with support of net metering hardware and feebates
4. Introduction of wind power generation

4.1. Installing new onshore wind power

4.2. Installing new offshore wind power

5. Increasing Natural Gas power generation as transition energy
   5.1. Upgrading diesel-fueled power plants to accept natural gas
   5.2. New capacity in natural gas generation
6. Expansion and improvement of electricity generation from biomass
   6.1. Expansion of usage of bagasse to electricity generation
   6.2. Conversion of Biochar to electricity generation
   6.3. Reduction of bagasse humidity content
   6.4. Electricity generation from biogas of agricultural residues
7. Reduction in transmission and distribution losses
   7.1. Reduction in losses from electricity transmission and distribution
8. Efficiency improvement on Space Cooling
   8.1. Improving energy efficiency on space cooling in residential and commercial sectors
   8.2. Improving energy efficiency on space cooling in the public sector
9. Efficiency improvement on water heating
   9.1. Commercial/ Residential - Switching away from LPG Boilers to electric and solar/heat pump
10. Efficiency improvement on lighting
    10.1. Replacing incandescent streetlights to LED
    10.2. Commercial/ Residential - switching away from incandescent and fluorescent to LED
11. Energy Efficiency on commercial, residential and public sector appliances

11.1. Reduction in electricity consumption on appliances due to EE standards, labels and feebates

12. Reduction of fuel wood consumption from cooking

12.1. Replacing wood for cooking by LPG, electricity, solar or other cleaner alternatives

The remainder of this section further explores the context, targets by scenario with associated assumptions, potential impacts, and implementation feasibility of each of these mitigation options.

2.4.1 Expansion of hydropower capacity

		Targets 2030			Targets 2040			Targets 2050		
Sub-action	Target parameter	BAU	HA	VHA	BAU	HA	VHA	BAU	HA	VHA
1.1. Installing new hydropower capacity	Installed hydropower capacity (MW)	55	74	74	55	74	74	55	74	74

The 2016 Belize NDC mentions installing 19-28MW of hydropower by 2025, with IRENA considering even higher potential adoption rates in its analysis for the enhanced NDC. Although energy stakeholders confirmed a contract has been approved for a developer which responded to an RfP for 19MW, they suggested that the target numbers may be excessive, based on the limited areas in Belize where hydro is effectively implementable. They indicated that there may be very few areas still not assessed for viability and suggested restricting addition of new capacity for the 2040 and 2050 targets.

The BAU assumes maintaining the current capacity (around 55MW), with capacity additions of 19MW considered feasible and incorporated into the 2030 targets for both the High Ambition and Very High Ambition scenarios. They also confirmed that this would be the ceiling potential due to environmental concerns and further expansion capacities should be confirmed with BEL's plans.

2.4.2 Expansion of grid solar power (utility-scale)

		Targets 2030			Targets 2040			Targets 2050		
Sub-action	Target parameter	BAU	HA	VHA	BAU	HA	VHA	BAU	HA	VHA
2.1. Installing utility-scale solar power capacity	Installed grid solar power capacity (MW)	15	15	45	15	75	135	15	120	225

This is a measure already under way through BEL's five-year plan and requests for proposals from developers, some of which have already been approved. For the shorter term, discussions for the enhanced 2021 NDC pointed to a target of 45MW for 2030, which was assumed for the LEDS VHA target in 2030 as well.

On the longer term, there is more divergence among stakeholders. For 2050, IRENA's Deeper Decarbonization (DDP) scenario projects new renewable capacity of 760MW (Solar: 290 MW; Wind: 470 MW), aiming at replacing most of expected electricity imports. This was generally considered too ambitious by stakeholders, who ended up agreeing on VHA target of 300 MW (3/4 Solar, 1/4 Wind) for 2050.

2.4.3 Expansion of distributed solar power generation

		Targets 2030			Targets 2040			Targets 2050		
Sub-action	Target parameter	BAU	HA	VHA	BAU	HA	VHA	BAU	HA	VHA
3.1. Deploying off-grid solar PV and battery storage in rural villages without access to the national grid	Share of population dependent on off-grid diesel generators (% of total)	8%	6%	4%	8%	5%	2%	8%	4%	0%
3.2. installing residential/ commercial solar panels, with support of net metering hardware and feebates	Number of urban household and commercial accounts utilizing solar installations	-	4,000	8,000	-	8,000	16,000	-	12,000	24,000

There are two pathways for this option: installing off-grid systems in rural villages and on-grid systems in urban zones.

For the first pathway, the objective is supplying more isolated communities who currently depend on diesel generators. Rural electrification is a primary objective under the European Development Fund and the new ministry has plans in place to implement micro solar grids. Although most of the Belizean population is connected to the grid, the 2019 Mitigation Strategy report estimates that currently 8% of population is not connected and dependent on diesel generators. Stakeholders agreed that this baseline assumption is based on legacy census numbers, and this was adopted preliminarily as BAU, pending a revision by later studies. VHA assumes this share is reduced to zero by 2050, with a faster pace initially and it is considered feasible by stakeholders.

The second pathway in this action is to install solar panels to grid-connected residential and commercial accounts, with support of net metering hardware and feebates. The agreed VHA assumes reaching about 20% of households by mid-century (estimate of about 120,000 households in Belize) in a linear progression. Some stakeholders suggested that the targets may be too aggressive and that the electric utility may have a study that looks at determining the percentage of load from distributed solar power generation that the national grid will be able to accept, which may need to be confirmed at a later stage. The group agreed that a target of 20% of households having at least some solar production would be a reasonable target to consider for the VHA in LEDS timeframe (2050).

2.4.4 Introduction of wind power generation

		Targets 2030			Targets 2040			Targets 2050		
Sub-action	Target parameter	BAU	HA	VHA	BAU	HA	VHA	BAU	HA	VHA
4.1. Installing new onshore wind power	Installed onshore wind power capacity (MW)	-	-	-	-	20	40	-	38	75
4.2. Installing new offshore wind power	Installed offshore wind power capacity (MW)	-	-	-	-	-	-	-	-	-

As mentioned, IRENA's Deeper Decarbonization (DDP) projection of new capacity of 760MW (solar, 290MW and wind, 470MW) for 2050 was considered overly ambitious by stakeholders. Sector stakeholders reinforced that there is a critical lack of investment-grade data for wind and agreed that the introduction of this new power source would not be feasible during NDC's 2030 target period.

The group agreed to a reduction of the overall renewable VHA targets to 300MW and agreed upon assumption that three-quarters of future renewable production should be attributed to solar and only one- quarter attributed to wind. Additionally, IRENA's 2050 DDP projection of offshore capacity of about 100MW is considered unfeasible due to costs. In this context, stakeholders agreed to maintain action for offshore wind for continued consideration, but no targets were set.

2.4.5 Increasing natural gas power generation as transition energy

		Targets 2030			Targets 2040			Targets 2050		
Sub-action	Target parameter	BAU	HA	VHA	BAU	HA	VHA	BAU	HA	VHA
5.1. Upgrading diesel-fuelled power plants to accept natural gas	Diesel-fuelled power capacity upgraded to natural gas (MW)	-	24	24	-	24	24	-	24	24
5.2. New capacity in natural gas generation	Installed natural gas power capacity (MW)	21	21	21	21	27	27	21	27	27

This option proposes two targets which include conversion of 24MW by 2030, and new capacity in natural gas generation. During stakeholder engagement, it was noted that the current move to convert 24MW to natural gas (from diesel) was primarily in an effort to expand overall capacity and reliability. BEL's shorter-term plans of upgrading 24MW are assumed for 2030 both in HA and VHA with no further action beyond that timeframe.

Subsequently, a second target was incorporated during the stakeholder engagement, aiming for increased capacity in natural gas generation. BEL's shorter-term plans of adding 21MW is assumed for 2030 in BAU, HA and VHA, with only 6MW of additional capacity after 2030. Consideration should be given to the potential need to further expand the natural gas capacity in case of need to compensate renewable generation variability.

2.4.6 Expansion and improvement of electricity generation from biomass

		Targets 2030			Targets 2040			Targets 2050		
Sub-action	Target parameter	BAU	HA	VHA	BAU	HA	VHA	BAU	HA	VHA
6.1. Expansion of usage of bagasse to electricity generation	Increase in biomass combusted for energy (000 tons)	-	100	200	-	200	400	-	300	600
6.2. Conversion of Biochar to electricity generation	Volume of coconut waste (000 tons)	-	25	50	-	37.5	75	-	50	100
6.3. Reduction of bagasse humidity content	Reduce emissions/ ton of biomass combusted (% of 2020 level)	-	2.5	5	-	5	10	-	10	20
6.4. Electricity generation from biogas of agricultural residues	Electricity generating capacity from biogas (MW)	-	1	2	-	2.5	5	-	3.5	7

This is a cross-cutting action with four targets, including converting biogas and biochar to electricity generation, and the reduction of bagasse humidity content. Energy sector stakeholders discussed the potential of each measure and considered the targets reasonable. However, the numbers were considered achievable based not only on planned improvements in the generation, but also untapped efficiencies for implementing in the fields. Belize is currently combusting over 700 tons of biomass from bagasse per year. Stakeholders stated that there is no use of HFO/diesel for co-combustion of bagasse at this time in Belize, and that Belcogen is interested in biomass production which would be in addition to other sources such as from the waste stream. While the group agreed regarding the current numbers, which assumes 30% fiber in sugarcane, they indicated that targets for the future are more difficult to pinpoint because the future utilization levels across the diverse applications of sugarcane crops is unknown. Based on various scenarios regarding those diverse applications, some members suggested doubling the projected biogas generation. The VHA target assumes doubling bagasse production by 2050 (compared to the HA target), which is slightly more ambitious than the one proposed within the energy report from Fundación Bariloche,[15] but is considered feasible by participants. However, the target should continue to be clarified through further discussion with a broader, more cross-sectoral group of stakeholders.

Biogas generation has a single target activity impacted by a combination of varying projects across different sub-sectors including solid waste, food and beverage production, and animal and agricultural waste. The 2019 Mitigation Strategy assumes a potential of 3.5MW, but energy stakeholders consider this too modest for the longer term. Stakeholders agreed that double that target is achievable in two decades as a VHA target for 2050 with a gradual increase from 2030.

2.4.7 Reduction in transmission and distribution losses

		Targets 2030			Targets 2040			Targets 2050		
Sub-action	Target parameter	BAU	HA	VHA	BAU	HA	VHA	BAU	HA	VHA
7.1. Reduction in losses from electricity transmission and distribution	Transmission and distribution losses (% of energy produced)	12%	11%	10%	12%	10.5%	9%	12%	10%	8%

This option is a single target action for the BEL electricity grid, based on secured plans for the replacement and expansion of transmission lines. The 2016 NDC proposed reducing the losses from 12% to 7%, but this was adjusted in the Energy meeting due to implementation challenges. Leadership from the Government of Belize Energy Unit estimated targets for reducing losses to 7% by 2050. During the sector focus group discussion, representatives from BEL indicated the target may be too ambitious even with a mid-century timeframe. Concerns were expressed regarding the BAU estimates for subsequent decades not indicating a technical increase, but it was determined that the current BAU of 12% losses was accurate based on other upgrades. The group agreed to a VHA target to reduce losses to 8% by 2050, with a linear progression until then.

[15]"Combining an overall increase in productivity from 49ton/Ha to 71 ton/Ha with a moderate expansion in sugar cane harvested area from 37,000 Ha to 42,000 Ha would increase yield from 1.8 (2019) to 3 million tons per year. Correspondingly, bagasse production would increase from 620,000 tons/year to 1,000,000 tons/year, increasing generation from 92,000 (2019) to 150,000 MWh/year (51 kWh/ton sugar cane excess electricity)" - Energy Report (FB)

2.4.8 Efficiency improvement on space cooling

		Targets 2030			Targets 2040			Targets 2050		
Sub-action	Target parameter	BAU	HA	VHA	BAU	HA	VHA	BAU	HA	VHA
8.1. Improving energy efficiency on space cooling in residential and commercial sectors	Reduction of electricity consumption on residential and commercial sector (% of BAU)	0%	7.5%	15%	0%	13.8%	27.5%	0%	25%	50%
8.2. Improving energy efficiency on space cooling in the public sector	Reduction of energy consumption on public buildings (% of BAU)	0%	7.5%	15%	0	13.8%	27.5%	0	25%	50%

This option currently includes two targets, with similar expected evolution. The initial target was based on MESTPU targets for energy efficiency, which included a goal of reducing consumption on new construction and existing building stock by at least 25% by 2030, including measures for private buildings (30%); hotel & tourism industry structures (30%), and residential households (25%). An intermediary level (27.5%) was assumed for two decades from now (2040) in the VHA, with an intermediary target (15%) adopted for the next decade and a more ambitious target (50%) assumed for mid-century. This was considered feasible by energy stakeholders and also in line with NDC targets and actions.

Following some discussion regarding the varied types of operations within the building stock, stakeholders proposed to break the action out to a second target to isolate buildings in the public sector which would need to be monitored and incentivized with different criteria. However, the assumptions and targets were mirrored from the original action.

According to IRENA, the current penetration of space cooling is 14% in the Residential sector and 60% in the commercial sector and all scenarios assume future penetrations projected by IRENA.

2.4.9 Efficiency improvement on water heating

		Targets 2030			Targets 2040			Targets 2050		
Sub-action	Target parameter	BAU	HA	VHA	BAU	HA	VHA	BAU	HA	VHA
9.1. Commercial/ Residential - LPG Boilers	Share LPG boilers (% total)	70%	70%	70%	70%	48%	35%	70%	25%	0%
9.2. Commercial/ Residential - Electric heaters	Share Electric heaters (% total)	30%	30%	30%	30%	15%	15%	30%	0%	0%
9.3. Commercial/ Residential - Solar thermal	Share Solar Thermal (% total)	0%	0%	0%	0%	30%	40%	0%	60%	80%
9.4. Commercial/ Residential - Heat Pumps	Share Heat Pumps (% total)	0%	0%	0%	0%	8%	10%	0%	15%	20%

According to IRENA, current penetration of water heating is 20% in the Residential sector and 80% in the commercial establishments. In terms of technology, current penetration of LPG boilers is 70% and electric water heaters, 30%. The VHA targets for 2050 assume the IRENA DDP scenario (LPG boilers and electric heaters reduced to zero; solar thermal with 80% and heat pumps with 20%) and HA 2050 assumes IRENA TES scenario (LPG boilers keep a participation of ¼).

The energy focus group participants agreed the measure is low-hanging fruit, but considered varying applications and scope, such as moderate versus high-quality heat, and heat re-use technologies. Group members discussed an interest in adopting international best practices and some debated the assumption that the industrial sector has a negligible return. Additional follow-up is needed in coordination with the NCCO to understand the implementation status of the Water Heater NAMA. In addition, sector and stakeholder priority for the on-the-ground implementation of such an initiative is still to be determined. As asignificant amount of research and planning is still needed, it was suggested that implementation should notstart until 2030 due to the high complexity.

2.4.10 Efficiency improvement on lighting

		Targets 2030			Targets 2040			Targets 2050		
Sub-action	Target parameter	BAU	HA	VHA	BAU	HA	VHA	BAU	HA	VHA
10.1. Replacing incandescent streetlights to LED	Share of streetlights upgraded to LED (%)	0%	20%	40%	0%	35%	70%	0%	50%	100%
10.2. Commercial/ Residential - Incandescent	Residential/ Commercial: Share Incandescent (% total)	60%	50%	40%	60%	30%	20%	60%	0%	0%
10.3. Commercial/ Residential - Fluorescent	Residential/ Commercial: Share Fluorescent (% total)	40%	40%	30%	40%	40%	25%	40%	40%	20%
10.4. Commercial/ Residential - LED	Residential/ Commercial: Share LED (% total)	0%	10%	30%	0%	30%	55%	0%	60%	80%

This option is fully focused on replacing incandescent and fluorescent technologies to LED lighting for streetlights and residential/ commercial uses. In the residential and commercial sector, IRENA estimates that incandescent bulbs have a current penetration of 60% and fluorescent lighting, 40%. Street lighting is based on a reference project focused on 4,100 lights Street replaced in Cayo District. Preliminary estimates from the 2019 Mitigation Strategy indicate a reduction on power consumption of at least 30/40%.

The objectives for residential/ commercial sectors are proposed through three inter-related targets, including Increasing the share of LED in commercial and residential use, while reducing fluorescent to 20% by 2050 and phasing out incandescent completely in that same time. All targets for 2050 initially assumed IRENA's scenarios and projections, but implementation was accelerated aiming at an even faster transition. The group noted the target's dependency on standardized labels and import standards for residential implementation but consider the action highly implementable. In advance to residential/ commercial lighting transition, the market has already begun a self-paced shift toward more efficient lighting technologies use.

Stakeholders were familiar with the initiatives in this area and mentioned support for the targets. They also stated that the Public Utility Commission currently intends to replace street lighting, an initiative aligned with a VHA target of 100% by 2030. Industrial lighting is not presently considered within LEDS targets, since the industrial sector consumption is currently limited in Belize.

2.4.11 Energy efficiency on commercial, residential, and public sector appliances

		Targets 2030			Targets 2040			Targets 2050		
Sub-action	Target parameter	BAU	HA	VHA	BAU	HA	VHA	BAU	HA	VHA
11.1. Reduction in electricity consumption on appliances due to EE standards, labels and feebates	Reduction of electricity consumption on residential, commercial and public sector (% of BAU)	0%	8%	16%	0%	16%	32%	0%	24%	48%

The energy sector focus group discussed the advantages and disadvantages in implementation, adoption rates, and ease of impact measurement, of breaking out refrigeration within appliance energy efficiency measures because it is the highest consumption source in Belize's residential sector. However, the group consensus was to keep refrigeration and other appliances within the same target in LEDS for two reasons. First, it is anticipated that reductions from shifts across other appliance type consumptions would be lost if left as stand-alone measures, and because the ministry has a tracking measure for refrigeration already in place.

The 2019 Mitigation Strategy estimated a 16% reduction on appliances electricity consumption by 2030. Sector stakeholders agreed with this target for the VHA scenario and considered that similar reductions werefeasible for the following decades as well, resulting in a total of almost 50% reduction by mid-century. This target was considered feasible by Energy stakeholders.

2.4.12 Reduction of fuel wood consumption from cooking

		Targets 2030			Targets 2040			Targets 2050		
Sub-action	Target parameter	BAU	HA	VHA	BAU	HA	VHA	BAU	HA	VHA
12. Reduction of fuel wood consumption from cooking	Reduction of fuel wood consumption (% of 2020 level)	0%	5%	10%	0%	13%	25%	0%	25%	50%

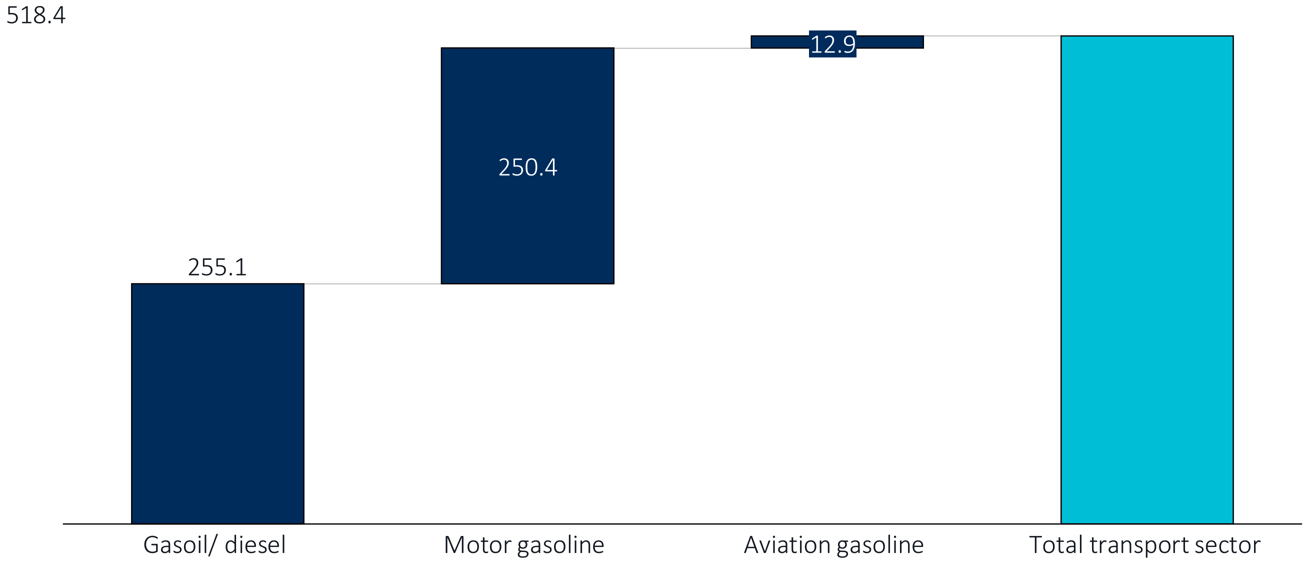
The 2016 NDC referred to a deployment of 10,000 clean cook stoves by 2030 and to achieve a reduction of fuel wood consumption by 27%-66%. Baseline data taken from the country census indicates that one in six households use wood exclusively for cooking, and an additional one in six utilize wood while having access to other fuels such as LPG as well.

The Government of Belize Energy Unit supports the clean cook stoves initiative identifying the potential but also pointed out that the measure will require collaboration and streamlining with diverse public sectors and that the benefits to all parties need to be understood properly. Several barriers to implementing the action were acknowledged and discussed, including that currently no incentivization has been identified. Some representatives proposed that Implementation should not start until 2030, but the group agreed that due to high complexity, it would be prudent to set conservative targets for 2030 to support initial work in progress. It was agreed that the range stated in the 2016 NDC (27-66%) is overly ambitious even for 2050, with the suggested implementation targets ranging from 25% (HA) to 50% (VHA).

2.5 Transport

For the Transport sector, it is estimated that GHG emissions arising from diesel (mostly trucks and buses) and gasoline (primarily light vehicles), are currently similar as shown in Figure 33. The gasoline and gasoil/ diesel figures cover road transport, shipping and non-road mobile machinery. Due to the lack of appropriate data, it was not possible to split out the fuel consumption into the different transport segments.

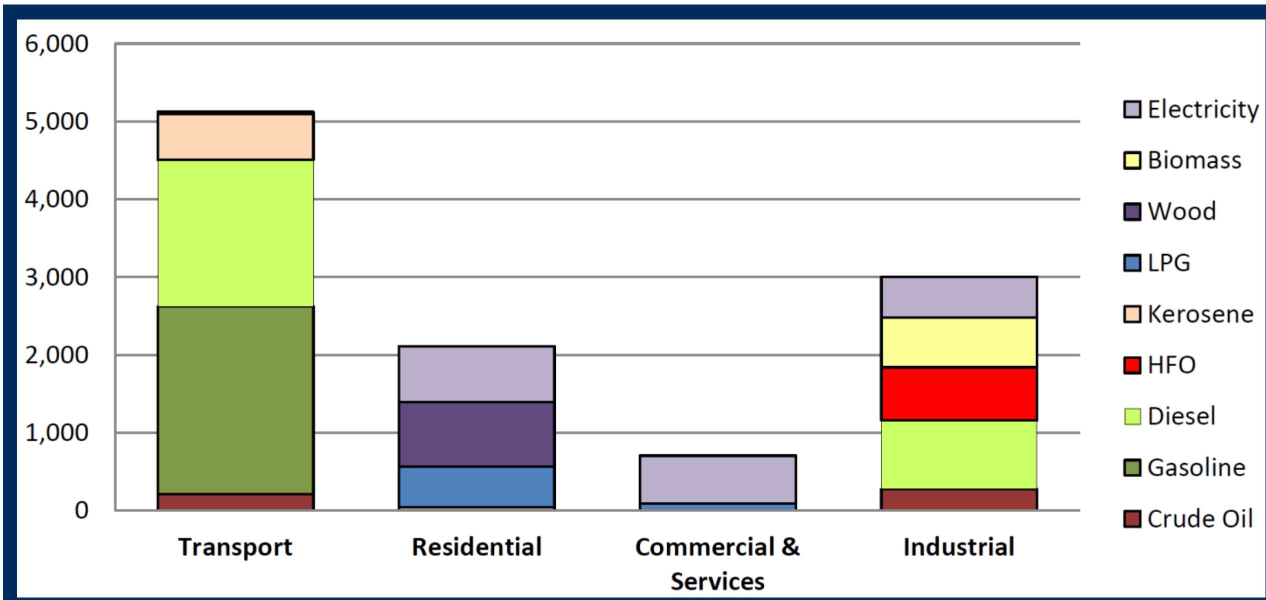
Figure 33 Estimated annual Transport sector GHG emissions in Belize, 2017, thousands tCO_2e



Source: Vivid Economic analysis, based on 4th National GHG Inventory

Box 1 Secondary Energy Consumption by Subsector and Fuel Type, 2010, TJ

In the broader energy matrix, historical data indicates that Transport leads energy consumption, followed by the Industrial Subsector. According to the National Energy Policy Framework, the transportation subsector was the biggest consumer of energy in 2010, accounting for 46.8% of total secondary energy consumption (10,946 TJ - or 261,437 TOE - was actually delivered to consumption points as secondary energy, after subtracting losses incurred in generating, transmitting and distributing electricity). The industrial sector consumed 27.4% of total secondary energy in 2010: 61.3% of this sector's consumption was due to the use of diesel, HFO and crude oil to run industrial motors and for steam generation; 21.3% was for the use of steam produced from bagasse within the sugar industry; and the remaining 17.4% was due to the direct consumption of electricity.

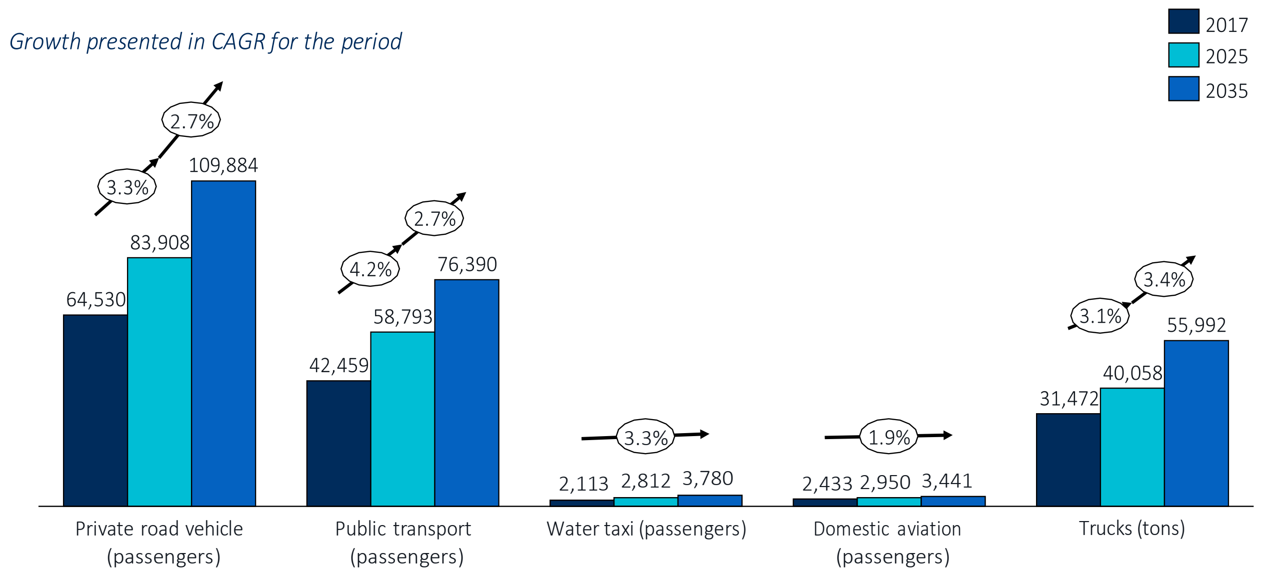


The remaining 25.8% of total secondary energy consumption in 2010 was due to the residential and commercial and services subsectors. Wood, used for cooking mainly in rural areas, accounted for 39.3% of residential energy consumption; while electricity and LPG accounted for 34% and 24.6% of residential energy consumption respectively. The main secondary fuel consumed by the commercial and services subsector was electricity (about 87.3%).

Source: (Tillett, 2011) (updated July 2012)

For BAU growth, we used as reference the growth projections of the Comprehensive National Transport Master Plan (CNTMP). For both, passenger vehicles and trucks, traffic is expected to grow around 3% annually, with a slight deceleration in passengers and a slight acceleration in trucks, as shown in Figure 34.

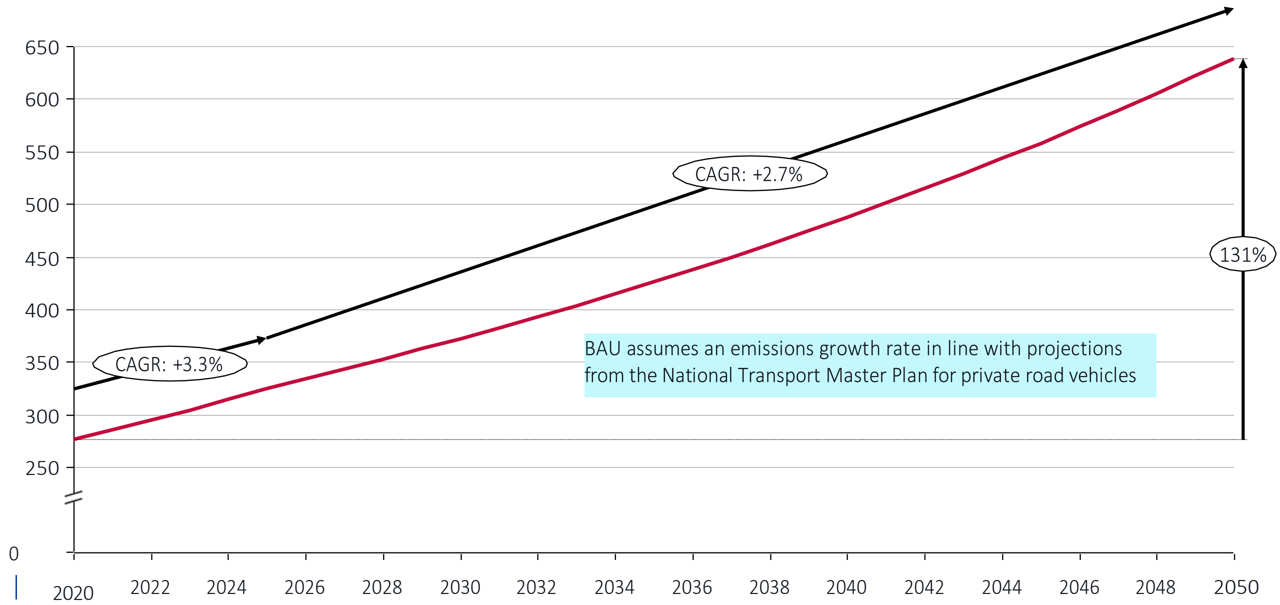
Figure 34 Transport activity (passengers/ tons) projections in the CNTMP



Source: Vivid Economics, based on activity data from Comprehensive National Transportation Master Plan

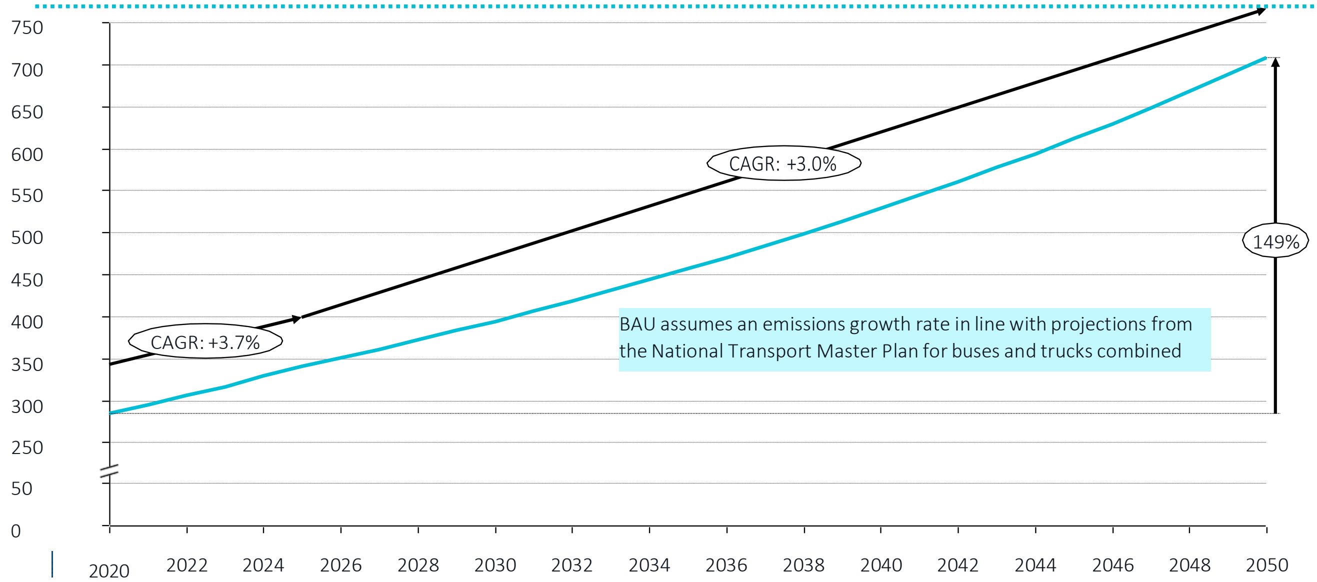
In line with the CNTMP, we are expecting slightly higher growth rates for gasoil/ diesel than motor gasoline. BAU projections estimate an increase of emissions of 131% for motor gasoline and 149% for gasoil/ diesel in the 2020-2050 period, as shown in Figure 35 and Figure 36 below.

Figure 35 Business-as-Usual projections: Transport Motor Gasoline annual GHG emissions; thousands tCO_2e



Source: Vivid Economics and Aether analysis

Figure 36 Business-as-Usual projections: Transport Gasoil/ Diesel annual GHG emissions; thousands tCO_2e



Source: Vivid Economics and Aether analysis

Mitigation pathways and targets

The analysis and stakeholder engagement in the Transport sector resulted in five actions with 14 targets spread among them, as shown below.

1. Reduction of fuel emissions in the public transit system
   - 1.1. Optimization of transit system: redesign of urban routes, replacement of larger buses by mini buses/ vans
   - 1.2. Increasing fuel efficiency and fleet renewal
   - 1.3. Replacement of conventional (ICE) with electrical buses (intra-district)
   - 1.4. Replacement of conventional (ICE) with electrical buses (inter-district)
   - 1.5. Attracting individual commuters to public transportation
2. Reduction of fuel emissions across private and commercial light vehicles
   - 2.1. Reducing the energy consumption in cars through fuel standards/ labels, tax incentives
   - 2.2. Replacing combustion cars with electric via import incentives
   - 2.3. Replacing combustion motorcycles with electric via import incentives
3. Improvement of fuel standards
   - 3.1. Blend of biodiesel in regular diesel
   - 3.2. Blend of ethanol in regular gasoline
   - 3.3. Introduction of fuel standards in diesel and gasoline
4. Reduction of emissions in freight transportation
   - 4.1. Implementing regulations/ standards and fleet renewal for road freight vehicles
5. Encourage non-motorized modes of transport
   - 5.1. Increased uptake of bikes for urban transportation
   - 5.1. Increased uptake of bikes for urban transportation

The remainder of this section will further explore context, targets by scenario with associated assumptions, potential impacts, and the implementation feasibility of each of these mitigation options.

2.5.1 Reduction of fuel emissions in the public transit system

		Targets 2030			Targets 2040			Targets 2050		
Sub-action	Target parameter	BAU	HA	VHA	BAU	HA	VHA	BAU	HA	VHA
1.1. Optimization of transit system: redesign of urban routes, replacement of larger buses by mini buses/ vans	Reduction in fuel consumption/ passenger for regular buses (% 2020 level)	-	2.5%	5%	-	2.5%	5%	-	2.5%	5%
1.2. Increasing fuel efficiency and fleet renewal	Reduction in fuel consumption/ passenger for regular buses (% 2020 level)	-	2.5%	5%	-	5.0%	10%	-	7.5%	15%

		Targets 2030			Targets 2040			Targets 2050		
Sub-action	Target parameter	BAU	HA	VHA	BAU	HA	VHA	BAU	HA	VHA
1.3. Replacement of conventional by electrical buses (intra-district)	Share of intra-district electric buses (% of total)	0%	4%	8%	0%	10.8%	21.5%	0%	17.5%	35%
1.4. Replacement of conventional by electrical buses (inter-district)	Share of inter-district electric buses (% of total)	0%	7.5%	15%	0%	18.8%	37.5%	0%	30%	60%
1.5. Attracting individual commuters to public transportation	Share of car drivers that switch to public transport (% of total)	0%	3%	5%	0%	8%	15%	0%	10%	20%

This action was composed based on references from IRENA's projections supporting Belize's NDC revision and strategies embedded in Belize's National Transport Masterplan. Estimates of reduction of pollutants emitted by buses is 12% emission reduction in intra-district and 4% emission reduction in Inter-district busescity-diesel in one decade, according to the Belize's Mitigation Technology Needs Assessment (TNA). The Director of Transport shared with stakeholders that the number of operator licenses is 141 for village shuttles and 49 for conventional buses, and that approximately two-thirds of the public transport vehicles are inter-district buses, with the remaining one-third intra-district.

This action can be split in 3 pathways: increasing efficiency of regular buses, replacing regular by electric buses and attracting passengers from individual transportation (cars and motorcycles) to the public transit system.

In the first pathway, one target is the optimization of public transit system via the redesign of urban routes, and replacement of larger buses by mini-buses and/or vans. The VHA target for route design and downsizing standard buses is to achieve a 5% reduction of fuel consumption per passenger by 2030, to be maintained through 2050. Another goal under this action is to increase fuel efficiency and renew the fleet of standard buses, which is expected to lead to the same 5% reduction of fuel consumption per passenger by 2030 but increases gradually to 15% in 2050. Stakeholder consensus is that the VHA target assuming a reduction of fuel consumption of 15% in three decades is achievable.

In the second pathway, it was proposed a goal to replace conventional buses with electric buses. In this regard, the National Transportation Plan mentions Deployment of 600 hybrid and electric buses by 2030 (200 by 2025). Stakeholders discussed the routes and vehicles currently in use and proposed that the targetshould be

split in two (inter-district and intra-district buses), with different ambitious levels. The latter has a VHA of 35% share of electric buses in the fleet by 2050, increasing gradually from 8% in 2030.
Implementation inter-district was considered easier due to better capacity of operators and higher savings, with a VHA target of 30% by 2050, increasing gradually from 60% in 2030. Participants agreed that success would be heavily dependent on support through government regulations, but that the targets discussed were achievable.

The final pathway within this action is to attract individual commuter to public transportation. Stakeholders agreed that additional modifications to the fleet would be needed to support the goal of making public transportation more attractive. They also pointed out that the target should be lowered to reflect the concurrent goal of transitioning private drivers to electric vehicles. The 2050 VHA target for incentivizing the use of public transportation over personal vehicles is switching 20% of drivers to public transit by 2050, with a gradual increase from 5% in 2030.

2.5.2 Reduction of fuel emissions across private and commercial light vehicles

		Targets 2030			Targets 2040			Targets 2050		
Sub-action	Target parameter	BAU	HA	VHA	BAU	HA	VHA	BAU	HA	VHA
2.1. Reducing the energy consumption in cars through fuel standards/ labels, tax incentives	Reduction of ICE cars fuel consumption (% 2020 level)	-	3%	5%	-	6%	13%	-	10%	20%
2.2. Replacing combustion cars with electric via import incentives	Share of electric cars (% of total)	1%	6%	10%	1%	26%	50%	1%	46%	90%
2.3. Replacing combustion motorcycles with electric via import incentives	Share of electric scooters/ motorcycles (% of total)	0%	3%	5%	0%	20%	40%	0%	38%	75%

As with the previous one, this option is composed of two pathways: improving fuel efficiency for regular ICE vehicles and replacing them by electric vehicles. All targets were initially based on IRENA's fleet projections, which were adjusted by sector stakeholders.

The first pathway proposes a target to reduce energy consumption in light vehicles (including taxis). Sector leadership from the Government of Belize Energy Unit indicated that the Belize Bureau of Standards will oversee the standards. The VHA assumes reaching a reduction in fuel consumption of 20% in two decades. To achieve this, some measures are proposed in the National Transportation Plan, including fuel economy labels/ standards, emissions testing and emissions-based taxes/ feebates for imported vehicles

The second pathway proposes targets for replacing ICE cars and motorcycles with electric models, via import incentives. Stakeholders indicated that the uptake would be slow at the beginning and set the VHA for cars at 10% in 2030, with a dramatic increase over time, to 90% by 2050. Stakeholders stated the same curve would likely apply to motorcycles as well, but that the overall adoption would be somewhat lower. The VHA for the share of motorcycles traded for electric power is just 5% for 2030, increasing to 75% in 2050.

2.5.3 Improvement of fuel standards

		Targets 2030			Targets 2040			Targets 2050		
Sub-action	Target parameter	BAU	HA	VHA	BAU	HA	VHA	BAU	HA	VHA
3.1. Blend of biodiesel in regular diesel	Share of diesel replaced by biodiesel (blend %)	0%	3%	5%	0%	5%	10%	0%	5%	10%
3.2. Blend of ethanol in regular gasoline	Share of gasoline replaced by ethanol (blend %)	0%	5%	10%	0%	10%	20%	0%	12.5%	25%
3.3. Introduction of fuel standards in diesel and gasoline	Reduction of fuel emissions (% 2020 level)	0%	3%	5%	0%	3%	5%	0%	3%	5%

This action can also be split in two different pathways: both the use of fuel blends and the introduction of fuel standards in diesel and gasoline.

In the first pathway, stakeholders considered two different fuel blends: diesel-biodiesel and gasoline- ethanol. Stakeholders then contrasted the cross-cutting factors related to utilizing one fuel for blending overanother. Based on the varied advantages discussed, stakeholders agreed that ethanol blending was a more promising option, but elected to maintain both options with varying targets, influenced by the industry outlook of the blend fuel for each. The VHA for biodiesel assumes reaching a blend of 10% in two decades and maintaining it. The VHA for ethanol assumes reaching a blend of 25% in regular gasoline until mid- century.

It was reiterated that the success of introducing fuel standards in diesel and gasoline was outside the scope of most stakeholder influence, but the group agreed to set targets for the activity with the assumption that the regulatory support necessary would be implemented. The stakeholders agreed to a VHA for fuel standards of a 5% fuel emissions reduction by 2030 to be maintained through the mid-century target.

2.5.4 Reduction of fuel emissions in freight transportation

		Targets 2030			Targets 2040			Targets 2050		
Sub-action	Target parameter	BAU	HA	VHA	BAU	HA	VHA	BAU	HA	VHA
4.1 Implementing regulations/ standards and fleet renewal for road freight vehicles	Reduction of trucks fuel consumption (% 2020 level)	0%	3%	5%	0%	5%	10%	0%	8%	15%

This option aims to reduce the fuel consumption in freight trucks through the implementation of regulations, standards, and fleet renewal. The Director of the PUC pointed out that the primary factor to impact the rate of adoption would be vehicle use. Stakeholders reiterated the dependency of the action on regulations that needed to be imposed but agreed the measure would provide roughly the same efficiency gains as the targets for buses. The group agreed to a VHA target of a 15% reduction in fuel consumption by 2050, with a gradual increase from 5% in 2030.

2.5.5 Encourage non-motorized modes of transport

		Targets 2030			Targets 2040			Targets 2050		
Sub-action	Target parameter	BAU	HA	VHA	BAU	HA	VHA	BAU	HA	VHA
5.1. Increased uptake of bikes for urban transportation	Share of passenger travels switched to bike (% total)	0%	3%	5%	0%	5%	10%	0%	5%	10%
5.2. Adoption of electric golf carts	Share of electric golf carts (% golf carts)	1%	3%	5%	0%	20%	40%	0%	38%	75%

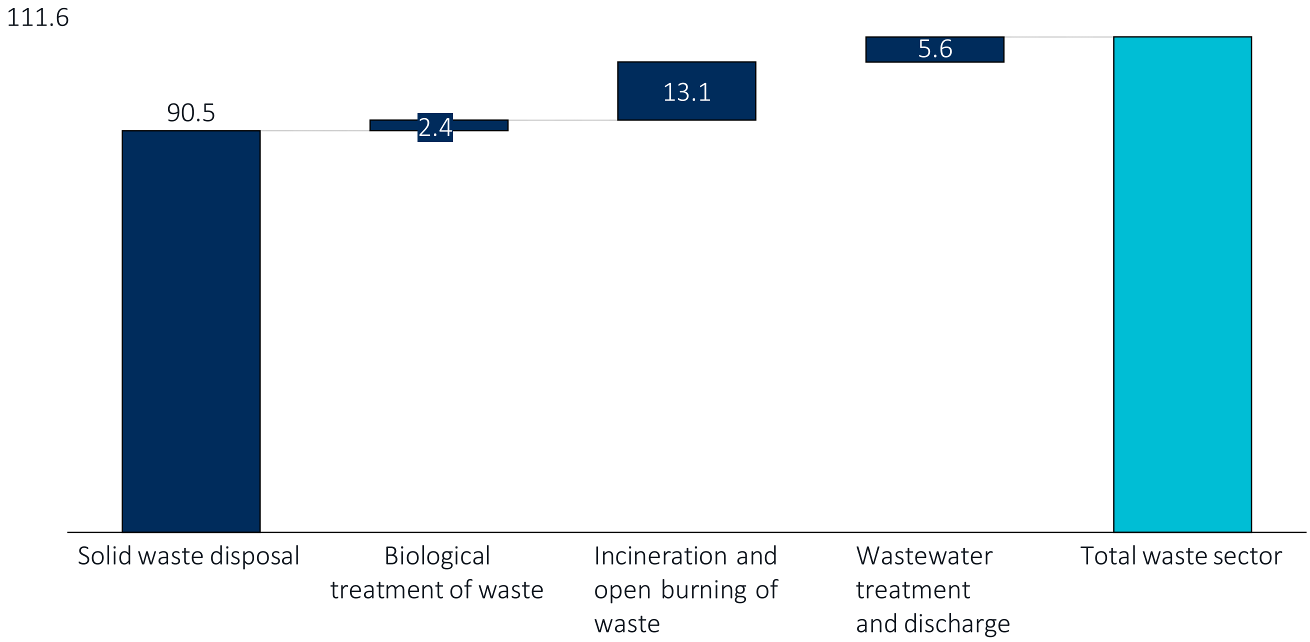
The option aims to reduce fuel emissions by switching drivers to non-combustion modes of travel wherever possible. Stakeholders agreed with the logic underlying the activity and indicated that while the adoption of bikes is a policy to be supported, that is not the case for golf carts, due to safety concerns.

In the case of bikes, the focus group agreed to a VHA of a 10% share of passengers switched to bikes by 2040, and assumes it is maintained moving forward. Regarding golf carts, it is accepted that their use will be maintained in specific circumstances and locations and, therefore, the overall level of adoption (about 5% of the travels, with very large concentration in specific locations) should not change. Nevertheless, the level of "electrification" of this mode should increase substantially in the next decades, following a pattern similar to motorcycles (75% in VHA 2050).

2.6 Waste

GHG emissions from waste come primarily from solid waste disposal. Typically, the most important sources of emissions in this sector are the CH_4 emissions from solid waste disposal, CH_4 emissions from wastewater treatment/ discharge, and CO_2 emissions related to incineration and open burning of waste. In baseline year, while the majority of emissions were estimated to come from solid waste disposal, only about 6% of emissions come from wastewater treatment (Figure 37).

Figure 37 Waste GHG emissions in Belize, 2017, thousands tCO_2e



Source: Vivid Economics, based on activity data from 4th National GHG Inventory

Solid waste disposal includes the emissions that occur in the treatment and disposal of municipal, industrial and other solid waste, but the GHG emission assessment has considered only municipal solid waste.
Municipal wastewater treatment plants are a source of various GHGs and bio-aerosols. A large amount of nitrous oxide is emitted into the atmosphere due to the process of nitrification and de-nitrification. There are two types of emission of GHGs from municipal wastewater treatment plants: on-site emissions and off- site emissions. Off-site emission is caused due to the process of generation of energy for bio solids transport; aerobic and hybrid treatments cause higher generation of greenhouse gasses. On-site emission of greenhouse gasses is caused due to energy generation for fossil fuel consumption and the treatment of bio solid.[16]

The NCCPSAP analyses the context of Waste Management, with a primary focus on Municipal Solid Waste (MSW). MSW includes everyday waste from households, schools and business places, contains biodegradable organic matter such as kitchen waste, garden waste, and paper which generates a mixture of carbon dioxide and methane upon their degradation, while the practice of open garbage burning emits blackcarbon and other toxic compounds as well as greenhouse gases. Inadequate waste collection systems also impact the health of the population and cause ocean pollution, thereby affecting coral reefs and affecting the livelihood of thousands of Belizeans whose livelihoods are directly and indirectly linked to fishing and eco-tourism.

Solid waste disposal emissions seem aligned with international references. Considering an estimated generation of 98,369 metric tonnes of municipal solid waste (MSW) in 2015,[17] Belize would produce 0.9 tCO_2e/ metric tonne of MSW. This aligns well with global estimates: according to the World Bank,[18] the world generated 2.01 billion tonnes of municipal solid waste and, based on the volume generated, its composition, and how it is managed, it is estimated that 1.6 billion tonnes of carbon dioxide (CO_2) equivalent greenhouse gas emissions were generated from solid waste treatment and disposal in 2016 (i.e., 0.8 tCO_2e/ metric tonne).

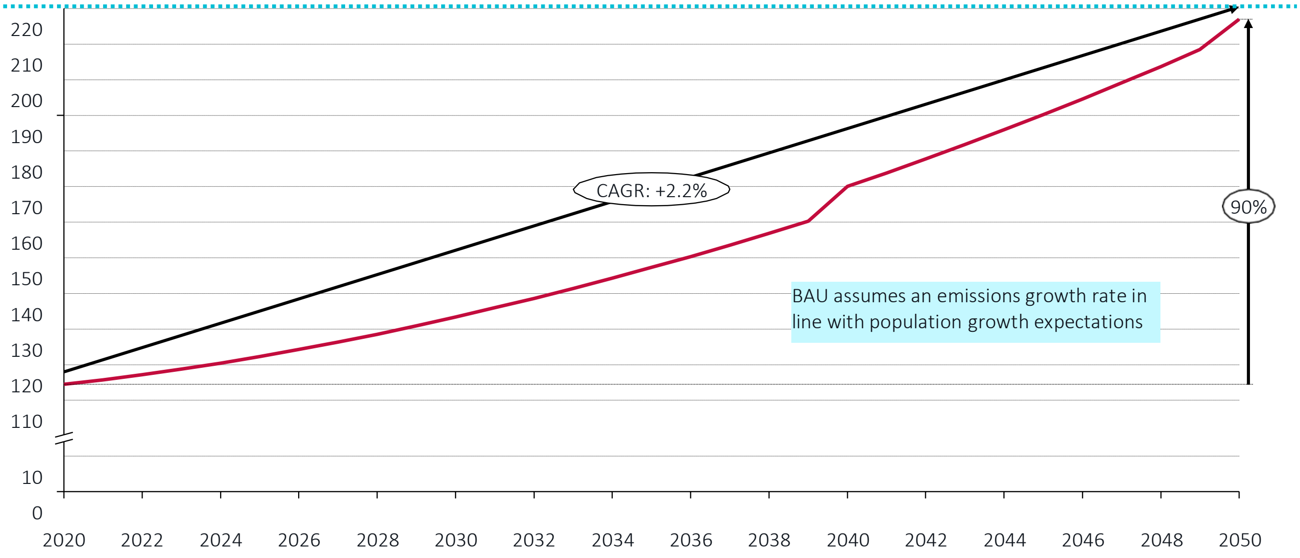
BAU projections for waste emissions are expected to grow in line with population. Census data (Belize, 2013) show that the national population increased from 249,000 to 325,000 in the period 2000-2010, with an annual growth of 2.7%. Meanwhile, annual growth rates for waste emissions are estimated to be 2.2%, as shown in Figure 38. For the Waste sector, BAU projections lead to almost doubling emissions in the 2020- 2050 period (Figure 38).

[16] https://sciforschenonline.org/journals/environmental-toxicological-studies/article-data/JETS-2-114/JETS-2-114.pdf

[17] NATIONAL SOLID WASTE MANAGEMENT STRATEGY & IMPLEMENTATION PLAN, June 2015

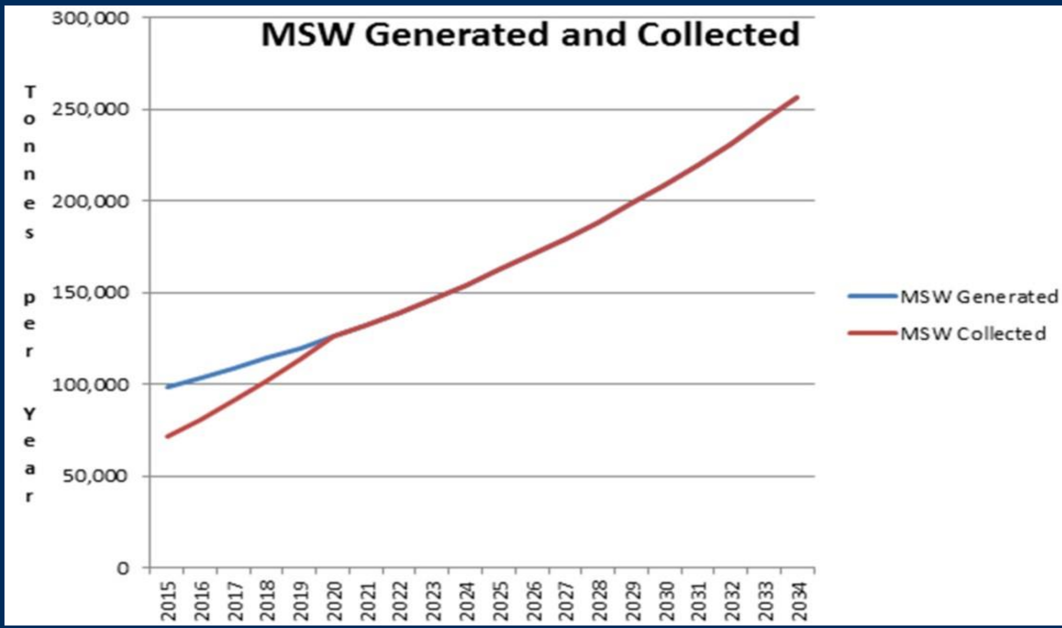
[18] https://datatopics.worldbank.org/what-a-waste/trends_in_solid_waste_management.html

Figure 38 Business-as-Usual projections: Waste GHG emissions; thousands tCO_2e



Source: Vivid Economics and Aether analysis

Box 2 Requirements for Additional MSW Handling Capacities



The NCCPSAP explains that uncontrolled dumping and burning of garbage was usual throughout Belize until recently but, since 2010, the GOB has made significant strides in addressing this issue. The GOB closed large open dump sites close to Belize City (mile 3) and San Ignacio and commissioned the new regional sanitary landfill facility at mile 24 to serve the Western Corridor (San Pedro Ambergris Caye, Caye Caulker, Belize City, Burrell Boom and San Ignacio/Santa Elena). With the establishment of this new disposal facility just outside of Belmopan, it estimates that the majority of waste generated is now disposed of through landfilling.

It is estimated that a bit more than 70% of the waste was collected in 2015 (71,584 out of 98,369 metric tonnes). The Belize Solid Waste Management Plan assumes a relatively quick catch-up, with collected waste reaching 100% of generated waste by 2020; after that, collected and generated quantities should grow together, reaching 256,744 metric tonnes by 2034.

Source: (Belize Solid Waste Management, 2015)

Mitigation pathways and targets

The analysis and stakeholder engagement in the Waste sector resulted in four actions with thirteen targets spread among them as shown below.

1. Improved waste collection and management
   - 1.1. Expansion of National Landfill, absorbing waste from the capital's metropolitan area
   - 1.2. Expansion of collection from other urban areas to the National Landfill
   - 1.3. Installing disposal sites in villages and start collecting rural waste
2. Reduction of methane generation at the National Landfill
   - 2.1. Flaring methane on National Landfill to reduce emissions

2.2. Using methane of solid waste for biogas energy

3. Reduction of solid waste volume by recycling and composting
   3.1. Collection and exporting of PET waste
   3.2. Installing recycling facilities at the National Landfill, at transfer stations and site collection
   3.3. Collecting and composting green waste
4. Reduction of GHG emissions in wastewater
   4.1. Upgrading treatment systems (Belmopan)
   4.2. Incentivizing residential connection to centralized sewage systems (CAPITAL)
   4.3. Incentivizing the adoption of appropriate septic tanks, for wastewater not connected to pipes (CAPITAL)
   4.4. Incentivizing residential connection to centralized sewage systems (OTHER AREAS)
   4.5. Incentivizing the adoption of appropriate septic tanks, for wastewater not connected to pipes (OTHER AREAS)

In the remainder of this section, we will further explore context, targets by scenario with associated assumptions, potential impacts, and implementation feasibility of each of these mitigation options.

2.6.1 Improved waste collection and management

		Targets 2030			Targets 2040			Targets 2050		
Sub-action	Target parameter	BAU	HA	VHA	BAU	HA	VHA	BAU	HA	VHA
1.1. Expansion of National Landfill, absorbing waste from the capital's metropolitan area	Share of Belize City solid waste collected to the Landfill (% of total)	80%	82.5%	85%	80%	85%	90%	80%	87.5%	95%
1.2. Expansion of collection from other urban areas to the National Landfill	Share of solid waste of other urban areas collected to the Landfill (% of total)	70%	75%	80%	70%	77.5%	85%	70%	80%	90%
1.3. Installing disposal sites in villages and start collecting rural waste	Share of solid waste of rural areas collected to the Landfill (% of total)	0%	15%	30%	0%	20%	40%	0%	33%	65%

This option relates to the expansion of the national landfill, action that is already under implementation. The expansion will absorb additional uncollected solid waste from the capital's metropolitan area where as much as 20% of waste may be dumped illegally. Focus group participants agreed on a VHA that assumes collecting 95% of Belize City waste by mid-century, with a gradual increased from a 2030 target of 85%. On other urban areas, the objective is increasing collection from the current level of 70% to approximately 90% by the mid-century, in the VHA.

In rural zones, the stakeholders reckon that no collection is made, with municipalities resorting to open dumps and open burning. The group reinforced the introduction of disposal sites for rural communities, building a collection infrastructure that brings rural solid waste to the National Landfill. The group agreed to a VHA target, which assumes collecting about two-thirds of waste in two decades through drop-off centers.

It is important to notice that the mitigation impact of this action is based on the assumption of transition of solid waste from uncategorized solid waste disposal (open dumps) to managed semi-aerobic (properly managed landfills), which the international experience indicates can lead to a reduction of GHG emissions of up to 40%.

2.6.2 Reduction of methane generation at the national landfill

		Targets 2030			Targets 2040			Targets 2050		
Sub-action	Target parameter	BAU	HA	VHA	BAU	HA	VHA	BAU	HA	VHA
2.1. Flaring methane on National Landfill to reduce emissions	Share of Landfill methane flared (% of total)	0%	5%	10%	0%	10%	20%	0%	15%	30%
2.2. Using methane of solid waste for biogas energy	Share of Landfill methane turned sold (% of total)	0%	0%	0%	0%	0%	0%	0%	10%	20%

The previous action on increasing collection should have a limited impact, as most of the waste still produces methane, which molecule has a GHG impact about 28 times higher than carbon dioxide. Ultimately, the country needs to consider strategies to burn or use the methane generated productively.

This option can be implemented through alternative, non-exclusive pathways. Stakeholders considered the options to flare the methane (which reduces, but does not eliminate, the GHG released), or to capture and convert methane into biogas energy, which requires more advanced technology and can be expensive. Presently there is no capture of any kind at the landfill and methane is passively released.

Stakeholders discussed an option to convert the methane to biogas and ultimately agreed on starting the conversion in about two decades, based on the feasibility of implementation. Stakeholders also agreed on starting to concentrate methane to be flared in the short-term, reaching 10% of total emission in 2030 and almost a third by mid-century.

2.6.3 Reduction of solid waste volume by recycling and composting

		Targets 2030			Targets 2040			Targets 2050		
Sub-action	Target parameter	BAU	HA	VHA	BAU	HA	VHA	BAU	HA	VHA
3.1. Collection and exporting of PET waste	Share of PET/ aluminum exported (% of total)	3%	11.5%	20%	3%	14.0%	25%	3%	21.5%	40%
3.2. Installing recycling facilities at the National Landfill, at Transfer stations and site collection	Share of waste collected for recycling (% of recyclables)	3%	9.0%	15%	3%	11.5%	20%	3%	16.5%	30%
3.3. Collecting and composting green waste	Share of total waste collected for composting (% of non-recyclables)	0%	3%	5%	0%	15%	30%	0%	25%	50%

According to sector stakeholders, the share of PET/ aluminum waste collected and exported is about 3%. The same share is estimated for other recyclables. The participation of organic waste (food and yard waste)is estimated as 27% possible, and the share of composting is currently considered negligible.

Critical mitigation options include the collection and exportation of PET and aluminum, installing recycling collection at municipal centers or commercial sites, and collecting and composting green waste. The Director of SWMA stated that the cost–benefit analyses support exportation rather than in-country recycling, but because that is primarily based on volume, there are plans to construct a recycling plant by 2050.

Stakeholders agreed to a VHA target which assumes exporting 40% of recyclable waste by 2050, increasing gradually from 20% in 2030, and collecting 30% of recyclable waste through collection sites by 2050, with a gradual increase from 15% in 2030.

Stakeholders indicated that the collection and composting of green waste had been previously considered, but there had been limitations to implementation due to the specific climate. The group agreed that a VHA target of 50% of waste composted by 2050 was reasonable.

2.6.4 Reduction of GHG emissions in wastewater

		Targets 2030			Targets 2040			Targets 2050		
Sub-action	Target parameter	BAU	HA	VHA	BAU	HA	VHA	BAU	HA	VHA
4.1. Upgrading treatment systems (Belmopan)	Reduction of emissions from collected wastewater (% of 2020 level)	0	5	10	0	10	15	0	15	20
4.2. Incentivizing residential connection to centralized sewage systems (CAPITAL)	Share of the wastewater collected by pipes in the capital (% of total)	20%	25%	30%	20%	30%	40%	20%	35%	50%
4.3. Incentivizing the adoption of appropriate septic tanks, for wastewater not connected to pipes (CAPITAL)	Share of wastewater NOT collected by pipes disposed in septic tanks in the capital (% of total)	50%	57.5%	65%	50%	65%	80%	50%	70%	90%
4.4. Incentivizing residential connection to centralized sewage systems (OTHER AREAS)	Share of the wastewater collected by pipes in other areas (% of total)	0%	5%	10%	0%	10%	20%	0%	15%	30%
4.5. Incentivizing the adoption of appropriate septic tanks, for wastewater not connected to pipes (OTHER AREAS)	Share of wastewater NOT collected by pipes disposed in septic tanks in other areas (% of total)	70%	75%	80%	70%	78%	85%	70%	80%	90%

Currently, wastewater collection and treatment are restricted to 3 locations in Belize: San Pedro (island), Belmopan, and Belize City. It is estimated that only 21% of the urban residents across the country were connected to municipal systems. The rest is either destined to septic tanks (about half of the wastewater of these locations and 70% in other areas) or latrines.

This action is, therefore, composed of 3 mutually supporting pathways: upgrading the wastewater that is currently collected centrally, increasing the wastewater share that is collected by the pipe network and fostering the adoption of septic tanks for the wastewater that remains not connected to the pipes.

The first pathway is already considered under existing plans to upgrade the treatment process and technology of the Belmopan plant to reduce the level of emissions. Participants of the waste sector group had no comment on the action. The VHA target assumes that it is possible to reduce 20% of emissions by mid-century through technological upgrade of wastewater treatment, increasing gradually from a VHA targetof 10% in 2030.

The second pathway is about increasing pipe collection across the country, with different targets in the 3 locations where the centralized system is already present and in other areas. In the former, the objective is gradually increasing the collection from about 20% currently to half of produced wastewater, increasing connections of households and commercial establishments to the pipe system. In the latter, the objective is to start collecting wastewater, especially in areas more densely populated, more environmentally sensitive or of touristic importance; the VHA scenario aims to reach about 30% of wastewater produced in those other areas by 2050.

The third pathway is to incentivize the adoption of appropriate septic tanks, for wastewater not connected to centralized system, in order to ensure minimum treatment standards in areas currently not covered by the pipe network. Stakeholders agreed with a VHA scenario in which 90% of all wastewaters not presently connected to pipes should be diverted to appropriate septic tanks by mid-century.

3 Potential impact of mitigation options on GHG emissions

This chapter focuses on estimating the potential impact of mitigation options in terms of reduction of GHG emissions. In line with the implementation targets discussed in the previous chapter, we build two alternative scenarios for each sector, the High Ambition (HA) and the Very High Ambition (VHA) and, comparing to Business As Usual (BAU) projections, we estimate potential aggregate reductions for each sector. Finally, considering that the country is a 'net sink', we present the overall impact for the country as a whole, considering different definitions of what the aggregate impact for Belize could be.

3.1 FOLU

3.1.1 Approach for estimates

Potential impacts of the Forestry and Other Land Use (FOLU) categories for BAU, HA and VHA scenarios have been estimated based on the implementation rates of the mitigation options as presented in chapter 2.1.

The emissions from FOLU have been split into two categories: (1) Forest Land and (2) Conversion to Other Land Uses. The mitigation actions described in chapter 2.1 are therefore assigned to one of these sources.

Forest Land:

For the three scenarios, emissions and removals from Forest Land assumes a constant rate of GHG emissions and removals by hectare of forest (for protected and non-protected areas), based on the estimates in the Mitigation Strategy for the year 2020. Since the area of forest land is shrinking due to deforestation, considering the forest land area that is annually lost, the total removals are reducing along the timeseries in the three scenarios.

Then, emissions and removals in HA and VHA are estimated by summing the mitigation potential of the different measures as follows:

- The restoration of riparian forest (option 2) reduces its degradation and therefore the carbon loss. The mitigation potential is based on the UN's Food and Agricultural Organization (FAO) analysis supporting Belize's NDC revision that considers a reduction from 40% to 10% of biomass loss when restoration occurs. The annual mitigation potential by hectare of riparian forest restored (estimated by FAO) is taken and then multiplied by the areas affected by restoration, as presented in chapter 2.2.
- The restoration of mangroves (option 4.1) increases the carbon in biomass, dead matter and soil in the areas restored. It is assumed that carbon stock in mangroves is reached 20 years after the conversion from other land use. The carbon stock in biomass is taken from Herrera-Silveira et al. (2020) and in deadwood, from the Wetlands Supplement IPCC 2014. In the case of carbon stock change in soils, it is assumed that vegetation is re-established through direct reseeding or purposeful planting, and therefore the emission factor is taken from Table 4.12 of Wetlands Supplement IPCC. It is assumed that the area restored was in equilibrium, i.e., emissions/removals from the land use prior to the restoration of mangroves is not accounted for. In the case of restoration of seagrass meadows, the estimates of its mitigation potential by hectare restored uses estimates of the FAO analysis supporting Belize's NDC revision. The annual mitigation potential by hectare of riparian

forest restored (estimated by FAO) is taken and then multiplied by the areas affected by restoration, as presented in chapter 2.2.

- In the case of reforestation of annual cropland, grassland, set-aside and degraded cropland (option 6) the mitigation potential is estimated based on FAO analysis supporting Belize's NDC revision. The average annual emissions reduction by hectare affected by each measure for 2020-2030 is assumed, and then emission reductions are escalated to the number of target area for each combination of year (2030, 2040, 2050) and scenario (HA or VHA) as presented in chapter 2.2 above. It is assumed that the annual uptake of the mitigation measures, for example grassland areas reforested, is linear.

Estimates prepared by FAO used the EX-ACT tool, which is a set of linked Microsoft Excel sheets that compares the situation without and with projects in place. The tool is more appropriate for shorter periods of time, up to 20 years when C in the new land uses or practice reaches equilibrium. Comparability between historical and projected emissions would be enhanced with the use of the same methodology as used in the GHG inventory.

Conversion to other land uses:

For the three scenarios, to estimate the mitigation potential of the reduction of deforestation rate (option 1), it is assumed a constant rate of GHG emissions and removals by hectare of forest (protected and non-protected areas), based on the estimates in the Mitigation Strategy for the year 2020. Since the area of forest land is shrinking due to deforestation, considering the forest land area that is annually lost, the total removals are reducing along the timeseries in the three scenarios.

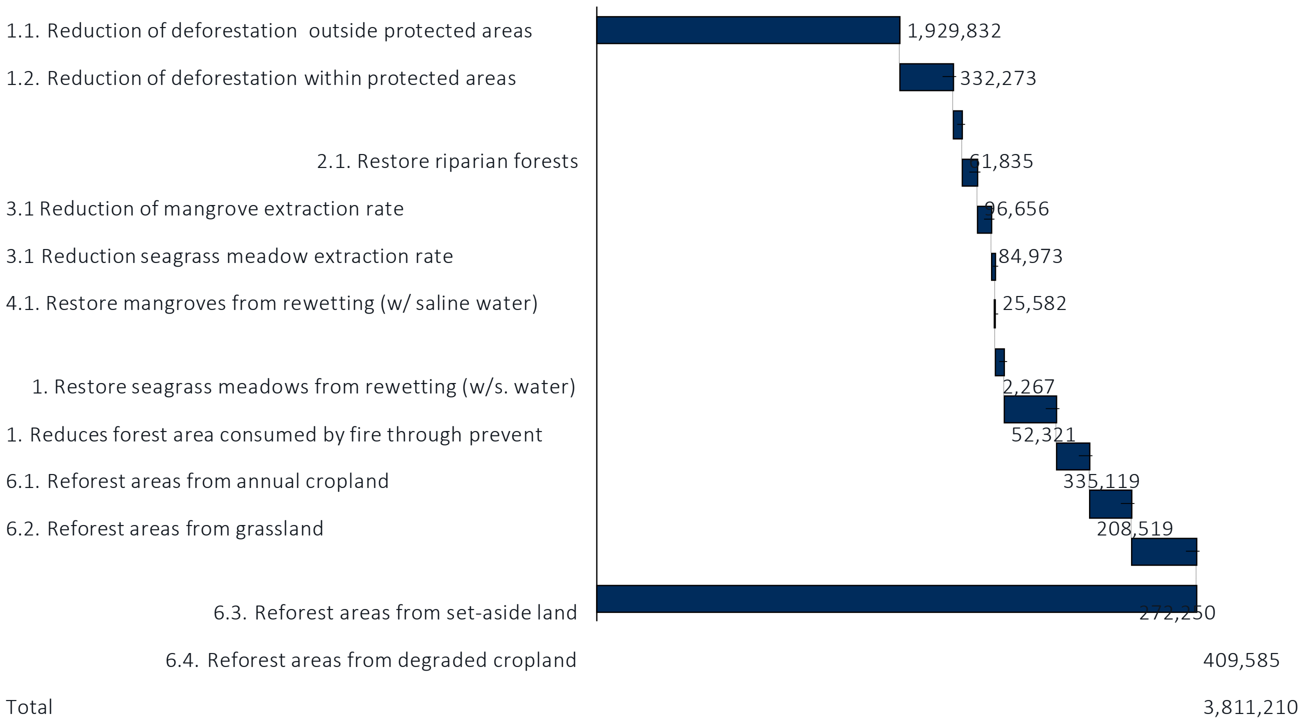
Then, emissions due to Conversion to other land uses for each scenario is estimated based on the rates of deforestation and meadows and seagrass extraction, that reduce in HA and VHA compared to BAU. The deforestation rate used in each combination year-scenario is presented in chapter 2.2. This approach does not consider that the growth rate of the forest varies with it age characteristics.

- Avoiding extraction of mangroves and seagrass meadows (option 3) reduces the loss of carbon in biomass and soils. The CO_2 emissions due to extraction are estimated based on the biomass and soil carbon stock for each ecosystem (mangrove and seagrass). Annual emission factors for soil carbon loss values used are those in table 4.12 of the Wetland Supplement IPCC 2014; and for biomass loss those in Herrera-Silveira et al. (2020). The extraction rate used in each combination year-scenario is presented in chapter 2.2. Since the extraction rate decreases along the period in the HA and VHA scenarios, the emissions are also estimated to decrease. The approach followed assumes that the carbon in mangrove and seagrass areas are in equilibrium. This means that the increase of carbon stocks in these ecosystems is not accounted for.
- The mitigation potential of prevention and control of forest fires (option 5) avoids emissions of GHG gases due to biomass burning. The emissions in different scenarios are based on the annual average emissions for the historical period. The BAU scenario assumes annual emission estimates for forest fires in 2025 – 2050 is half of the average of historical emissions. VHA and HA assumes further reductions, as presented in chapter 2.2.
- The reduction of land dedicated to pastures (option 1.1), described in chapter 2.3 Agriculture, is also included under Conversion to other land uses. The estimated mitigation impact by hectare affected equals the mitigation potential of reforested grassland areas (option 6.2). The areas affected are estimated based on the decrease of area needed for breeding livestock (from 1 ha per head to 4 ha per head in 2050 in VHA).

3.1.2 Potential emissions reduction impact

The VHA scenario projects a reduction of emissions of 3.8 $MtCO_2e$, led by a reduction of deforestation outside protected areas (option 1.1). Impact is higher outside protected areas since not only the area affected is higher, but the rates of deforestation are also much higher than in protected areas. Proactive reforestation (option 6) is the second measure with highest mitigation impact; in particular, reforesting areasof degraded cropland would have a significant impact due to the low carbon stock in these areas.

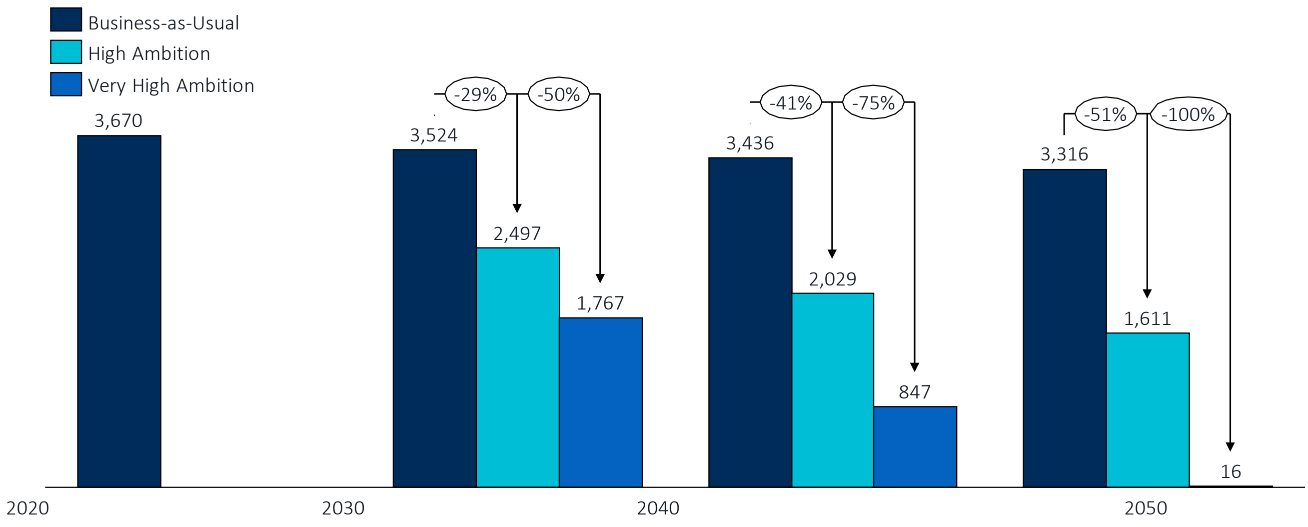
Figure 39 Very High Ambition scenario: Impact of FOLU mitigation options in 2050; tCO_2e



Source: Vivid Economics and Aether analysis

Conversion of forest land to other land uses could have emissions virtually eliminated by 2050. BAU scenario projects relatively stable emissions from conversion, with a total reduction of 10% of emissions in the 2020 – 2050 period. The HA scenario projects a reduction of about half of projected BAU emissions in 2050 and the VHA scenario projects a reduction of up to 99%.

Figure 40 GHG emissions of Conversion to other land uses: Estimate of HA and VHA vs. BAU scenario; thousands tCO_2e

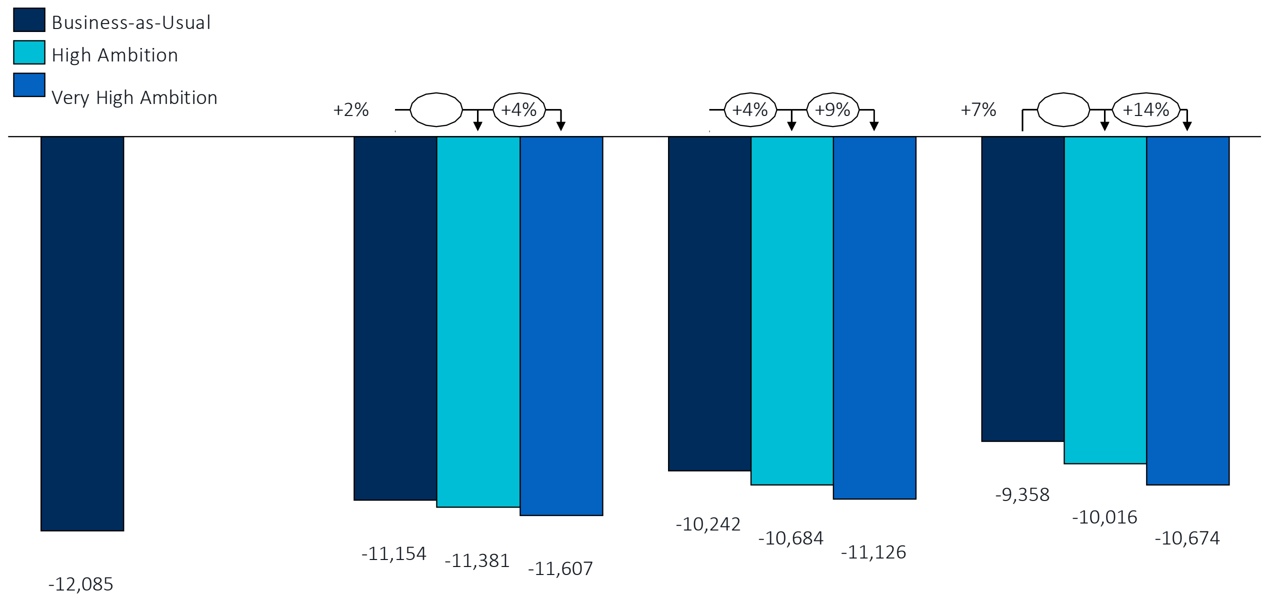


Those estimates consider the impact of option 1.1. Reduction of land dedicated to pasture from the Agriculture sector

Source: Vivid Economics and Aether analysis

Forest Land could have a removal increase of up to 1.3 $MtCO_2e$ annually over BAU by 2050. Due to continuous reduction of forest area in the country, GHG removals are expected to fall about 2.7 $MtCO_2e$ or almost ¼ of current levels. FOLU mitigation options should halt those losses, eliminating about half of this negative impact.

Figure 41 GHG removals of Forest Land: Estimate of HA and VHA vs. BAU scenario thousands tCO_2e



Source: Vivid Economics and Aether analysis

3.2 Agriculture

3.2.1 Approach for estimates

The potential impacts of the mitigation options targeting the agriculture sector for BAU, HA and VHA scenarios are estimated based on the implementation rates as presented in chapter 2.1.

The agriculture emissions have been split into two categories agriculture: livestock and aggregated emissions from land use. The mitigation actions described in chapter 2.1 are therefore assigned to one of these categories.

Livestock:

Livestock emissions in the BAU scenario are assumed to follow the same trend as reported in the 4th National Communication between 2012 and 2017, both for Enteric fermentation and Manure management.

It is assumed that the total livestock emissions (i.e., enteric fermentation and manure management) are directly proportional to the time required to cattle maturity. Therefore, the reduction of time required to cattle maturity (option 1.2) is directly proportional to the reduction in time (days) required. The time required to maturity is presented in chapter 2.3 and is lower in HA and VHA compared to BAU scenario. A better understanding of the relation between time required to cattle maturity and livestock emissions would enhance the accuracy of the mitigation potential estimates.

The emissions reductions for the VHA scenario are set as the target reductions based on the stakeholder group consultation, i.e., 30% reduction of emissions from enteric fermentation due to improved cattle feeding and probiotics (option 1.3) and 25% reduction of emissions due to Capture, store and treat animal manures sustainably, including probiotics (option 1.4), compared to 2020 emission level in BAU scenario. This approach assumes a reduction of emissions without a clear consideration of how the measures will be implemented and their impact on activity data or emissions factors. The assessment could be enhanced if it were built on the basic livestock and manure management features.

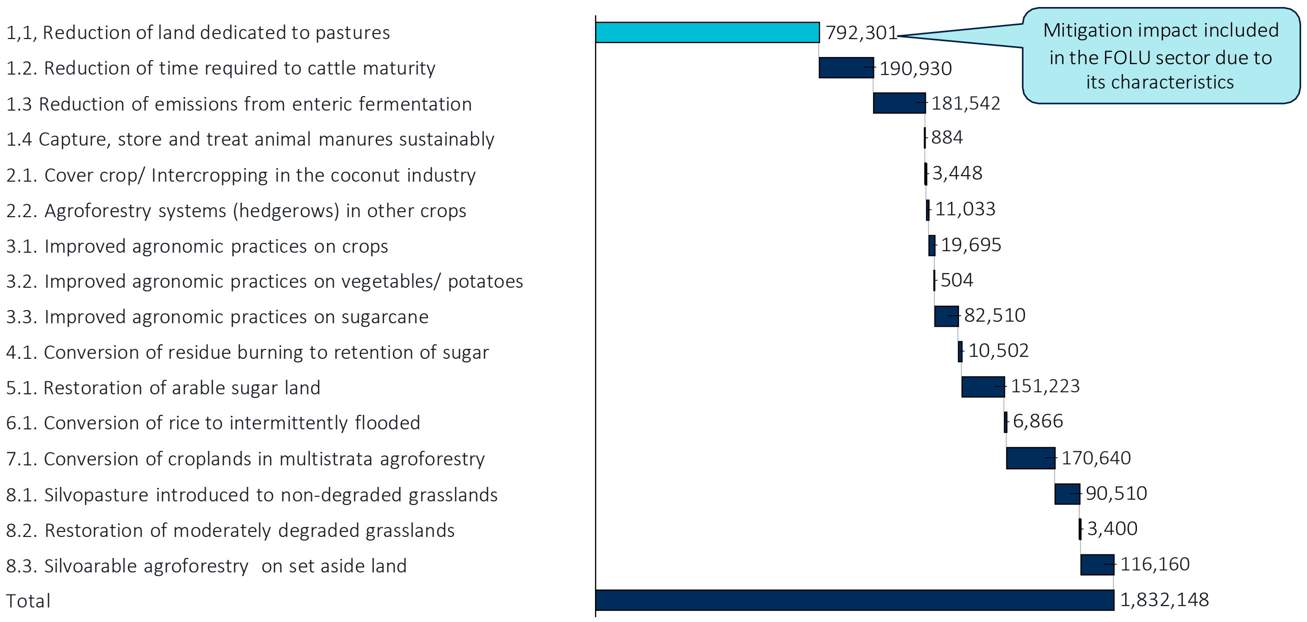
Aggregated emissions on land use:

Aggregated emissions on land use in the BAU scenario are assumed to follow the same trend as reported in the 4th National Communication between 2012 and 2017. The estimated emission reductions due to mitigation actions (options 2, 3, 4, 5, 6, 7 and 8) are based on FAO reduction estimates in its analysis supporting Belize's NDC revision for the period 2020-2030. The average annual emissions reduction by hectare affected by each measure for 2020-2030 is assumed, and then multiplied by the number of hectares affected in each year (2030, 2040, 2050) and scenario (HA or VHA) as presented in chapter 2.3 above. It is assumed that the annual uptake of the mitigation measures (for example areas converted from residue burning to retention of sugarcane cropland) is linear. Estimates prepared by FAO used the EX-ACT tool. Comparability between historical and projected emissions would be enhanced with the use of the same methodology as used in the GHG inventory.

3.2.2 Potential emissions reduction impact

Agriculture sector could reduce its GHG emissions by 1.04 MtCO_2e under the VHA scenario, excluding the reduction of land dedicated to pasture that is included in the FOLU sector due to its characteristics. Figure 42 shows that the biggest proportion of this reduction is from the reduction of time required to cattle maturity and the reduction of emissions from enteric fermentation due to improved cattle feeding and probiotics (options 1.2 and 1.3), which are expected to reduce livestock emissions by 191 and 182 KtCO_2e in 2050 compared to the BAU scenario. Of the measures targeting crops cultivation, those with the highest estimated mitigation potential are the conversion of cropland to multistrata agroforestry and restoration of arable sugar land (options 7.1 and 5.1). The mitigation potential is linked to biomass growth and sequestration of organic carbon in soils

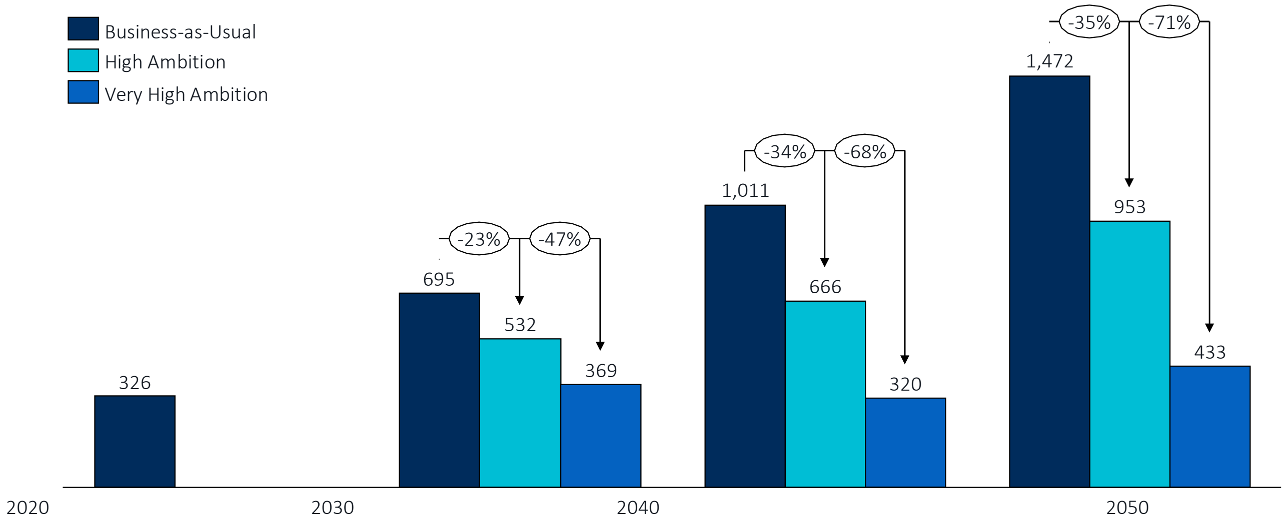
Figure 42 Very High Ambition scenario: Impact of Agriculture mitigation options in 2050; tCO_2e



Source: Vivid Economics and Aether analysis

The agriculture sector could have an emissions reduction of up to 70% over BAU by 2050. Agriculture is expected to be the sector with the steepest increase of emissions, which are expected to grow over 1 $MtCO_2e$ annually in the 2020-50 period. The implementation of mitigation options is expected to almost fully neutralize this growth under the VHA scenario, leading to 2050 emissions comparable to the current level.

Figure 43 GHG emissions of the agriculture sector: Estimate of HA and VHA vs. BAU scenario; thousands tCO_2e



Those estimates do not consider the impact of option 1.1. Reduction of land dedicated to pasture, which is included in FOLU estimates

Source: Vivid Economics and Aether analysis

3.3 Energy

3.3.1 Approach for estimates

The projected GHG emissions associated with electricity production sector have been compiled utilizing information from the 2018 BEL report on the GWh generated by fuel in Belize in 2018 and assumes that without any intervention that production levels would remain static and that any increasing demand (assumed to be at the rate of 3.2% annually) would be met by increasing the amounts of electricity imported from Mexico. As identified previously, the emissions arising from imports have been included in the analysis due to the large impact that this has on Belize's emissions, and it has been assumed that Mexico's grid electricity emission factor[19] for 2019 has been assumed to be applicable for future years.

In order to be able to calculate the impact of the electricity production and electricity demand reduction measures included in the HA and VHA scenarios, CO_2, CH_4 and N_2O emission factors for the different fuels combusted in the energy industries sector were obtained from the 2006 IPCC guidelines and were applied accordingly.

For charcoal production, activity data for 2015 to 2017 was obtained from the 2019 Mitigation Analysis report and then an assumption has made that activity levels will increase in line with projections of household numbers provided in the IRENA report.

For combustion of fuels in the industrial sector, activity levels for 2015 to 2017 have been obtained from UN Energy Statistics and it has been assumed that activity levels increase by 2% per year from 2018 to 2050.

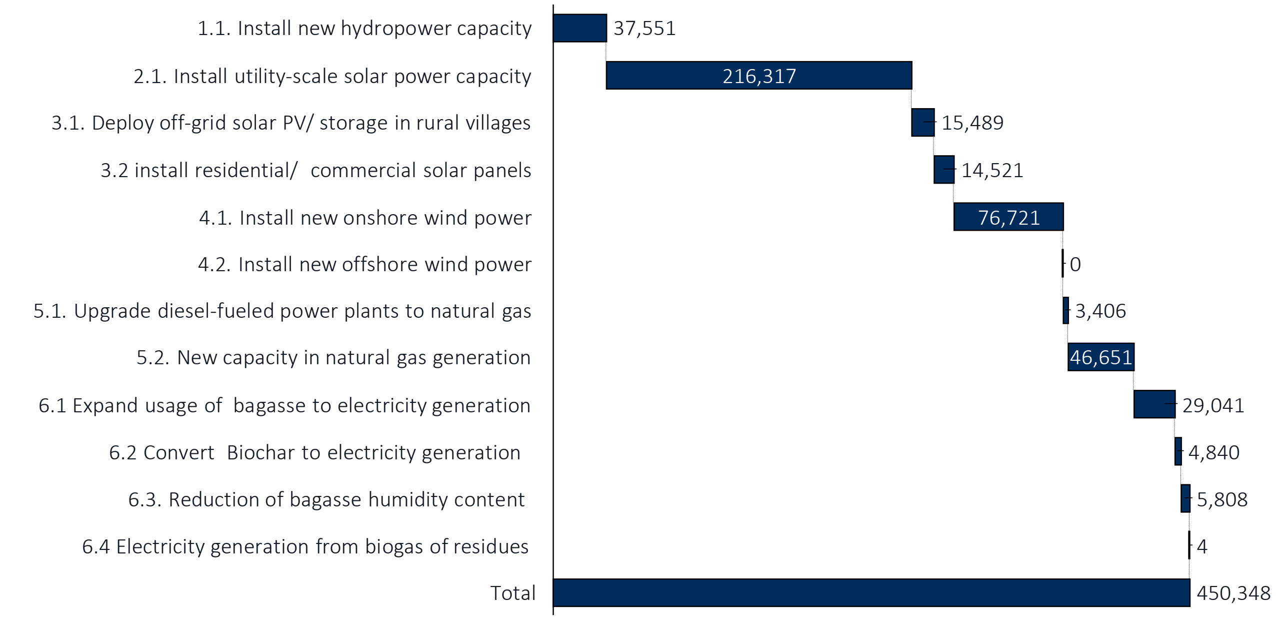
For combustion of fuels in the residential sector, activity levels for 2015 to 2017 have been obtained from the 2019 Mitigation Analysis report and Belize's 4th GHG Inventory report and then assumed to grow in line with projected household numbers provided in the IRENA report.

3.3.2 Potential emissions reduction impact

Energy mitigation options can reduce Belizean GHG emissions in about 0.65 $MtCO_2e$ by 2050. From this total, Energy Generation has an estimated reduction of emissions of 0.45 $MtCO_2e$ under the VHA scenario, led by solar (2.1), wind power (4.1) and natural gas (5.2). These replace the high grid electricity emission factor for Mexico, in which there is a large amount of diesel generation. In addition, under the VHA scenario, an estimated reduction of emissions of 0.2 $MtCO_2e$ should come from Energy Efficiency, led by water heating (9.1), LED lighting (10.2-10.4) and efficiency of appliances (11.1).

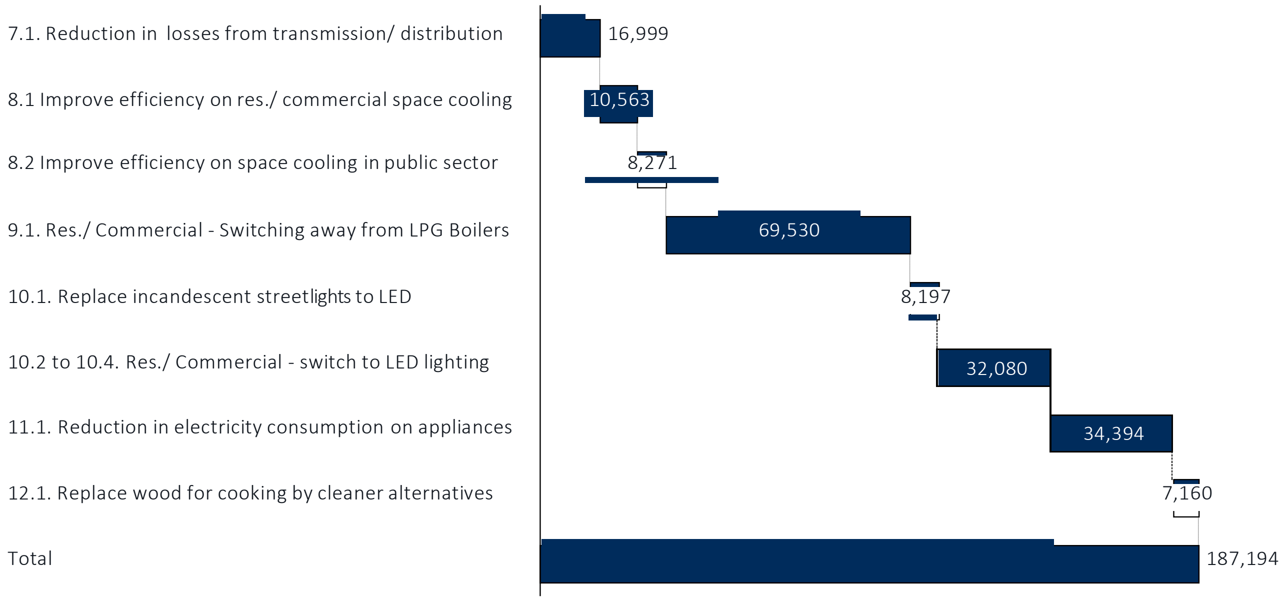
[19] https://www.climate-transparency.org/wp-content/uploads/2019/11/B2G_2019_Mexico.pdf

Figure 44 Very High Ambition scenario: Impact of Energy Generation mitigation options in 2050; tCO_2e



Source: Vivid Economics and Aether analysis

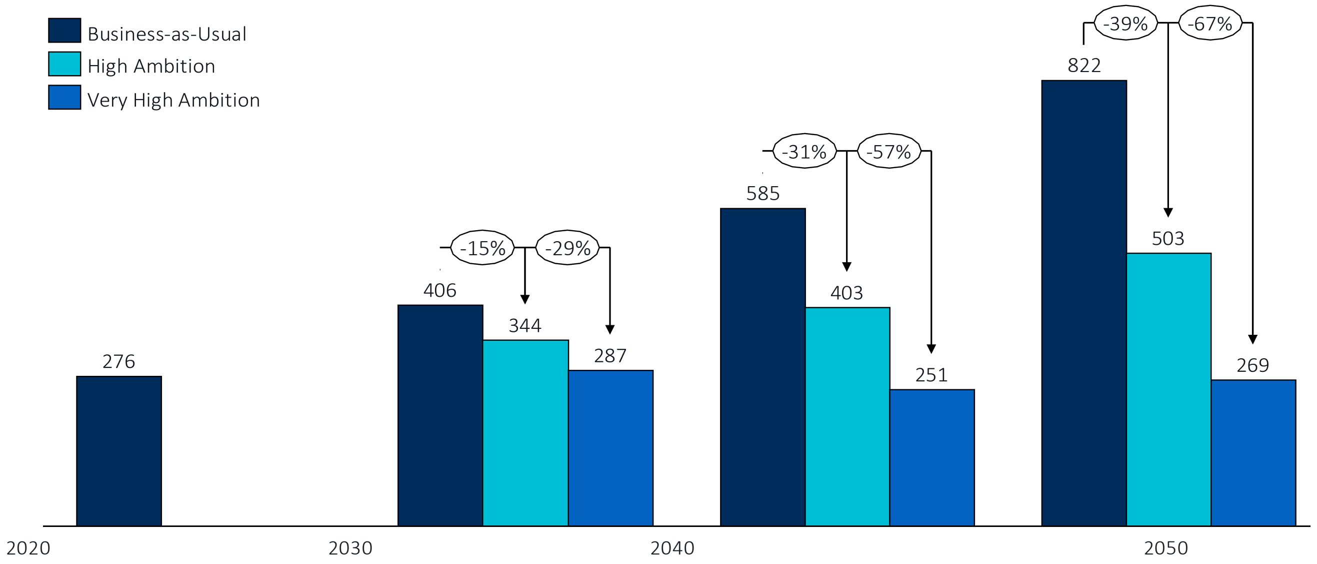
Figure 45 Very High Ambition scenario: Impact of Energy Efficiency mitigation options in 2050; tCO_2e



Source: Vivid Economics and Aether analysis

The Energy sector (including electricity imports) could reduce 2/3 of its emission in relation to BAU by 2050. Energy is the sector that projects the second steepest growth of emissions under the BAU scenario, with an almost 200% growth in the 2020-50 period. Similarly to Agriculture, mitigation options should neutralize this growth, assuring emissions remain roughly constant over the 2020-50 period (Figure 46).

Figure 46 GHG emissions of the Energy sector (incl. Imports): Estimate of HA and VHA vs. BAU scenario; thousands tCO_2e



Source: Vivid Economics and Aether analysis

3.4 Transport

3.4.1 Approach for estimates

The road transport BAU projections are based on fuel consumption estimates provided in Belize's National Transportation Master Plan and their public transport and truck demand forecasts for 2025 and 2035 with interpolation and extrapolation.

The GHG emissions arising from the transport sector in Belize both under the HA and VHA scenarios heavily utilize information provided by IRENA in their Transport Report.[20] This provides information on the number of vehicles in Belize by type, the average annual mileage and the fuel consumed per kilometre on average.

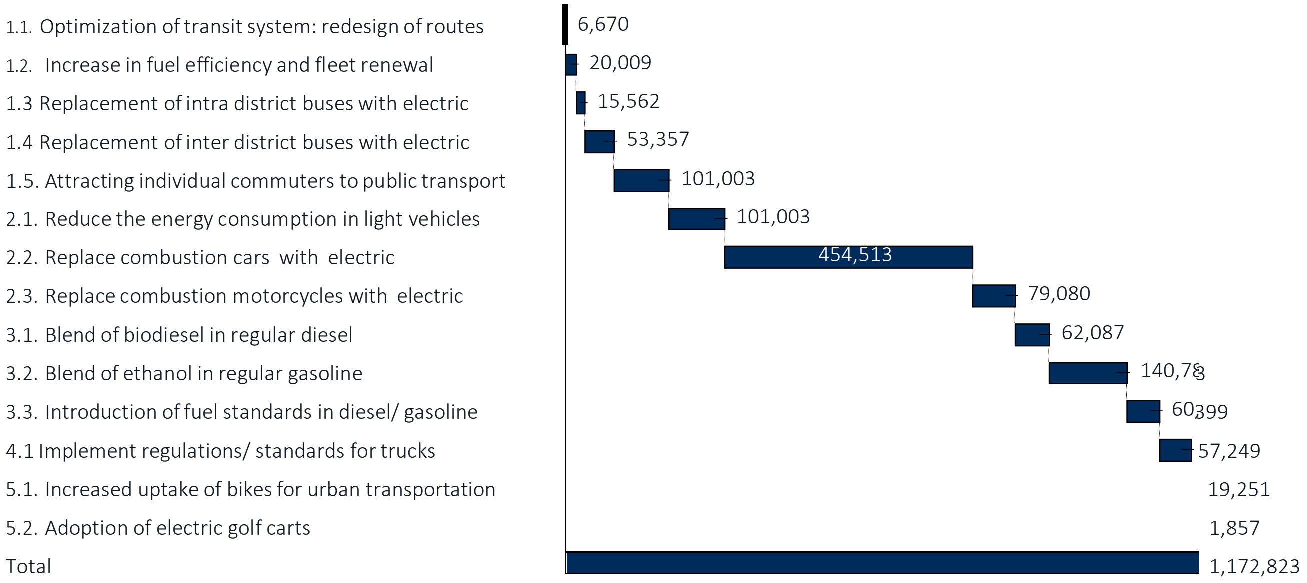
Due to a lack of information on activity in the navigation and non-road mobile machinery sectors, it has been assumed that all fuel consumed in the transport sector is accounted for in the road transport sector.

3.4.2 Potential emissions reduction impact

The VHA scenario estimates a reduction in emissions of approximately 1.2 $MtCO_2e$ in 2050. This is dominated by light duty vehicles measures (option 2) such as replacing fossil fuel cars and motorcycles with electricity and reducing the energy consumption of light vehicles. Other mitigation actions, such as replacing diesel buses with electrically powered ones, increasing the uptake of biofuels and encouraging the use of bikes for urban transportation also contribute towards GHG emission reductions.

[20] Remap Belize. Transport Sector. November 2020. International Renewable Energy Agency.

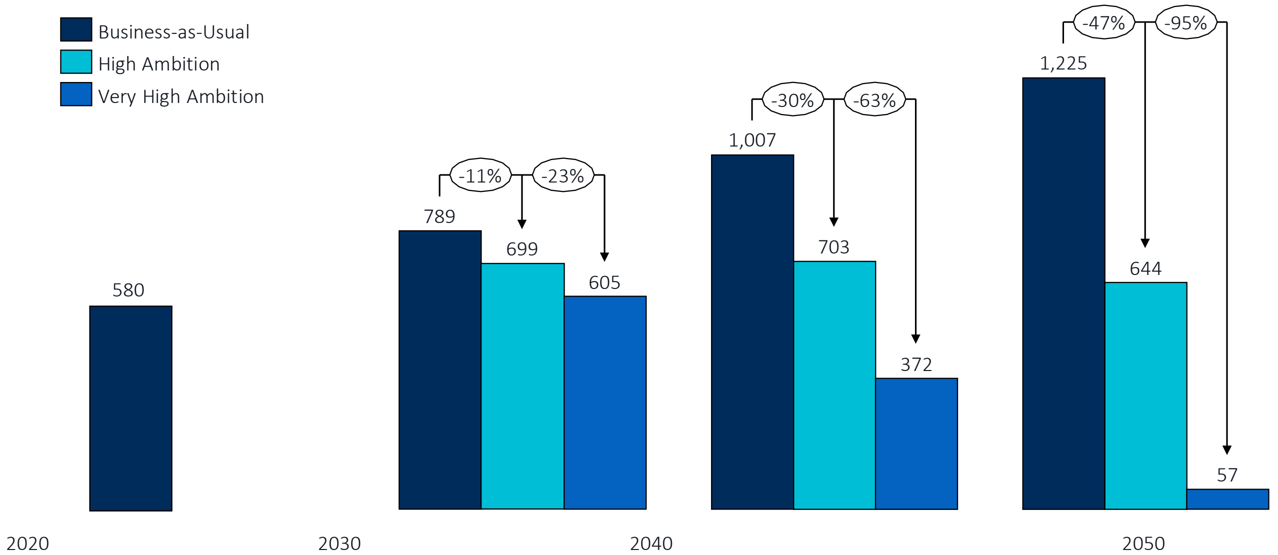
Figure 47 Very High Ambition scenario: Impact of Transport mitigation options in 2050; tCO_2e



Source: Vivid Economics and Aether analysis

Mitigation actions in the transport sector could lead the sector to virtual carbon neutrality by 2050. Under BAU scenario, sector emissions should expect relevant growth, more than doubling in absolute terms in the 2020-50 period. Under VHA, sector emissions could be reduced by 95% over BAU by 2050, as it is shown in the Figure 48.

Figure 48 GHG emissions of the Transport sector: Estimate of HA and VHA vs. BAU scenario; thousands tCO_2e



Source: Vivid Economics and Aether analysis

3.5 Waste

3.5.1 Approach for estimates

Emissions from landfill were calculated using the IPCC landfill model using 2006 IPCC defaults for parameters such as degradable organic carbon and the methane generation rate constant. The waste composition was sourced from the 4th National Inventory report, originally from a waste characterization study carried out in 2011, and the percentage of waste landfilled in the different landfill types was sourced from the GHG Mitigation assessment and national mitigation strategy report. The historic population was taken from the SIB and the projected population from the GHG Mitigation assessment and national mitigation strategy report. The rate of waste generation was also from the GHG Mitigation assessment and national mitigation strategy report.

Emissions for the BAU and mitigation scenarios were calculated using implied emission factors (IEFs) for each waste and landfill type. The use of IEFs is not an entirely fair representation of the emissions from landfill as the annual emissions, used to calculate the IEFs, include emissions from waste sent to landfill up to 50 years previously. However, this was the simplest methodology to apply to the multiple scenarios. The amount of each waste type sent to landfill was calculated using the waste composition, and total amount of waste sent to landfill. The total amount of waste sent to landfill was calculated using population from SIB and rate of waste generation, 4th National Inventory report, minus the amount of waste recycled, composted and open burnt. The waste composition was adjusted to account for waste recycled and composted in the BAU and mitigation scenarios based of the projected percentages of waste diverted. How much waste was sent to different landfill types was determined using the projected percentages of waste sent to the different landfill types and Belize City, other urban and rural populations. For rural populations it was assumed all waste not sent to sanitary landfills or open burnt was sent to open dumps. Increased collection of rural waste was assumed to not impact the amount of waste sent to these open dumps; it was assumed that the waste was diverted from open burning. The 4th Inventory report identifies the National Landfill as a semi-aerobic landfill and other landfill sites, to be closed, serving the urban population as managed anaerobic sites. The open dumps used by the rural population were classified as uncategorized sites. It was assumed that the new landfill sites to serve the rural population would be semi-aerobic landfill sites like the National Landfill.

Emissions reductions from flaring or energy recovery of landfill gas were calculated using the total landfill gas produced minus the expected percentage of landfill gas captured. Emissions from the burning of the landfill gas for energy recovery were included in the Energy sector.

Emissions from industrial composting, for all scenarios, were sourced from the GHG Mitigation assessment and national mitigation strategy report. The additional emissions from composting the organic waste portion of municipal waste in the mitigation scenarios were calculated using the amount of waste composted and the IPCC 2006 guidance default emission factors for composting. The amount of composted waste was calculated using the percentage of food and garden waste, total waste generated, and the percentage of waste expected to be diverted from landfill.

Emissions from open burning were calculated using the amount of waste open burnt and the IPCC 2006 guidance default emission factors. The amount of waste open burnt in the BAU scenario was calculated using the population, the national rate of open burning and IPCC default for the fraction of waste treated that is burnt of 0.6. For the BAU and mitigation scenarios the amount of waste open burnt was calculated similarly except the rate of open burning was calculated using the rural population and percentage of rural population open burning minus the projected percentage of waste diverted to the National Landfill.

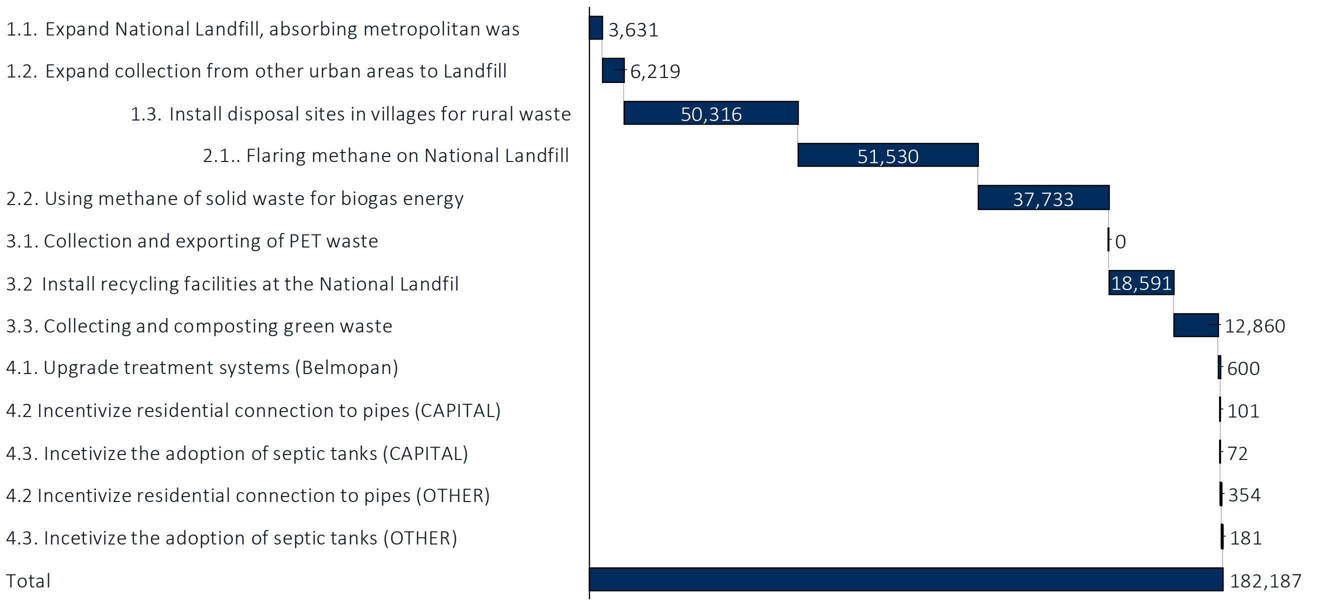
Emissions of CH_4 from wastewater treatment were calculated using the population data from the SIB fractions of the population using different wastewater treatment types from the census and IPCC 2006 guidance default parameters and emission factors for the BOD, CH_4 EF and MCFs and factor for co-discharge of industrial wastewater. For emissions in the BAU and mitigation scenarios the fractions of population using different wastewater treatment types were adjusted using the mitigation targets. Emissions of N_2O from were calculated using the population data, protein consumption data from FAO and IPCC 2006 guidelines parameters. The latest year available for protein consumption was 2017; it has been assumed that this would not change significantly in future years.

3.5.2 Potential emissions reduction impact

Mitigation options could reduce waste emissions by almost 0.2 $MtCO_2e$ under the VHA scenario[21]. Figure 49 shows the largest share of this reduction is from the burning of landfill gas for energy recovery or flaring (option 2), which are expected to reduce waste sector emissions by 51 and 37Kt CO_2e, respectively. Options to divert waste from landfill (option 3) have an intermediary impact on GHG emissions. As PET waste is inert, the collection and export of PET waste is not expected to impact GHG emissions. However, the recycling of other waste, such as paper and card, and composting of organic waste is expected to reduce GHG emissions by 19 and 13Kt CO_2e respectively in the VHA scenario.

On waste collection (option 1), the most significant impact comes from rural zones, in which collection services are still incipient (option 1.3). In this context, reducing the amount of open burning by building landfills to serve the rural population is also shown to reduce GHG emissions. Options related to increasing the use of the National Landfill are also expected to reduce emissions as these policies are increasing the share of waste sent to a semi-aerobic landfill site, simultaneously reducing the share sent to the more anaerobic landfills. The wastewater policies (option 4) have minimal impact on GHG emissions, as the majority of emissions from wastewater are N_2O, which is not impacted by the proposed changes to wastewater treatment and only the nitrogen content of the water.

Figure 49 Very High Ambition scenario: Impact of Waste mitigation options in 2050; tCO_2e

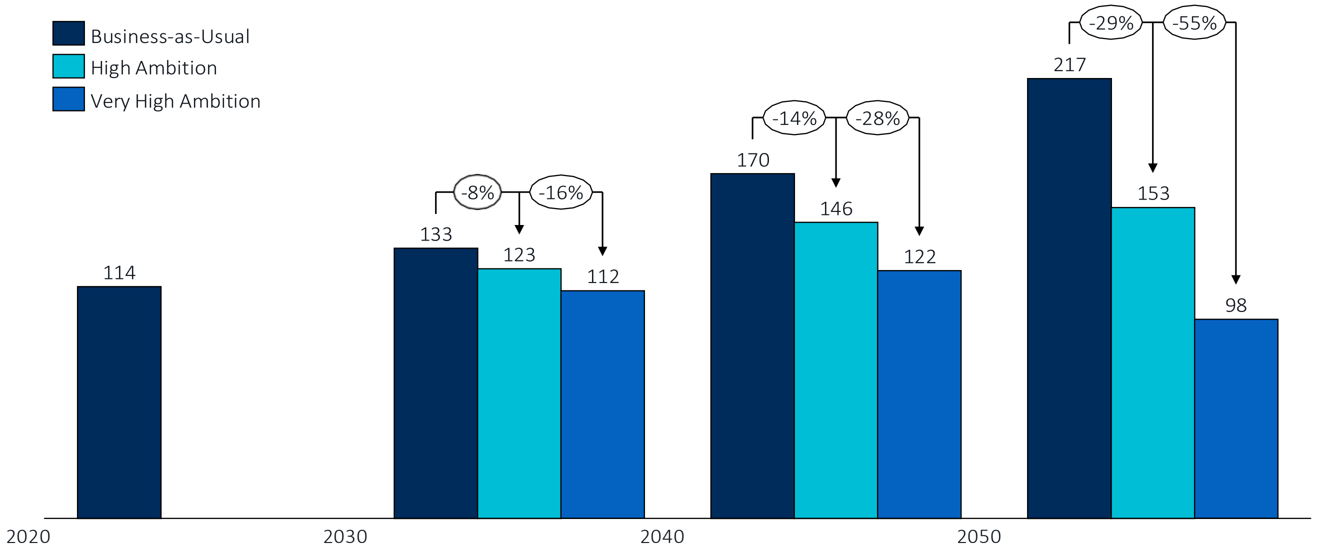


Source: Vivid Economics and Aether analysis

[21]Note: Although a combined GHG saving as a result of all of the measures is presented in the figure above, the total here is based on each policy option being assessed individually. If all of the measures were implemented, you would get a slightly different overall result. For example, reducing the amount of waste generated will impact on the amounts of landfill gas produced.

Mitigation actions in the waste sector could reduce more than half of emissions by 2050. BAU projections indicate a growth of about 90% over the 2020-50 period. Mitigation options would more than neutralize this growth, leading to a modest reduction of absolute emissions in relation to the 2020 baseline under the VHA scenario. VHA scenario would represent a reduction of emissions by approximately 55% over BAU, as shown in Figure 50.

Figure 50 GHG emissions of the Waste sector: Estimate of HA and VHA vs. BAU scenario; thousands tCO_2e



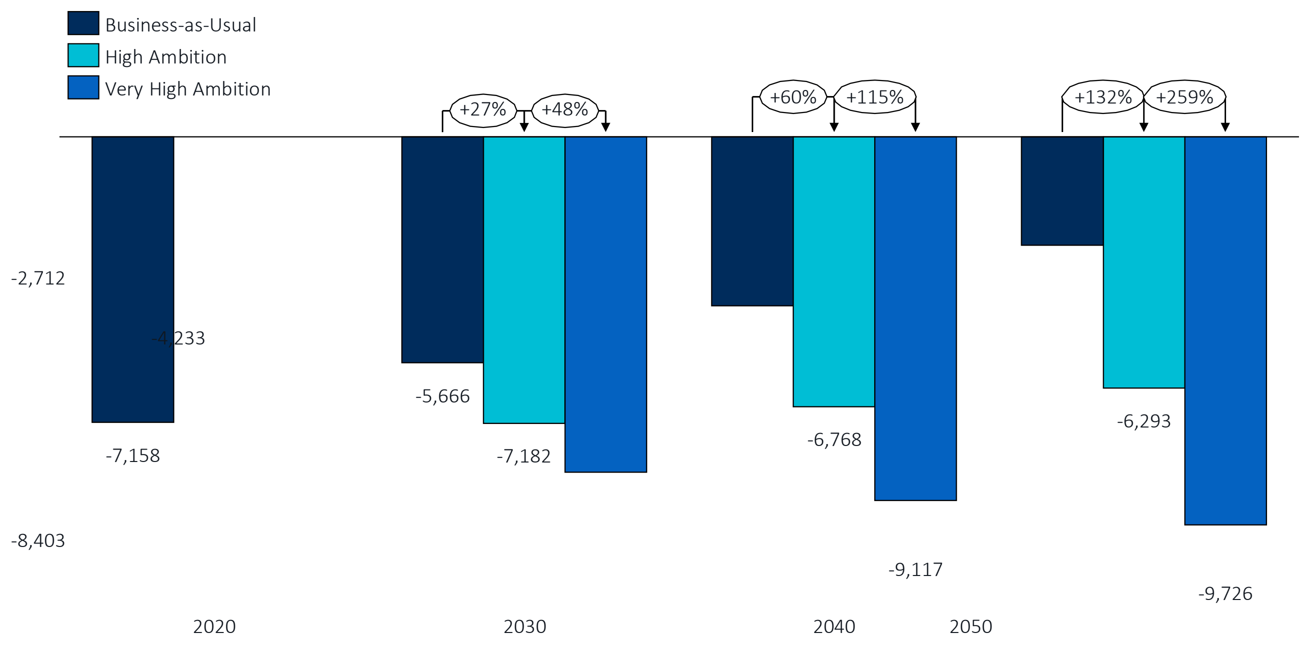
Source: Vivid Economics and Aether analysis

3.6 Overall potential impact on GHG emissions for Belize

Perspectives on the overall impact of policies may change depending on the indicators used for assessment. Similarly to section 2.1, we analyze the overall impact of the mitigation policies proposed in this LEDS through 3 different indicators: aggregate emissions including FOLU, aggregate emissions excluding FOLU andgross emissions (including conversions of forest land and electricity imports), which we consider the most appropriate concept for the case of Belize.

Aggregate emissions including FOLU are heavily negative due to the effect of carbon removals by forest lands (Figure 51). Due to the compounded effect of deforestation, which has a direct effect of directly releasing carbon into the atmosphere and a more permanent effect of reduced future removals (reduction of forest area), BAU projections see a dramatic reduction of Belizean contributions (from -7.2 to -2.7 $MtCO_2e$or -62%). Using this indicator, mitigation options also have a dramatic impact (from -2.7 to -9.7 $MtCO_2e$ or +259%!) under the VHA scenario.

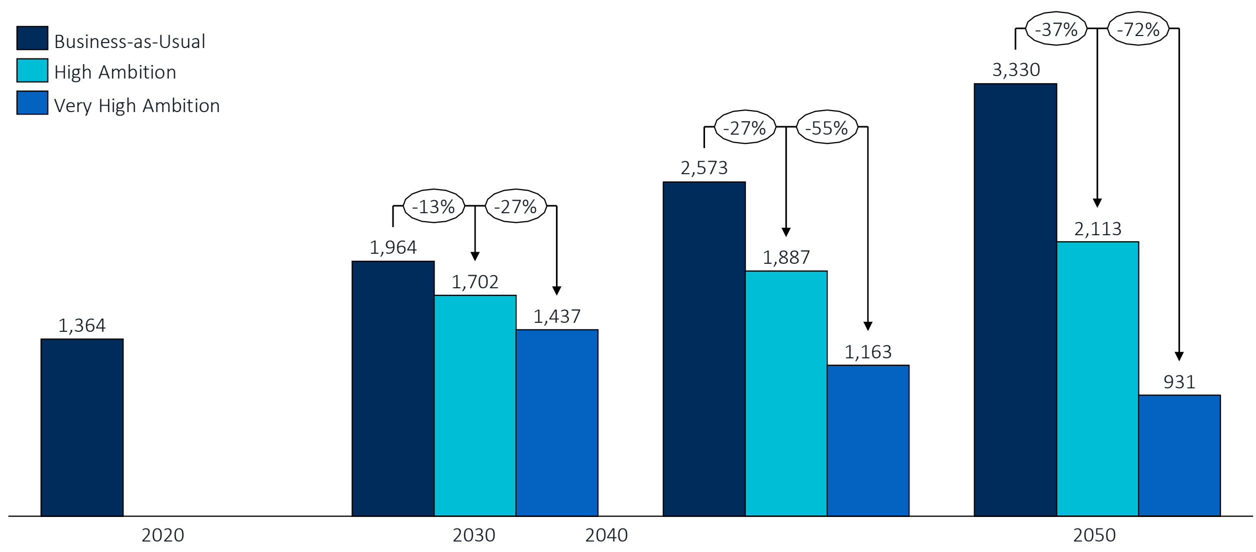
Figure 51 Belizean GHG emissions: Estimate of HA and VHA vs. BAU scenario; Aggregate emissions including FOLU; thousands tCO_2e



Source: Vivid Economics and Aether analysis

Using aggregate emissions excluding FOLU, emissions could be reduced by more than 70% over BAU by 2050 (Figure 52). Although this concept is more clearly understandable, it underestimates the impact mitigation policies, since the most impactful mitigation options are exactly in the FOLU sector.

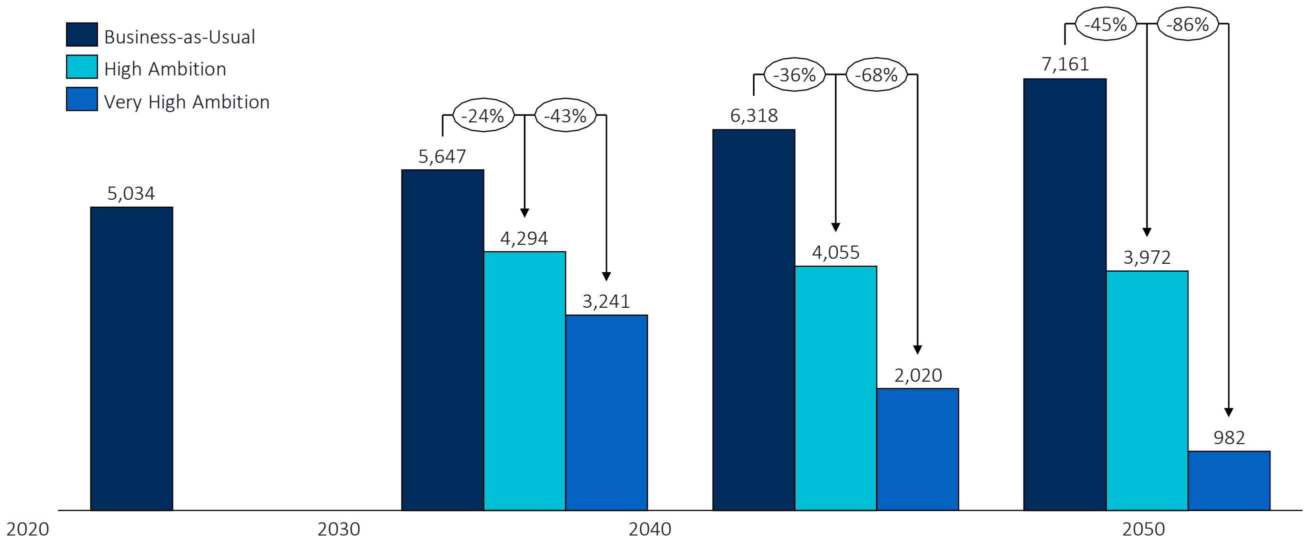
Figure 52 Belizean GHG emissions: Estimate of HA and VHA vs. BAU scenario; Aggregate emissions excluding FOLU; thousands tCO_2e



Source: Vivid Economics and Aether analysis

Considering gross emissions as the reference indicator, mitigation options proposed in this LEDS could cut almost 90% of expected emissions by 2050. As explained in section 2.1, gross emissions would exclude only forest land removals, but they would include electricity imports in order to fully account for the effect of energy options. Using this concept, the LEDS estimates that Belize's gross emissions would grow more than 40% in the 2020-2050 period under BAU scenario to 7.2 $MtCO_2e$. In relation to this scenario, gross emissions could drop by 45% under the High Ambition scenario and could be reduced to 86% under Very HighAmbition scenario by mid-century (Figure 53).

Figure 53 Belizean GHG emissions: Estimate of HA and VHA vs. BAU scenario; Gross emissions (incl. Conversion, Imports); thousands tCO_2e



Source: Vivid Economics and Aether analysis

4 Potential impact of mitigation options on costs and jobs

Drawing on the targets for the Very High Ambition (VHA) scenario, as well as international data on marginal abatement costs (MAC) and job multipliers, this chapter provides an estimate of the accumulated net effect of implementing the mitigation policies on both costs and job creation.

4.1 Approach to estimating net costs

A Literature review undertaken to identify the most appropriate data to be used revealed two main types of studies: global greenhouse gas abatement studies and specific country studies. The global studies have the advantage of considering Marginal Abatement Costs (MACs) across multiple sectors on a consistent basis but drawing on average cost data that are not country specific, whilst the country studies, due to their nature, are focused on national costs and assumptions.

The MAC method is relatively simple and intuitive and can be used to help communicate important aspects of the costs of climate actions. The early work of McKinsey (2007, 2009) on MAC curves is probably the most well-known. However, more recently, Goldman Sachs (2019, 2020) have improved on the McKinsey approach by estimating net present value in their MAC calculations.

However, the MAC approach does have some important limitations that should be taken into consideration. For instance, the approach does not provide any information about the rate at which abatement is possible and may misrepresent the difficulty, expense and time needed for the transition to low carbon options. In addition, this approach does not often provide information on the up-front costs associated with implementation and can be unclear about the energy sources they replace where applicable. A recent academic paper by Friedman et al (2020) discusses more broadly the development of methodological approaches to mitigation costs. They conclude that the MAC approach underestimates costs and does not fully represent the required investment. Friedman et al present a 'Levelized Cost of Carbon Abatement' (LCCA) as an improved approach. However, to adopt such an approach requires a significant amount of national cost and CO_2 emission reduction data that was not readily available in the case of Belize.

In the context of limited Belize-specific information, it was decided to base estimates on a global MAC approach, but to 'sense-check' costs against some of the costs calculated for specific country studies in the Caribbean and Latin America. The current Belize work draws heavily on the MACs presented in the Goldman Sachs (2020) study, as this provides an internally consistent set of data, with current prices for most of the sectors of interest. All costs are applied throughout the scenario period up to 2050 and do not assume any future changes. It is recognized that many of the proposed abatement technologies are still undergoing major development, which is likely to increase in their availability and market penetration, and hence result in a future decrease in their associated costs. Hence, our approach may overestimate the cost of some mitigation measures, especially in the latter years of the scenarios.

A number of individual Caribbean and Latin American country studies were identified and have been used to sense-check the Goldman data. The following reports were of specific value:

1. A study for Trinidad and Tobago by Factor CO_2 (2015) that provided mitigation costs for the waste to energy data measures not included in the Goldman Sachs' work.

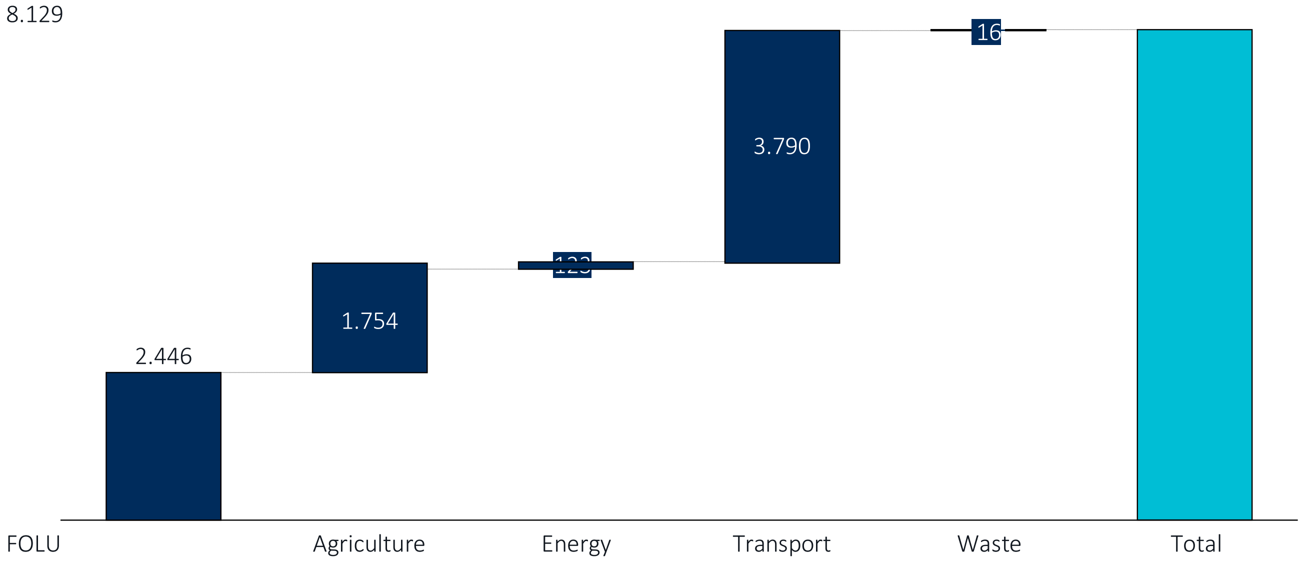
2. A Mexican study reported under the Partnership on Transparency (2019) that provides net mitigation costs by sector. The work has provided a good sense check for the reforestation measuresin the FOLU sector provided by Goldman Sachs and for the waste to energy data from the Trinidad and Tobago study.

Several earlier studies in the region were also identified but reflected older cost data (pre-2010) and were not considered appropriate for cross-checking.

4.2 Potential net impact on costs

Net costs are driven primarily by Transport, FOLU and Agriculture sectors (Figure 54). The estimated total sectoral costs are presented in Figure 54 and show the transport sector is responsible for around 47% of net costs, followed by FOLU (30%) and Agriculture (22%) sectors. Energy and Waste sectors can be considered more "cost efficient", since annual savings from new technologies and approaches compensate most capital and operational expenditures, resulting in low net costs.

Figure 54 Estimate of accumulated net costs for implementing mitigation options; USD millions (2020 prices)



Source: Vivid Economics and Aether analysis

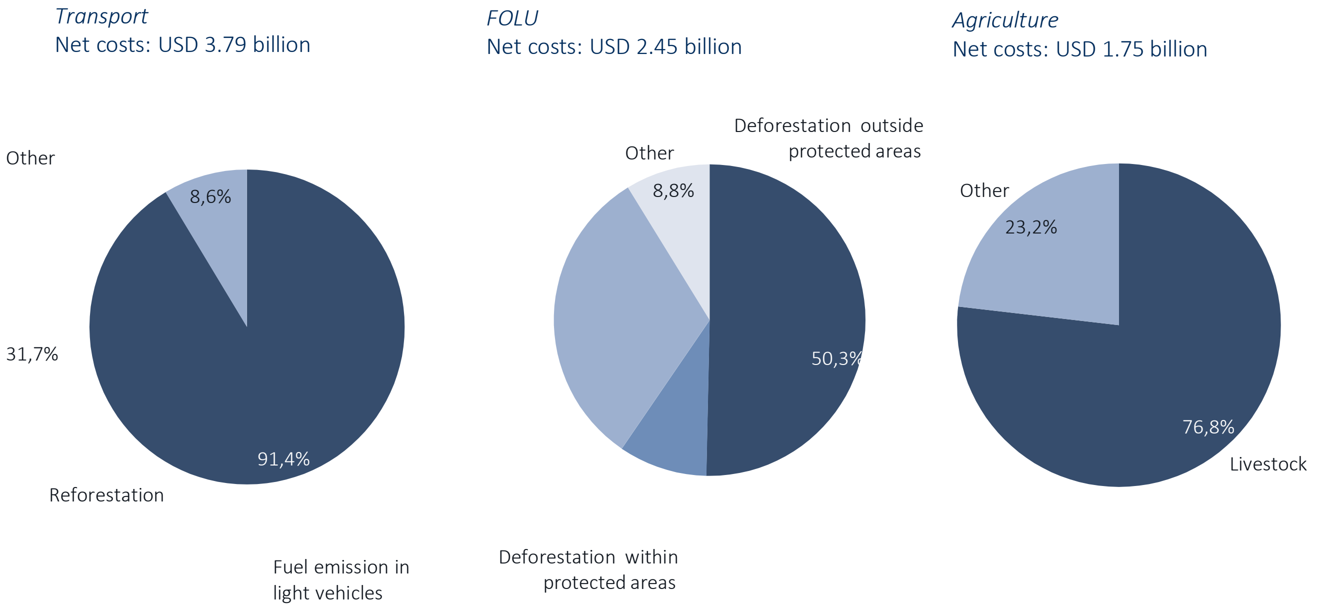
The high total cost for the transport masks a wide variation in the costs attributed to the range of different types of measures considered. As shown in the figure below, mitigation options arising from conventional vehicles, such as through increasing the uptake of biofuels, replacing fossil fueled cars and motorcycles with electric versions and introducing fuel standards makes up most of the costs. The "other" category includes increasing the adoption of electric golf cars and replacing fossil fueled buses with electric versions in both the inter and intra urban environment. Some measure, such as 'Attracting individual commuters to public transportation', the 'Increased uptake of bikes for urban transport' and the 'Introduction and implementation of fuel standards for diesel and gasoline vehicles' result in net negative costs (i.e., there are cost savings). However, in the HA and VHA scenarios considered, the greatest GHG reductions were achieved by the replacement of combustion engine vehicles with electric ones, and this is one of the most expensive mitigation options. It is anticipated that the cost of electric vehicles will reduce further as the technologies become more developed and their market penetration increases; hence, as discussed in the previous sectionthese costs may reduce in future years and therefore that presented may be over-estimated.

The relatively high proportion of costs attributed to FOLU are in line with those reported in other studies, most notably the Mexican work described above. There are many local site factors involved in the costs associated with the implementation of specific FOLU measures; however, the total sectoral cost presented is considered to be representative for the sector. There are no 'negative costs' in the FOLU sector, and all mitigation actions require significant investment costs and additional funding to be obtained.

In the agriculture sector, the costs are dominated by the measures associated with the 'Increase in Sustainable Livestock'. Although there is major CO_2 emission reduction potential from these measures, they are expensive to achieve. Costs related to livestock include reducing GHG emissions from livestock enteric fermentation, reducing the amount of land dedicated to pasture and reducing the amount of time required for cattle to reach maturity.

Figure 55 provides a more detailed breakdown of the net costs by mitigation action for transport, deforestation/ reforestation for FOLU and livestock for Agriculture.

Figure 55 Participation of key options in accumulated net costs by sector



Source: Vivid Economics and Aether analysis

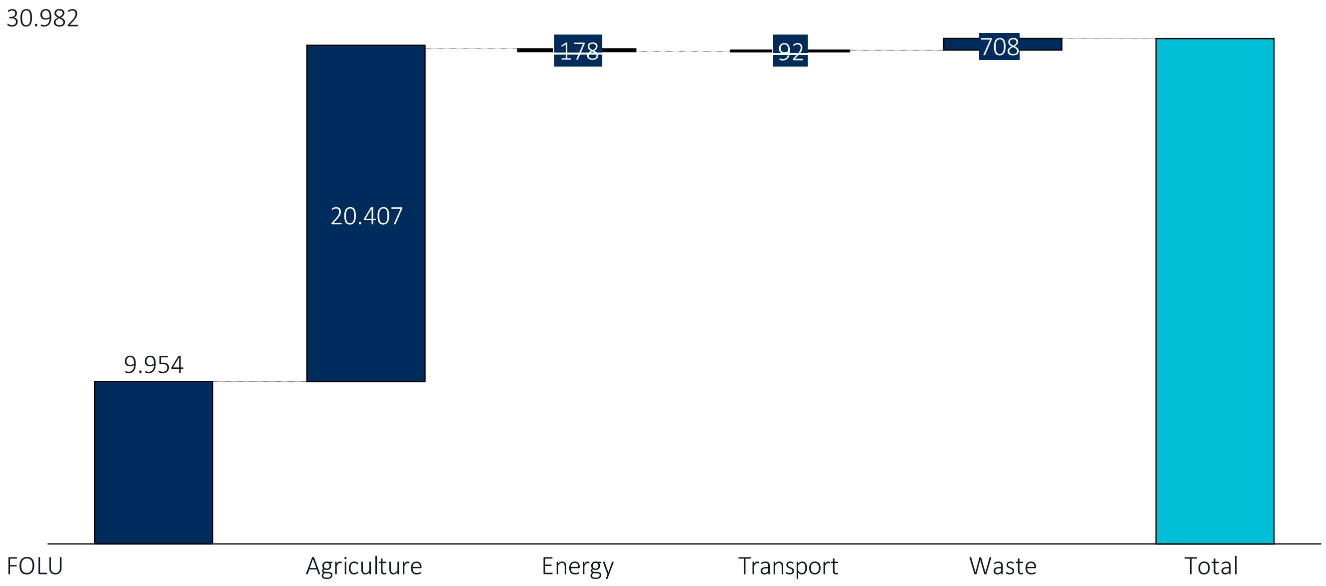
4.3 Approach to estimating supported jobs

The methodology for the estimation of jobs is based on an extensive study looking at the GHG mitigation potential in South Africa (Department of Environmental Affairs, 2014), which included detailed macroeconomic modelling. The modelling assessed the impacts on employment for individual measures and at a sectoral level. These factors have been used to provide an estimate of the impact on employment in Belize. It is recognized that the study is not for the Caribbean or Central America and therefore there will be uncertainty in the figures. However, this was thought to be the best dataset available, across a variety of mitigation options.

4.4 Potential impact on supporting new jobs

Mitigation actions in the FOLU and Agricultural sectors have been found to result in the most job benefits, as shown in Figure 56. In the South African study this was attributed to the fact that these sectors include many measures that are employment intensive. Although the same is likely to be true in Belize, it is recognized that there is a significant degree of uncertainty associated with these results.

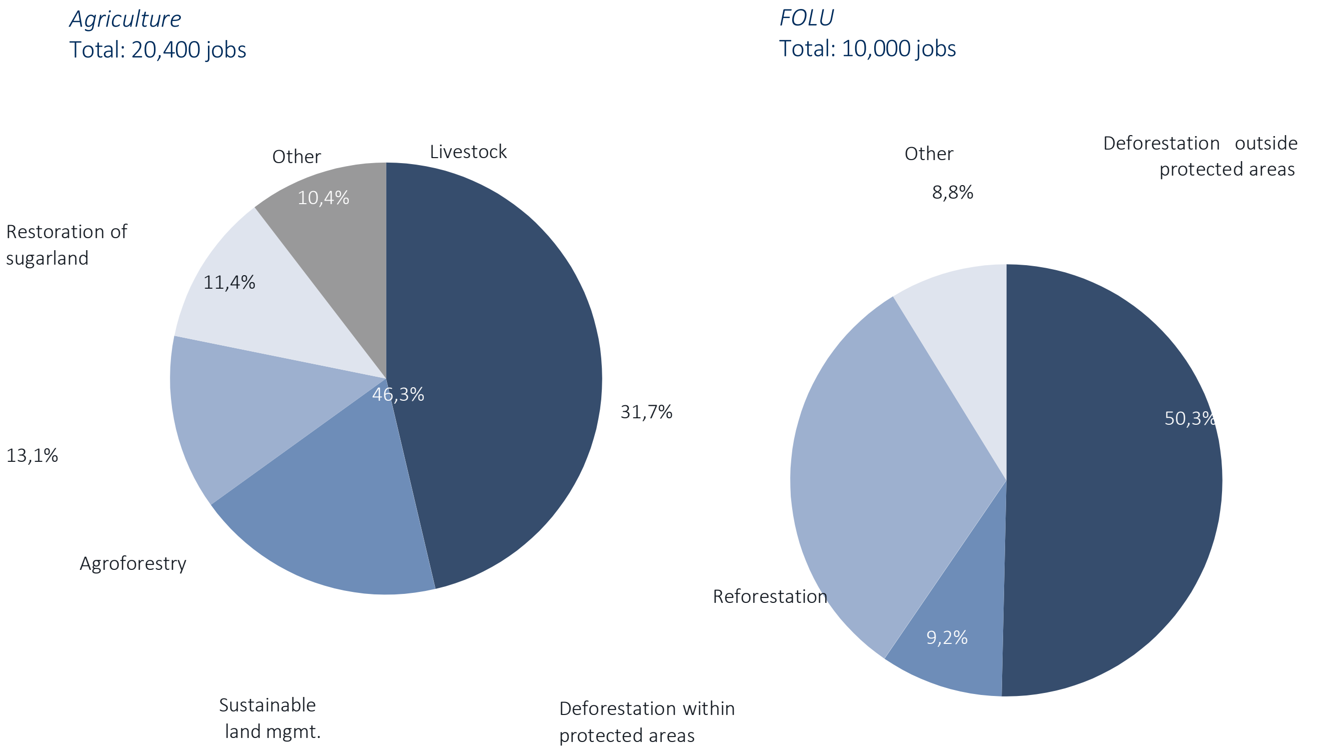
Figure 56 Estimate of total jobs supported by implementing mitigation options



Source: Vivid Economics and Aether analysis

Many jobs are predicted to be created alongside the GHG mitigation actions for the agriculture and FOLU sectors. On Agriculture, job creation is led by sustainable livestock and land management, including those in arable and livestock farming and in converting farmland to more appropriate uses. In the FOLU sector, reducing deforestation and reforestation activities support more jobs. Many jobs are expected to be created with reforestation, in particular due to the amounts of work required to plant trees, mangroves and seagrass meadows. A breakdown for the agriculture and FOLU sector is provided in the Figure 57.

Figure 57 Estimated job creation in the agriculture and FOLU sectors



Source: Vivid Economics and Aether analysis

On other sectors, job creation opportunities are more concentrated in particular activities. In the energy sector, jobs are primarily created through the installation of new technologies and products in the commercial and residential sectors, in the transport sector with the introduction of new technologies such asthe sales of electric vehicles and in the waste sector through the creation of recycling, composting and landfill sites.

5 Prioritization of mitigation options in each sector

After assessing the impact of mitigation options both in terms of reducing GHG emissions and their net impact in costs and jobs, this chapter focuses on supporting a prioritization of mitigation options.

While ideally all measures proposed in this document should be implemented in the course of 3 decades of duration of this policy, it is reasonable to expect that they will be implemented at different paces. This implementation pace should be affected by characteristics intrinsic to each mitigation option, as well as external conditions, such as budget and team availability. In a context of limited financial resources and administration capabilities, it is important to provide tools for decision makers to choose the most critical options to implement.

Within the context of LEDS, the prioritization of mitigation options was done through a combination of two dimensions: potential impact and ease to implement. For each dimension, we performed a multi-criteria assessment combining a variety of factors, with a score from 0 (lowest impact) to 4 (highest impact) attributed to each mitigation option and factor. Those factors were then combined through a weighted average, reaching two separate 0-4 scores. These scores were then plotted in bidimensional matrixes and the mitigation options in the top-right corner were considered priority ones, since they would present the best combination of potential impact and ease to implement. It is important to note that criteria, scores and factor weights were all attributed by the most critical stakeholders in each sector, through sector-specific consultations conducted in the first quarter of 2021.

The ease to implement analysis consists of a multi-criteria assessment of two groups of criteria with equal weights (50% each group): costs and enabling conditions. By their turn, each group was subdivided in two individual factors. The cost group was split in up-front investments and operational costs, both with the same weighting as well (total weight of 25% for each criterion); in both cases, the factor names were adjusted to "modest up-front investments" and "low operational costs", so that a high score was consideredpositive. The enabling conditions group was split into regulatory/ policy coordination and in-country technical expertise; in this case, the former factor was attributed a higher score (30%), with the remaining weight (20%) attributed to the latter. The justification was that regulatory and policy coordination aspects are usually more impactful and harder to build (technical expertise can be "imported", for instance). The definition of groups and factors and all the weights were validated and confirmed by sector stakeholders.

The potential impact is also a multi-criteria assessment, combining GHG mitigation impact and other impact factors. GHG mitigation is the only factor of the whole analysis that does not come from stakeholders' assessments but comes directly from the analyses performed in chapter 3. In order to combine this with other impact factors, the impact on emissions estimated in chapter 3 was converted to a 0-4 scale, in which the mitigation option with highest impact was attributed a 4 and the score of other mitigation options was a proportion in relation to the highest one. In case of outliers (when the top mitigation option of the sector has an impact much higher than all the others), a score of 4 was attributed to the top two mitigation optionsand the second highest impact was considered as the reference for the remaining scores.

The other factors composing the potential impact assessment were sector specific. For each sector, a preliminary set of sector-appropriated factors was proposed to stakeholders, who then would adjust, eliminate and/ or include new factors and then decide on relative weight for each one. In order to assure alignment with LEDS overall objectives, a minimum weight of 50% was considered for GHG mitigation, but actual weights (and associated scores) were decided by stakeholders during sector-specific consultations.

In the following section, we comment on the results of this analysis, including the decisions on weights, comparative scores and final prioritization.

5.1 FOLU

In the FOLU sector, stakeholders outlined additional factors: job creation, reduced water footprint, climate/ biological resilience and biodiversity & ecosystem protection. Stakeholders attributed a 60% weight for GHG mitigation and attributed equal weights to the remaining factors (10% each).

GHG mitigation is led by '1.1. Reduction of deforestation rate outside the Natural Protected Areas System', which has an impact much higher than all other measures (outlier). The second highest impact was '6.4. Reforest areas from degraded cropland', to which a 4 was attributed as well, and was the reference for calculation of remaining options. In addition to these two, other sub-options of option 6 (general reforestation) performed well in this indicator. In relation to other potential impact indicators:

- In 'Job Creation', active options such as reforestation performed slightly better than passive options (e.g., reducing deforestation);
- In 'Reduced Water Footprint', options related to riparian forests and mangroves performed a bit better than the others;
- In both, 'Climate/ Biological Resilience' and 'Biodiversity & Ecosystem protection', restoration measures performed better than others, since they proactively increase vegetation cover.

For the cost group of Ease to Implement, impact factor 'Modest Up-Front investment' was higher for passive measures (lower initial capital expenditures), while 'Low Operational Costs' was higher for active measures (closer to 'one-off' investments). The assessments, therefore, roughly compensate each other.

For the enabling conditions group of Ease to Implement, while '1.2. Reduction of deforestation rate in areas within the National Protected Areas Systems' stand out in 'Regulatory/ Policy Coordination', mangrove sub-options stand-out for 'In-Country Technical Expertise'.

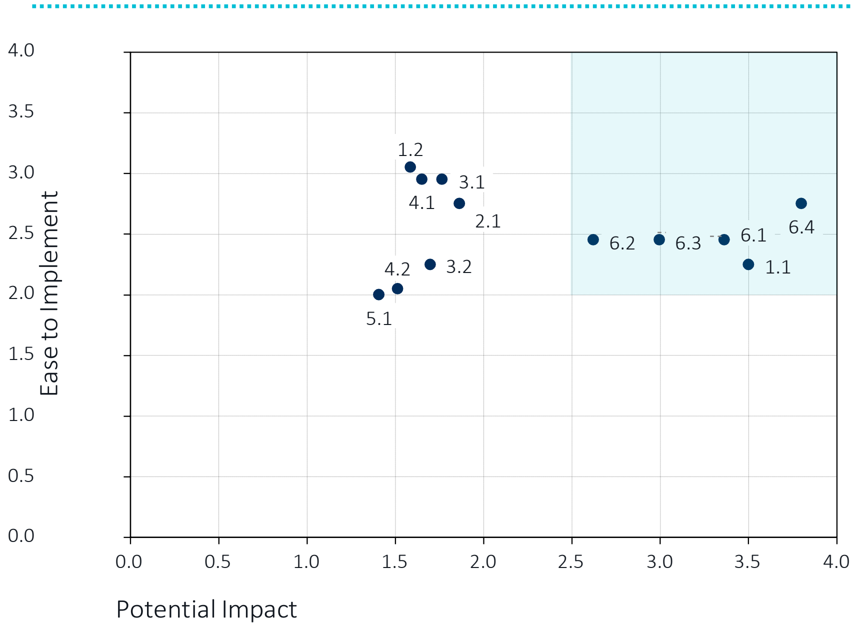
Figure 58 Assessment of FOLU options: potential impact and ease to implement

		Potential Impact					Ease to Implement			
Mitigation Option	Sub action	Mitigation	Job creation	Reduced Water Footprint	Climate/ Biological Resilience	Biodiversity & Ecosystem protection	Modest Up-Front Investment	Low Operational Cost	Regulatory/ Policy Coordination	In-Country Technical Expertise
Weights		60%	10%	10%	10%	10%	25%	25%	30%	20%
1. Reduction of deforestation rate	1.1. Reduction of deforestation rate outside Natural Protected Areas System	4.0	2.0	3.0	3.0	3.0	3	2	2	2
	1.2. Reduction of deforestation rate in areas within Natural Protected Areas System	0.8	2.0	3.0	3.0	3.0	3	2	4	3
2. Restore forests in key watersheds	2.1. Restore riparian forests	0.6	3.0	4.0	4.0	4.0	2	3	3	3
3. Avoided extraction of mangroves and seagrass meadows	3.1 Reduction of mangrove extraction rate	0.9	2.0	4.0	3.0	3.0	3	2	3	4
	3.2 Reduction seagrass meadow extraction rate	0.8	2.0	4.0	3.0	3.0	3	2	2	2
4. Restoration of mangroves and seagrass meadows	4.1. Restore mangroves from rewetting (w/ saline water)	0.2	3.0	4.0	4.0	4.0	2	3	3	[illegible]
	4.2. Restore seagrass meadows from rewetting (w/ saline water)	0.02	3.0	4.0	4.0	4.0	2	3	2	1
5. Improve prevention and control of forest fires.	5.1. Reduces forest area consumed by fire through prevention and control	0.5	2.0	3.0	3.0	3.0	2	2	2	2
6 Reforestation (secondary broad-leaf forests) inside and outside protected areas	6.1. Reforest areas from annual cropland	3.3	3.0	3.0	4.0	4.0	2	3	2	3
	6.2. Reforest areas from grassland	2.0	3.0	3.0	4.0	4.0	2	3	2	3
	6.3. Reforest areas from set-aside land	2.7	3.0	3.0	4.0	4.0	2	3	2	3
	6.4. Reforest areas from degraded cropland	4.0	3.0	3.0	4.0	4.0	2	3	3	3

Source: Vivid Economics and Lucid Solutions analysis

Reduction of deforestation and proactive reforestation have higher priority due to the good balance between potential impact and ease to implement. Since differences in Ease to implement are modest (most sub-options are positioned in the 2-3 range), the impact was mostly driven by potential impact, especially GHG mitigation.

Figure 59 Prioritization of options in the FOLU sector



Mitigation Option	Sub action
1. Reduction of deforestation rate	1.1. Reduction of deforestation rate outside Natural Protected Areas System
	1.2. Reduction of deforestation rate in areas within Natural Protected Areas System
2. Restoration of forests in key watersheds	2.1. Restoration of riparian forests
3. Avoided extraction of mangroves and seagrass meadows	3.1 Reduction of mangrove extraction rate
	3.2 Reduction of seagrass meadow extraction rate
4. Restoration of mangroves and seagrass meadows	4.1. Restoration of mangroves from rewetting (w/ saline water)
	4.2. Restoration of seagrass meadows from rewetting (w/ saline water)
5. Improved prevention and control of forest fires.	5.1. Reduced forest area consumed by fire through prevention and control
6 Reforestation (secondary broad-leaf forests) inside and outside protected areas	6.1. Reforestation of areas from annual cropland
	6.2. Reforestation of areas from grassland
	6.3. Reforestation of areas from set-aside land
	6.4. Reforestation of areas from degraded cropland

Source: Vivid Economics and Lucid Solutions analysis

5.2 Agriculture

In the Agriculture sector, stakeholders outlined additional factors: job creation, reduced water footprint, climate/ biological resilience and input usage efficiency. Stakeholders attributed a 60% weight for GHG mitigation and attributed equal weights to the remaining factors (10% each).

GHG mitigation is led by ‘1.1. Reduction of land dedicated to pastures’, which has an impact much higher than all other measures (outlier). The second highest impact was ‘1.2. Reduction of time required to cattle maturity’, to which was attributed a 4 as well and was the reference for calculation of remaining options. In addition to these two, sub-options ‘1.3. Reduction of emissions from enteric fermentation’ and ‘5.1. Restoration of arable sugar land’ performed well in this indicator. In relation to other potential impact indicators:

- In ‘Job Creation’, options related to introduction of silvoarable/ silvopasture systems (option 8) and waste management in coconut production tend to generate more jobs;
- In ‘Reduced Water Footprint’, impact is led by improvement of flooded rice (option 6) and green mechanical harvest (option 4), followed by improved agronomic practices (option 3);
- In ‘Climate/ Biological Resilience’, options related to introduction of silvoarable/ silvopasture systems (option 8), introduction of agroforestry systems (option 7) and intercropping (option 2) tend to have the highest impact;
- In ‘Input Usage Efficiency’, impact is led by options related to livestock (option 1) and improved agronomic practices (option 3).

For the cost group of Ease to Implement, green mechanical harvesting (option 4), restoration of degraded sugar land (option 5), and improvement of flooded rice (option 6) have better performance in 'Low Operational Costs'; green mechanical harvest (option 4) also leads in 'Modest Up-Front investment'.

For the enabling conditions group of Ease to Implement, measures related to sugarcane production stand out in 'Regulatory Policy Coordination', due to the higher sophistication of the sector and strength of producer associations. They also have better performance in terms of 'In-Country Technical Expertise', as well as sustainable livestock (option 1) and improved agronomic practices (option 3).

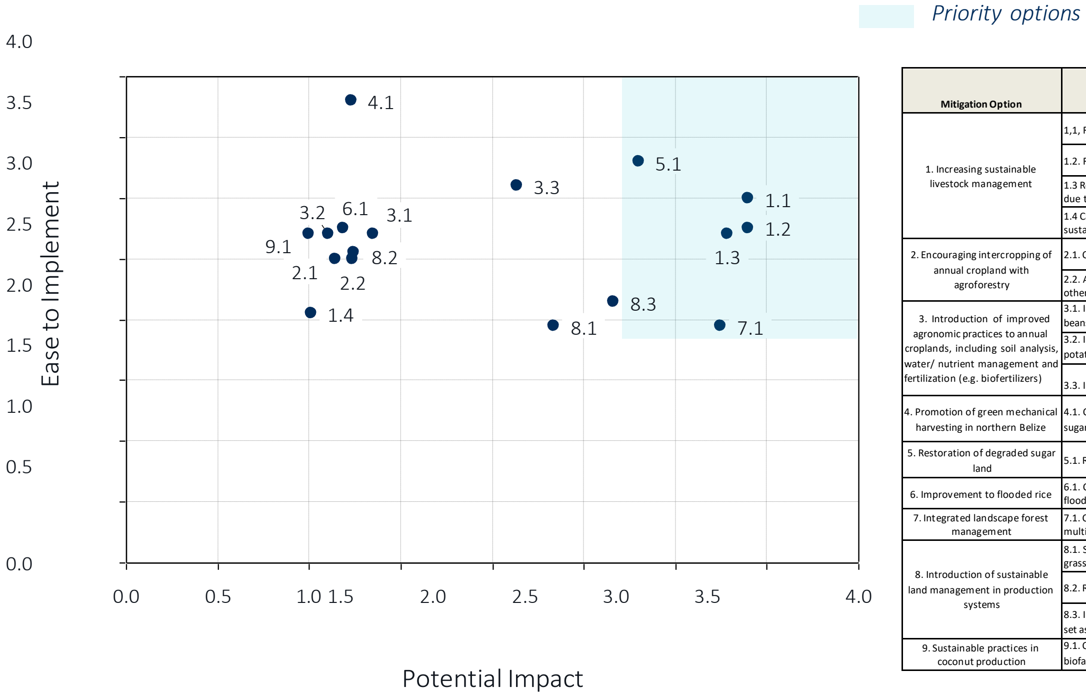
Figure 60 Assessment of Agriculture options: potential impact and ease to implement

		Potential Impact					Ease to Implement			
Mitigation Option	Sub action	Mitigation	Job creation	Reduced Water Footprint	Climate/ Biological Resilience	Input usage efficiency	Modest Up-Front Investment	Low Operational Cost	Regulatory/ Policy Coordination	In-Country Technical Expertise
Weights		60%	10%	10%	10%	10%	25%	25%	30%	20%
1. Increase sustainable livestock management	1,1, Reduction of land dedicated to pastures	4.0	2.0	2.0	2.0	4.0	3	3	3	3
	1.2. Reduction of time required to cattle maturity	4.0	2.0	2.0	2.0	4.0	2	3	3	3
	1.3 Reduction of emissions from enteric fermentation due to improved cattle feeding and probiotics	3.8	2.0	2.0	2.0	4.0	3	3	2	3
	1.4 Capture, store and treat animal manures sustainably, including probiotics	0.0	2.0	2.0	2.0	4.0	2	3	2	1
2. Encourage intercropping of annual cropland with agroforestry	2.1. Cover crop/ Intercropping in the coconut industry	0.1	2.0	2.0	4.0	3.0	3	3	2	2
	2.2. Agroforestry systems (hedgerows) introduced to other conventional annual cropland	0.2	2.0	2.0	4.0	3.0	3	3	2	2
3. Introduction of improved agronomic practices to annual croplands, including soil analysis, nutrient management/ fertilization (e.g. biofertilizers), and water management	3.1. Improved agronomic practices on crops (corn, RK beans and soybeans)	0.4	2.0	3.0	2.0	4.0	3	3	2	3
	3.2. Improved agronomic practices on vegetables and potatoes	0.0	2.0	3.0	2.0	4.0	3	3	2	3
	3.3. Improved agronomic practices on sugarcane	1.7	2.0	3.0	2.0	4.0	3	3	4	2
4. Promotion of green mechanical harvesting in northern Belize	4.1. Conversion of residue burning to retention of sugarcane cropland	0.2	2.0	4.0	2.0	3.0	4	4	4	3
5. Restoration of degraded sugar land	5.1. Restoration of arable sugar land	3.2	2.0	2.0	2.0	3.0	2	4	4	3
6. Improvement to flooded rice	6.1. Conversion of irrigated rice from continuously flooded to intermittently flooded single aeration	0.1	2.0	4.0	2.0	3.0	3	4	2	2
7. Integrated landscape forest management	7.1. Conversion of conventional annual croplands into multistrata agroforestry systems	[illegible]	2.0	2.0	4.0	3.0	2	3	1	2
8. Introduction of sustainable land management in production systems	8.1. Silvopasture systems introduced to non-degraded grasslands	1.9	3.0	2.0	4.0	3.0	2	3	1	2
	8.2. Restoration of moderately degraded grasslands	0.1	3.0	2.0	4.0	3.0	2	3	[illegible]	2
	8.3. Introduction of silvoarable agroforestry systems on set aside land	[illegible]	3.0	2.0	4.0	3.0	2	3	1	3
9. Sustainable practices in coconut production	9.1. Waste management (biochar, composting, biofabrics)	-	3.0	2.0	2.0	3.0	3	3	2	3

Source: Vivid Economics and Lucid Solutions analysis

Livestock options (1.1, 1.2, 1.3) have higher priority due to the good balance between potential impact and ease to implement. On other options, the restoration of sugar land (5.1) stands out for being relatively easy to implement, while retaining good impact. In addition, the conversion of croplands into agroforestry (7.1) has the highest impact (alongside livestock), despite having implementation a little more challenging.

Figure 61 Prioritization of options in the agriculture sector



Mitigation Option	Sub action
1. Increasing sustainable livestock management	1,1, Reduction of land dedicated to pastures
	1.2. Reduction of time required to cattle maturity
	1.3 Reduction of emissions from enteric fermentation due to improved feeding/ probiotics
	1.4 Capture, store and treat animal manures sustainably, including probiotics
2. Encouraging intercropping of annual cropland with agroforestry	2.1. Cover crop/ Intercropping in the coconut industry
	2.2. Agroforestry systems (hedgerows) introduced to other conventional annual cropland
3. Introduction of improved agronomic practices to annual croplands, including soil analysis, water/ nutrient management and fertilization (e.g. biofertilizers)	3.1. Improved agronomic practices on crops (corn, RK beans and soybeans)
	3.2. Improved agronomic practices on vegetables and potatoes
	3.3. Improved agronomic practices on sugarcane
4. Promotion of green mechanical harvesting in northern Belize	4.1. Conversion of residue burning to retention of sugarcane cropland
5. Restoration of degraded sugar land	5.1. Restoration of arable sugar land
6. Improvement to flooded rice	6.1. Conversion of irrigated rice from continuously flooded to intermittently flooded single aeration
7. Integrated landscape forest management	7.1. Conversion of conventional annual croplands into multistrata agroforestry systems
8. Introduction of sustainable land management in production systems	8.1. Silvopasture systems introduced to non-degraded grasslands
	8.2. Restoration of moderately degraded grasslands
	8.3. Introduction of silvoarable agroforestry systems on set aside land
9. Sustainable practices in coconut production	9.1. Coconut waste management (biochar, composting, biofabrics)

Source: Vivid Economics and Lucid Solutions analysis

5.3 Energy

In the Energy sector, stakeholders outlined additional factors: job creation, local environment, system resilience and energy access. Stakeholders attributed a 60% weight for GHG mitigation and attributed equal weights to the remaining factors (10% each).

In Energy Generation, GHG mitigation is led by '4.1. Installing new onshore wind power', which has an impact much higher than all other measures (outlier). The second highest impact was '2.1. Installing utility-scale solar power capacity', to which was attributed a 4 as well and was the reference for calculation of remaining options. In relation to other potential impact indicators:

- In 'Job Creation', no option stands out, but upgrading natural gas plants has the lowest impact;
- In 'Local Environment', options are led by utility-scale (option 2) and distributed solar power (option 3);
- In 'System Resilience', options are led by new capacity in natural gas generation (5.2), option which improves system's capacity of response to fluctuation of generation;
- In 'Energy Access', options are led by distributed solar power (option 3), which brings other consumers to the network through off-grid systems.

For the cost group of Ease to Implement, upgrading natural gas (5.1) is the impact leader in 'Modest Up-Front investment', while 'Low Operational Costs' was higher for renewables (options1, 2, 3 and 4).

For the enabling conditions group of Ease to Implement, while natural gas plants (option 5) and off-grid systems (option 3.1) stand out in 'Regulatory/ Policy Coordination', the latter also stand-out for 'In-Country Technical Expertise', as well as expansion of usage of bagasse for electricity generation.

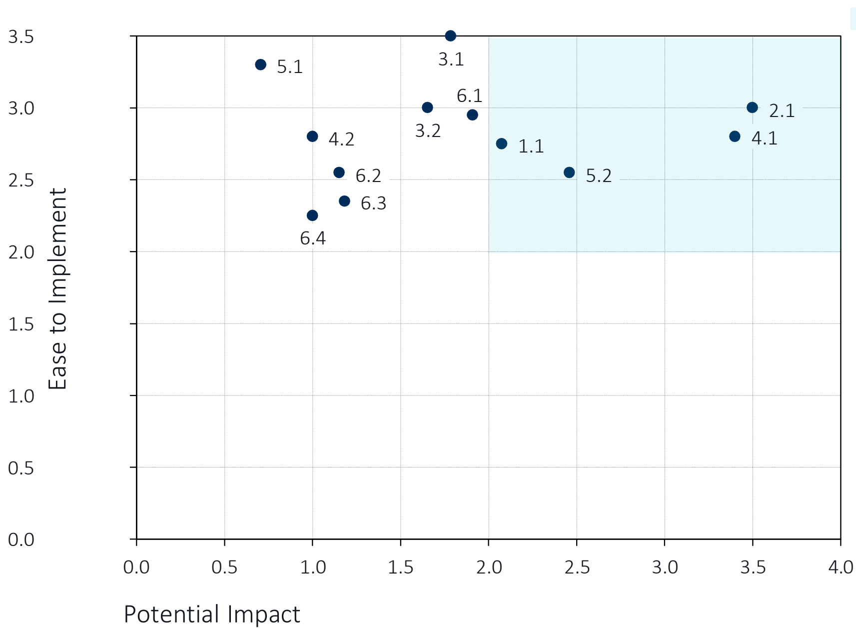
Figure 62 Assessment of energy generation options: potential impact and ease to implement

Mitigation Option	Sub action	Potential Impact: Mitigation	Potential Impact: Job creation	Potential Impact: Local environment	Potential Impact: System resilience	Potential Impact: Energy access	Ease to Implement: Modest Up-Front Investment	Ease to Implement: Low Operational Cost	Ease to Implement: Regulatory/ Policy Coordination	Ease to Implement: In-Country Technical Expertise
Weights		60%	10%	10%	10%	10%	25%	25%	30%	20%
1. Expand hydropower capacity	1.1. Installing new hydropower capacity	2.0	2.0	2.0	2.0	3.0	1	4	3	3
2. Expand grid solar power (utility-scale)	2.1. Installing utility-scale solar power capacity	4	2.0	4.0	2.0	3.0	2	4	3	3
3. Expand distributed solar power generation	3.1. Deploying off-grid solar PV and battery storagein rural villages without access to the national grid	0.8	2.0	4.0	3.0	4.0	2	4	4	4
	3.2. installing residential/ commercial solar panels, with support of net metering hardware and feebates	0.8	2.0	4.0	2.0	4.0	2	4	3	3
4. Introduce wind power generation	4.1. Installing new onshore wind power	4.0	2.0	3.0	2.0	3.0	2	4	3	2
	4.2. Installing new offshore wind power	0.0	2.0	3.0	2.0	3.0	2	4	3	2
5. Increase Natural Gas power generation as transition energy	5.1. Upgrading diesel-fueled power plants to accept natural gas	0.2	1.0	2.0	.0	1.0		2		3
	5.2. New capacity in natural gas generation	2.4	2.0	1.0	4.0	3.0	2	1	4	3
6. Expand and improve electricity generation from biomass	6.1. Expansion of usage of bagasse to electricity generation	1.5	2.0	2.0	3.0	3.0	2	3	3	4
	6.2. Conversion of Biochar to electricity generation	0.3	2.0	2.0	3.0	3.0	2	3	3	2
	6.3. Reduction of bagasse humidity content	0.3	2.0	2.0	3.0	3.0	2	3	3	1
	6.4. Electricity generation from biogas of agricultural residues	0.0	2.0	2.0	3.0	3.0	2	3	2	2

Source: Vivid Economics and Lucid Solutions analysis

Utility-scale solar (2.1) and wind power (4.1) are clearly the priority options in energy generation, due to the balance between potential impact and ease to implement. They are followed by natural gas (5.2) and hydropower (1.1), which have slightly lower performance on ease to implement and somewhat lower performance on potential impact.

Figure 63 Prioritization of options in energy generation



Mitigation Option	Sub action
1. Expansion of hydropower capacity	1.1. Installing new hydropower capacity
2. Expansion of grid solar power (utility-scale)	2.1. Installing utility-scale solar power capacity
3. Expansion of distributed solar power generation	3.1. Deploying off-grid solar PV and battery storage in rural villages without access to the national grid
	3.2. installing residential/ commercial solar panels, with support of net metering hardware and feebates
4. Introduction of wind power generation	4.1. Installing new onshore wind power
	4.2. Installing new offshore wind power
5. Increasing Natural Gas power generation as transition energy	5.1. Upgrading diesel-fueled power plants to accept natural gas
	5.2. New capacity in natural gas generation
6. Expansion and improvement of electricity generation from biomass	6.1. Expansion of usage of bagasse to electricity generation
	6.2. Conversion of Biochar to electricity generation
	6.3. Reduction of bagasse humidity content
	6.4. Electricity generation from biogas of agricultural residues

Source: Vivid Economics and Lucid Solutions analysis

In Energy Efficiency, GHG mitigation is led by '9. Efficiency improvement in water heating', using the same scale of Energy Generation; other efficiency options have a significantly lower performance in this factor. In relation to other potential impact indicators, measures generally do not stand out, but options of energy efficiency in lighting and appliances tend to have lower impact on jobs.

For the cost group of Ease to Implement, energy efficiency in appliances (option 11) clearly leads in both 'Modest Up-Front investment' and 'Low Operational Costs'. In the latter factor, reduction of transmission and distribution losses (option 7) also perform well.

For the enabling conditions group of Ease to Implement, reduction of transmission and distribution losses (option 7) and replacing incandescent lights by LED (option 10), are clearly the leaders in 'Regulatory/ Policy Coordination', as they are already at full speed implementation. LED lighting is also the leader in terms of 'In-Country Technical Expertise'.

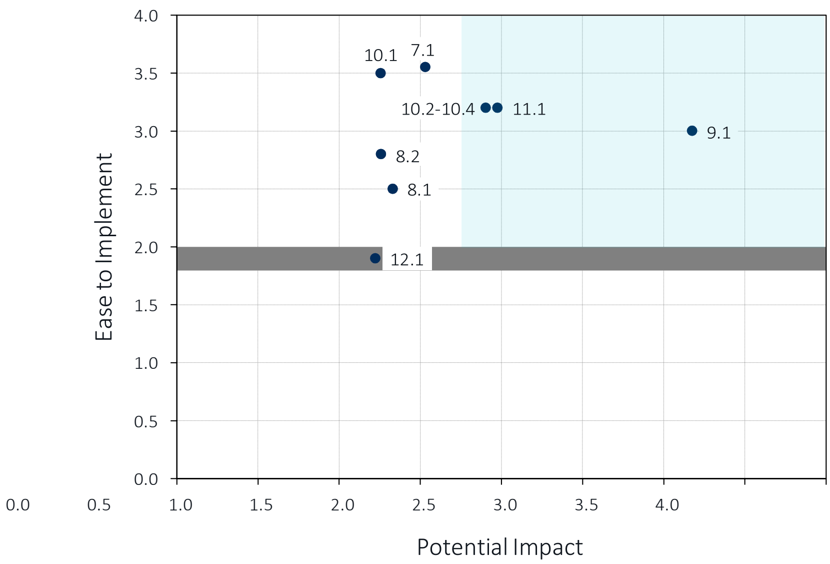
Figure 64 Assessment of energy efficiency options: potential impact and ease to implement

		Potential Impact					Ease to Implement			
Mitigation Option	Sub action	Mitigation	Job creation	Local environment	System resilience	Energy access	Modest Up-Front Investment	Low Operational Cost	Regulatory/ Policy Coordination	In-Country Technical Expertise
Weights		60%	10%	10%	10%	10%	25%	25%	30%	20%
7. Reduction in transmission and distribution losses	7.1. Reduction in losses from electricity transmission and distribution	0.9	2.0	3.0	3.0	2.0	3			3
8. Efficiency improvement on Space Cooling	8.1. Improving energy efficiency on space cooling in residential and commercial sectors	0.6	2.0	3.0	3.0	2.0	3	3	2	2
	8.2. Improving energy efficiency on space cooling in the public sector	0.4	2.0	3.0	3.0	2.0	3	3	3	2
9. Efficiency improvement on water heating	9.1. Commercial/ Residential - Switching away from LPG Boilers to electric and solar/heat pump	3.6	2.0	3.0	3.0	2.0	3	3	3	3
10. Efficiency improvement on lighting	10.1. Replacing incandescent street lights to LED	0.4	2.0	3.0	3.0	2.0	3	3	4	4
	10.2 to 10.4. Commercial/ Residential - switching away from incandescent and fluorescent to LED	1.7	1.0	3.0	3.0	2.0				4
11. Energy Efficiency on commercial, residential and public sector appliances	11.1. Reduction in electricity consumption on appliances due to EE standards, labels and feebates	1.8	1.0	3.0	3.0	2.0	4	4	2	3
12. Reduction of fuel wood consumption from cooking	12.1. Replacing wood for cooking by LPG, electricity, solar or other cleaner alternatives	0.4	2.0	3.0	3.0	2.0	2	2	1	3

Source: Vivid Economics and Lucid Solutions analysis

Water heating upgrade (9.1) is clearly the priority measure in Energy Efficiency, due to a much higher impact than all other measures. They are followed by efficiency on appliances (11.1) and LED lighting (10.2-10.4), in a somewhat distant second position.

Figure 65 Prioritization of options in energy efficiency



Priority options

Mitigation Option	Sub action
7. Reduction in transmission and distribution losses	electricity transmission and distribution
8. Efficiency improvement on Space Cooling	8.1. Improving energy efficiency on space cooling in residential and commercial sectors
	8.2. Improving energy efficiency on space cooling in the public sector
9. Efficiency improvement on water heating	9.1. Commercial/ Residential - Switching away from LPG Boilers to electric and solar/heat pump
10. Efficiency improvement on lighting	10.1.Replacing incandescent street lights to LED
	10.2 to 10.4. Commercial/ Residential - switching away from incandescent and flourescent to LED
11. Energy Efficiency on commercial, residential and public sector appliances	11.1. Reduction in electricity consumption on appliances due to EE standards, labels and feebates
12. Reduction of fuel wood consumption from cooking	12.1. Replacing wood for cooking by LPG, electricity, solar or other cleaner alternatives

Source: Vivid Economics and Lucid Solutions analysis

5.4 Transport

In the Transport sector, stakeholders outlined additional factors: job creation, improved air quality, public safety and transport congestion/ efficiency. Stakeholders attributed a 60% weight for GHG mitigation and attributed equal weights to the remaining factors (10% each).

GHG mitigation is led by '2.2. Replacing combustion cars with electric', which has an impact much higher than all other measures (outlier). The second highest impact was '3.2. Blend of ethanol in regular gasoline', to which was attributed a 4 as well and was the reference for calculation of remaining options. In addition tothese two, sub-option '1.5. Attracting individual customers to public transportation' performed relatively well in this indicator. In relation to other potential impact indicators:

- In 'Job Creation', options related to blending biodiesel and ethanol to regular fuels tend to have higher impact, since they stimulate the agricultural production value chain;
- In 'Improved Air Quality', options related to the introduction of electrical vehicles for buses (options 1.3 and 1.4), light vehicles (options 2.2 and 2.3), and last mile (options 5.1 and 5.2) clearly stand out;
- In both, 'Public Safety' and 'Transport Congestion/ Efficiency', options related to the public transit system have better performance, especially attracting commuters (option 1.5) and optimization of the system (option 1.1). Furthermore, last mile options (options 5.1 and 5.2) also have an important contribution in 'Transport Congestion/ Efficiency'.

For the cost group of Ease to Implement, impact factor 'Modest Up-Front investment' was higher for fuel efficiency measures (options 1.2, 2.1, 3,3, and 4.1), while 'Low Operational Costs' was higher for options related to the introduction of electrical vehicles for buses (options 1.3 and 1.4), light vehicles (options 2.2 and 2.3), and last mile (options 5.1 and 5.2).

For the enabling conditions group of Ease to Implement, the introduction of fuel standards is clearly the leader in both factors. In addition, increasing bike uptake (option 5.1) also stands out in 'Regulatory/ Policy Coordination', while blending ethanol in gasoline (option 3.2) also performs well for 'In-Country Technical Expertise'.

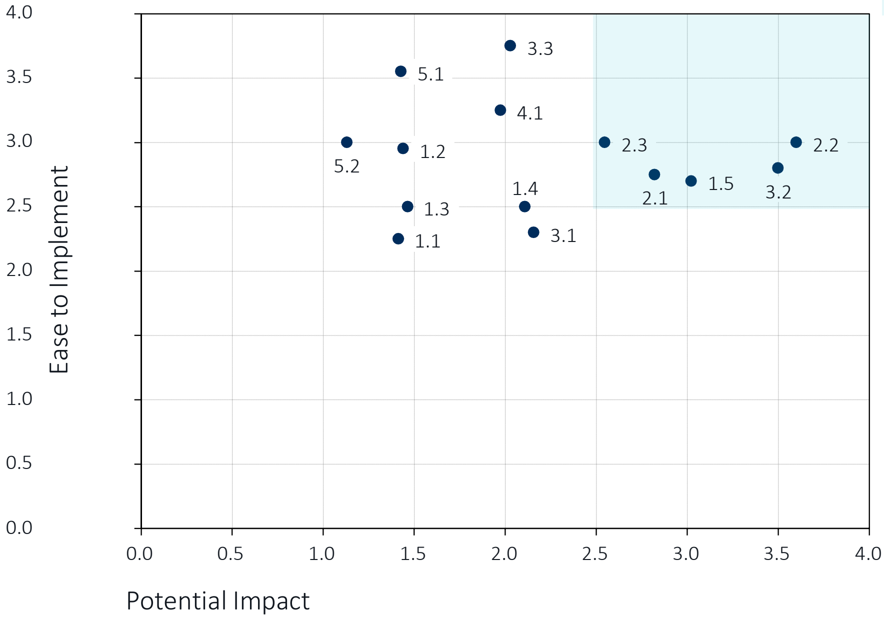
Figure 66 Assessment of Transport options: potential impact and ease to implement

Mitigation Option	Sub action	Potential Impact: Mitigation	Potential Impact: Job Creation	Potential Impact: Improved Air Quality	Potential Impact: Public Safety	Potential Impact: Transport Congestion/ Efficiency	Ease to Implement: Modest Up-Front Investment	Ease to Implement: Low Operational Cost	Ease to Implement: Regulatory/ Policy Coordination	Ease to Implement: In-Country Technical Expertise
Weights		60%	10%	10%	10%	10%	25%	25%	30%	20%
1.Reduction of fuel emissions in the public transit system	1.1. Optimization of transit system: redesign of urban routes, replacement of larger buses by minibuses/ vans	0.2	2.0	3.0	4.0	4.0	2.0	3.0	2.0	2.0
	1.2. Increasing fuel efficiency and fleet renewal	0.6	2.0	3.0	3.0	3.0	4.0	3.0	2.0	3.0
	1.3. Replacement of conventional by electrical buses (intra-district)	0.4	2.0	4.0	3.0	3.0	2.0	4.0	2.0	2.0
	1.4. Replacement of conventional by electrical buses (inter-district)	1.5	2.0	4.0	3.0	3.0	2.0	4.0	2.0	2.0
	1.5. Attracting individual commuters to public transportation	2.9	2.0	3.0	4.0	4.0	3.0	3.0	2.0	3.0
2. Reduction of fuel emissions across private and commercial light vehicles	2.1. Reducing the energy consumption in cars through fuel standards/ labels, tax incentives	2.9	2.0	3.0	3.0	3.0	4.0	3.0	2.0	2.0
	2.2. Replacing combustion cars with electric via import incentives	4	2.0	4.0	3.0	3.0	2.0	4.0	3.0	3.0
	2.3. Replacing combustion motorcycles with electric via import incentives	2.2	2.0	4.0	3.0	3.0	2.0	4.0	3.0	3.0
3. Improvement of fuel standards	3.1. Blend of biodiesel in regular diesel	1.8	3.0	3.0	2.0	3.0	3.0	3.0	2.0	1.0
	3.2. Blend of ethanol in regular gasoline	4	3.0	3.0	2.0	3.0	3.0	3.0	2.0	3.5
	3.3. Introduction of fuel standards in diesel and gasoline	1.7	2.0	3.0	2.0	3.0	4.0	3.0	4.0	4.0
4. Reduction of fuel emissions in freight transportation	4.1 Implementing regulations/ standards and fleet renewal for road freight vehicles	1.6	2.0	3.0	2.0	3.0	4.0	3.0	3.0	3.0
5. Encourage non-motorized modes of transport	5.1. Increased uptake of bikes for urban transportation	0.5	2.0	4.0	1.0	4.0	3.0	4.0	4.0	3.0
	5.2. Adoption of electric golf carts	0.1	2.0	4.0	1.0	4.0	2.0	4.0	3.0	3.0

Source: Vivid Economics and Lucid Solutions analysis

Overall, the adoption of electrical cars (options 2.2) and blending ethanol with gasoline (3.2) are priority measures due to higher potential impact. Other light vehicle options (2.1 and 2.3) and attracting commuters to buses (1.5) are also measures that strike a good balance between potential impact and ease to implement.

Figure 67 Prioritization of options in transport



Priority options

Mitigation Option	Sub action
1.Reduction of fuel emissions in the public transit system	1.1. Optimization of transit system: redesign of urban routes, replacement of larger buses by minibuses/ vans
	1.2. Increasing fuel efficiency and fleet renewal
	1.3. Replacement of conventional by electrical buses (intra-district)
	1.4. Replacement of conventional by electrical buses (inter-district)
	1.5. Attracting individual commuters to public transportation
2. Reduction of fuel emissions across private and commercial light vehicles	2.1. Reducing the energy consumption in cars through fuel standards/ labels, tax incentives
	2.2. Replacing combustion cars with electric via import incentives
	2.3. Replacing combustion motorcycles with electric via import incentives
3. Improvement of fuel standards	3.1. Blend of biodiesel in regular diesel
	3.2. Blend of ethanol in regular gasoline
	3.3. Introduction of fuel standards in diesel and gasoline
4. Reduction of emissions in trucks	4.1 Implementing regulations/ standards and fleet renewal for road freight vehicles
5. Encourage non-motorized modes of transport	5.1. Increased uptake of bikes for urban transportation
	5.2. Adoption of electric golf carts

Source: Vivid Economics and Lucid Solutions analysis

5.5 Waste

In the Waste sector, stakeholders outlined additional factors: job creation, public health/ safety, and input usage efficiency. Stakeholders attributed a 50% weight for GHG mitigation, 25% for public health/ safety, 15% for input usage efficiency, and 10% for job creation.

GHG mitigation is led by '2.1. Flaring methane on the National Landfill' and '1.3. Installing disposal sites in villages and start collecting rural waste'. In addition to these two, sub-option '2.2. Using methane of solid waste for biogas energy' performed relatively well in this indicator. In relation to other potential impact indicators:

- In 'Job Creation', options related to improved waste collection (option 1) and recycling/ composting (option 3) tend to create more jobs;
- In 'Public Health/ Safety', options related to improved waste collection (option 1) and wastewater (option 4) performed better than the others;
- In 'Input Usage Efficiency' is led by measures of recycling/ composting (option 3) and using solid waste methane for biogas energy (option 2.2).

In terms of 'Ease to Implement', impact factor 'Modest Up-Front investment' was higher for collecting and composting green waste (option 3.3), while 'Low Operational Costs' was higher for flaring methane at the landfill (option 2.1). The latter option also stands out in 'Regulatory/ Policy Coordination', while measures related to septic tanks (options 4.3 and 4.5) stand out for 'In-Country Technical Expertise'.

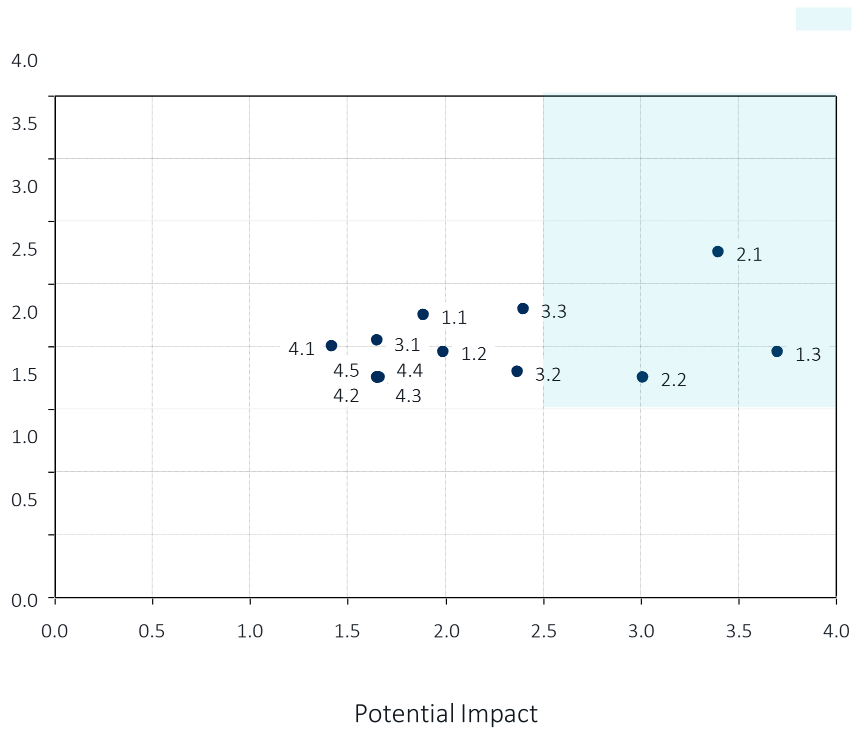
Figure 68 Assessment of Waste options potential impact and ease to implement

		Potential Impact				Ease to Implement			
Mitigation Option	Sub action	Mitigation	Job creation	Public Health/ Safety	Input usage efficiency	Modest Up-Front Investment	Low Operational Cost	Regulatory/ Policy Coordination	In-Country Technical Expertise
Weights		50%	10%	25%	15%	25%	25%	30%	20%
1. Improved waste collection and management	1.1. Expansion of National Landfill, absorbing waste from the capital's metropolitan area	0.3	3.0	4.0	3.0	3	3	3	3
	1.2. Expansion of collection from other urban areas to the National Landfill	0.5	3.0	4.0	3.0	3	2	3	3
	1.3. Installing disposal sites in villages and start collecting rural waste	3.9	3.0	4.0	3.0	3	2	3	3
2. Reduction of methane generation at the National Landfill	2.1.. Flaring methane on National Landfill to reduce emissions	4.0	2.0	3.0	3.0	3	4	4	2
	2.2. Using methane of solid waste for biogas energy	2.9	2.0	3.0	4.0	1	3	3	1
3. Reduction of solid waste volume by recycling	3.1. Collection and exporting of PET waste	0.0	3.0	3.0	4.0	3	3	2	3
	3.2. Installing recycling facilities at the National Landfill, at Tranfer stations and site collection	1.4	3.0	3.0	4.0	2	3	2	3
	3.3. Collecting and composting green waste	1.0	3.0	4.0	4.0	4	3	2	3
4. Reduction of GHG emissions in wastewater	4.1. Upgrading treatment systems (Belmopan)	0.05	2.0	3.0	3.0	2	3	3	3
	4.2. Incentivising residential connection to centralized sewage systems (CAPITAL)	0.01	2.0	4.0	3.0	1	3	3	3
	4.3. Incentivising the adoption of appropriate septic tanks, for wastewater not connected to pipes (CAPITAL)	0.01	2.0	4.0	3.0	3	2	2	4
	4.4. Incentivising residential connection to centralized sewage systems (OTHER AREAS)	0.03	2.0	4.0	3.0	1	3	3	1
	4.5. Incentivising the adoption of appropriate septic tanks, for wastewater not connected to pipes (OTHER AREAS)	0.01	2.0	4.0	3.0	3	2	2	4

Source: Vivid Economics and Lucid Solutions analysis

Reduction of methane at the landfill (option 2) and building a collection network for rural waste (1.3) are options that should have a higher priority due to the good balance between potential impact and ease to implement.

Figure 69 Prioritization of options in waste



Mitigation Option	Sub action
1. Improved waste collection and management	1.1. Expansion of National Landfill, absorbing waste from the capital's metropolitan area
	1.2. Expansion of collection from other urban areas to the National Landfill
	1.3. Installing disposal sites in villages and start collecting rural waste
2. Reduction of methane generation at the National Landfill	2.1. Flaring methane on National Landfill to reduce emissions
	2.2. Using methane of solid waste for biogas energy
3. Reduction of solid waste volume by recycling and composting	3.1. Collection and exporting of PET waste
	3.2. Installing recycling facilities at the National Landfill, at Transfer stations and site collection
	3.3. Collecting and composting green waste
4. Reduction of GHG emissions in wastewater	4.1. Upgrading treatment systems (Belmopan)
	4.2. Incentivizing residential connection to centralized sewage systems (CAPITAL)
	4.3. Incentivizing the adoption of appropriate septic tanks, for wastewater not connected to pipes (CAPITAL)
	4.4. Incentivizing residential connection to centralized sewage systems (OTHER AREAS)
	4.5. Incentivizing the adoption of appropriate septic tanks, for wastewater not connected to pipes (OTHER AREAS)

Source: Vivid Economics and Lucid Solutions analysis

6 High-Level Action Plan

This chapter describes LEDS Action Plan framework and explores obstacles and challenges to the implementation of mitigation options, as well as high-level interventions proposed to address those obstacles and challenges.

6.1 The Action Plan Framework

Belize's LEDS Action Plan framework is generally designed at a higher level of granularity. While the LEDS Action Plan presents specific interventions, responsibilities and timeframes, those features are defined at a higher level, which is appropriate to long duration of the LEDS (2020 -2050 period). Each mitigation sub- option typically has 2 to 5 high-level interventions associated with its critical challenges and barriers, rather than detailed activities required to execute them, as is customary for short-term plans. The LEDS timeframesare broad and include: very short-term (2020-25), short-term (2025-30), medium-term (2030-40), and long- term (2040-50). The responsibilities are assigned to institutions rather than individuals, to support constancyacross the long implementation period.

This Action Plan framework is a tool aimed at supporting alignment and influencing the design and revision of ancillary action plans related to Climate Change, such as the Nationally Determined Contributions (NDC) and the National Climate Change Policy Strategy and Action Plan (NCCPSAP). While timeframe of the LEDS is three decades, related action plans and strategies associated with climate change usually expire in 5 to 10 years and require revision or redesigning for the subsequent period. They are also much more detailed, deploying specific activities, responsibilities, milestones, and deadlines. The overarching principle is that the LEDS presents critical interventions that should be considered in these more detailed, immediate action plans. Therefore, the LEDS Action Plan should work as a guideline, informing and orienting the revision or redesign of current and future shorter-term policies.

The Action Plan framework evolves from sectors and mitigation options developed in previous phases. The sectors are the same as those used for the LEDS Concept, and the Action Plan is composed of five independent Sector Action Plans, with a total of 36 mitigations and 67 sub-options: FOLU (6 options, 12 sub-options), Agriculture (9 options, 17 sub-options), Energy (12 options, 20 sub-options), Transport (5 options, 15 sub-options), and Waste (4 options, 13 sub-options). For each sub-option, the framework presents target parameters and targets for Business-as-Usual (BAU), High Ambition (HA) and Very High Ambition (VHA), for three-time horizons (2030, 2040, and 2050), as defined by sector stakeholders. This can be seen in Figure 70below.

Figure 70 Presentation of targets in the Action Plan, illustration for the Energy sector

Mitigation Option	Sub Option	Target Parameter	Targets 2030			Targets 2040			Targets 2050		
			BAU	HA	VHA	BAU	HA	VHA	BAU	HA	VHA
1. Expansion of hydropower capacity	1.1. Installing new hydropower capacity	Installed hydropower capacity (MW)	55	74	74	55	74	74	55	74	74
2. Expansion of grid solar power (utility-scale)	2.1. Installing utility-scale solar power capacity	Installed grid solar power capacity (MW)	15	15	45	15	75	135	15	120	225

Source: Vivid Economics

The core of the Action Plan consists of barriers, interventions, timeframe and responsibilities. Building upon obstacles, barriers and gaps for the implementation of mitigation options identified in previous stages, the Action Plan framework identifies specific high-level interventions and activities required for overcoming the barriers and successfully implementing each sub-option (for instance, delivering distributed solar power in urban zones will probably require approving net-metering regulation in order to manage the relationship between power producing households and the electricity utility company). For each intervention leading responsibilities entities, supporting entities for implementation, and high-level implementation timeframes, were also identified. For the latter, broad timeframes were characterized in "very short-term" (2020-25 period, and category "1"), "short-term" (2025-30 period, and category "2"), "medium term" (2030-40 period, and category "3"), and "long-term" (2040-50 period, and category "4"). These are set out in Figure 71 below.

Figure 71 Presentation of barriers, interventions, timeframe and responsibilities in the Action Plan

Mitigation Option	Sub Option	Action Plan: Key Barriers/ Challenges	LEDS High-Level Interventions	Timeframe	Leading entity	Other critical stakeholders
1. Expansion of hydropower capacity	1.1. Installing new hydropower capacity	Existing and future uncertainties in water availablity due to climate change	Revise and implement National Integrated Management and National Water Plan	1	Energy Unit	Dept of Rural Transformation, Dept of Forestry, Dept of Natural Resources, Public Utilities Commission, Belize Electicity Limited, NGOs, Vulnerable Groups leaders, public
		Uncertainty on locations with the highest potential	Undertake feasiblity study to ascertain the best locations for hydropower plants in the country	1	Enegy Unit/ BEL	consultant, Dept of Forestry monitoring committee, Dept of Natural Resources, Dept of Lands, Vulnerable groups, Public
		High local environmental impact, especially due to dam construction	Assessing the environmental impact of the locations recommended in the feasiblity study	1	Energy Unit	consultant, BEL, Dept of Forestry monitoring committee, Dept of Lands, Vulnerable groups, Public
		Limited current capacity on renewables	Construct new hydropower plants	1	BEL	Developer, Energy Unit, PUC
2. Expansion of grid solar power (utility-scale)	2.1. Installing utility-scale solar power capacity	Uncertainty on locations with the highest potential	Undertake feasiblity study to ascertain the best locations for solar farms in the country	1	Enegy Unit/ BEL	consultant, Dept of Forestry monitoring committee, Dept of Natural Resources, Dept of Lands, Vulnerable groups, Public
		Limited current capacity on renewables	Build utility-scale solar farms	2	BEL	Developer, Energy Unit, PUC
		Lack of data regarding the overall maximum potential and ability to manage the variability.	Develop an electric grid optimisation study to ascertain the level of MW of solar power to be installed	1	Energy Unit	Consultant, Developer, BEL, PUC
		Limited incentives for installing solar PV panels	Reduce taxes on imported solar PV panels and study the possibility of a feed in tariff to pay solar PV owners for their contribution to the electricity grid	1	Energy Unit	Consultant, PUC, BEL, Economic Development Council, Assets and Utilities Care Unit, Dept of Economic Development

Source: Vivid Economics

Finally, the Action Plan Framework also includes additional guidelines for detailing activities and associated costs in the future. For each intervention, the framework explores potential cost implications, in one of four possible categories: consulting services, OPEX (operational expenditures of programs and initiatives such as training or educational campaigns), increased staff and administrative costs, and CAPEX (capital expenditures). It is of note that each one of these cost implications usually has detailed activities associated with it. For instance, a capital expenditure project is typically associated with the requirement for detailed designs, Environmental Impact Assessments, and supplier bidding processes, among others. This is illustratedin Figure 72 below.

Figure 72 Presentation of cost implications in the Action Plan, example of the Energy sector

		Plan	Resource requirements				
Mitigation Option	**Sub Option**	**LEDS High-Level Interventions**	**Cost implications**	**Consultancy**	**Program OPEX**	**Staff/ Adm.**	**CAPEX**
1. Expansion of hydropower capacity	1.1. Installing new hydropower capacity	Revise and implement National Integrated Management and National Water Plan	a. Consultancy to revise and suopport implementation of the Water Plan	✓			
		Undertake feasiblity study to ascertain the best locations for hydropower plants in the country	a. Consultancy to undertaking feasiblity study	✓			
		Assessing the environmental impact of the locations recommended in the feasiblity study	a. Consultancy to develop comprehensive studies of site, water, and overall grid design	✓			
		Construct new hydropower plants	a. CAPEX to install new hydro plants				✓
2. Expansion of grid solar power (utility-scale)	2.1. Installing utility-scale solar power capacity	Undertake feasiblity study to ascertain the best locations for solar farms in the country	a. Consultancy to undertaking feasiblity study	✓			
		Build utility-scale solar farms	a. CAPEX to install new solar farms and connect them to the grid				✓
		Develop an electric grid optimisation study to ascertain the level of MW of solar power to be installed	a. Consultancy to develop electricity grid optimisation study	✓			
		Reduce taxes on imported solar PV panels and study the possibility of a feed in tariff to pay solar PV owners for their contribution to the electricity grid	a. Consultancy to revise costs and incentives to the installation of solar PV systems	✓			

Source: Vivid Economics

In the next sections, we explore the high-level action plan for individual sectors. Recapping the ambition of each mitigation option through its VHA 2050 targets, we identify key barriers and challenges for implementation and propose potential high-level interventions. We also identify responsibilities, especially the leading entity that should be responsible for implementation. Finally, we also discuss suggested high-level timeframes for starting the implementation, in line with the features discussed above.

6.2 FOLU

The majority of interventions in deforestation were linked to creating an effective enforcing system. This starts with improving monitoring systems, strengthening field teams responsible for enforcing sanctions and revising regulations to ensure appropriate punishment for those involved in illegal acts (Figure 73).

Restoration of forests is both expensive and labour intensive requiring public-private collaboration. On theone hand, it is important to incentivize private sector interest, which can be achieved through a proper system of rewards, such as building a Payment for Ecosystems Services (PFES) scheme. On the other hand,investment in public restoration programs for degraded areas may be required for areas neglected by the private sector, as well as for accelerating the transition process. This particularly holds true for the restoration of riparian forests (Figure 73), the restoration of mangrove and seagrass meadows (Figure 74), as well as the general restoration of forest areas (Figure 75).

Figure 73 FOLU Action Plan: 1. Reduction of deforestation rate; 2. Restoration of forests in key watersheds

Mitigation Option	Sub Option	Target Parameter	BAU 2030	VHA 2050	Key Barriers/ Challenges	LEDS High-Level Interventions	Time frame	Leading entity
1. Reduction of deforestation rate	1.1. Reduction of deforestation rate outside Natural Protected Areas System	Annual deforestation rate outside Natural Protected Areas System (% forested area)	1.25%	0.40%	Current REDD+ monitoring system allows identifying primary deforestation sources (claiming title, hurricanes), but it does not have a trackable reporting system	Expand and Improve monitoring and information system	1	Forestry Dept
					Annual taxes for land use incentive conversion on 'unproductive' land. The lack of land use tiers in existing property tax structure incentivizes deforestation in non-protected areas.	Revise Land Tenure Act and associated taxes system so to establish minimum forest reserve requirements (especially on riparian forest areas) and those taxes increase with degradation (With exemption for native forests)	1	Forestry Dept
	1.2. Reduction of deforestation rate in areas within Natural Protected Areas System	Annual deforestation rate within Natural Protected Areas System (% forested area)	0.18%	0.00%	Deficient enforcement of illegal deforestation	Creation of a diverse, neutral monitoring unit for identifying illegal deforestation and enforcing sanctions	1	Forestry Dept
					Limited punishment for illegal	Revise legislation on protected areas so to	1	Forestry
2. Restoration of forests in key watersheds	2.1. Restoration of riparian forests	Area of riparian forests restored (ha)	-	6,000	Lack of clarity on stock of areas for potential restoration of riparian forests mangroves and seagrass	Map degraded riparian forests, mangroves and seagrass, prioritizing areas for potential restoration with estimated costs	1	Forestry Dept.
					Lack of financial incentives for private parties and NGOs to restore degraded areas	Design of a national Payment-for-Ecosystem Services (PFES) scheme, providing regular payments for investing on arrangements with higher level of carbon storage	3	Forestry Dept.
					Increasing stock of 'abandoned' degraded areas of riparian forests, mangroves and seagrass, amenable to restoration with the right actions.	Investment on a public restoration program for degraded 'wet forests' (riparian forests, mangroves and seagrass) without clear ownership, in partnership with intern. NGOs	2	NGOs

Source: Vivid Economics and Lucid Solutions analysis

There are indications that overlapping responsibilities for mangrove extraction and dredging may hinder efficient permitting and enforcement processes. There may be a lack of clarity in permitting requirements and granting guidelines between the two, as dredging and mangrove extraction activities often overlap, especially in rapidly developing tourist areas, which stakeholders identified as the most problematic. In all cases, it was concluded that the clause “at the discretion of the minister” in legislation limits informed and impartial decision making. Granting permitting authority to a regulatory committee representing diverse interests and aligning with a publicly transparent application review process with monitoring system capable of oversight would enhance efforts toward consistent, transparent processes and long-term planning (Figure74).

In addition, unintended consequences of decentralized authority were identified. Increased oversight and transparency is needed over existing coordination mechanisms, to ensure that the local perspective of impacts is also considered. Inversely, in some cases permission is granted at the municipal level without ministry oversight, precluding consideration of long-term land use goals which have been developed based on national mapping, grading, and monitoring data, as well as further limiting the equity and transparency of the permitting process and enforcement of sanctions.

Figure 74 FOLU Action Plan: 3. Avoided extraction of mangroves and seagrass meadows; 4. Restoration of mangroves and seagrass meadows

Mitigation Option	Sub Option	Target Parameter	BAU 2030	VHA 2050
3. Avoided extraction of mangroves and seagrass meadows	3.1 Reduction of mangrove extraction rate	Annual mangrove extraction rate (% of total mangrove area)	0.10%	0.01%
	3.2 Reduction of seagrass meadow extraction rate	Annual seagrass meadow extraction rate (% of total mangrove area)	0.05%	0.01%
4. Restoration of mangroves and seagrass meadows	4.1. Restoration of mangroves by rewetting (w/ saline water)	Area of mangroves restored by rewetting (ha)	-	1,000
	4.2. Restoration of seagrass meadows from rewetting (w/ saline water)	Area of seagrass meadows restored from rewetting (ha)	-	3,000

Key Barriers/ Challenges	LEDS High-Level Interventions	Time frame	Leading entity
Process to acquire permission extracting mangroves/ seagrass is excessively permissive. "At the discretion of the minister" clause in the Mangrove Act allows it to be easily waived or ignored.	Revise Mangrove Act and other laws to eliminate "at the discretion of the minister" clause, include seagrass and strengthening sanctions for extraction	1	Dept of Environment/ Forest Department
No clear governance of mangrove/ seagrass monitoring activities, especially in tourism development zones	Create a mangrove and seagrass governance committee, including DOE, NGOs, Fisheries, CZMAI, and public private, to oversee evaluation of extraction/ restoration and propose corrective actions	1	Dept of Environment/ Forest Department
Limited enforcement of the mangrove act in high extraction area and low response to reporting of extraction.	Create a mangrove and seagrass monitoring unit within DOE to strengthen monitoring, responses and apply sanctions for irregular extraction.	1	Dept of Environment/ Forest Department
Lack of clarity on stock of areas for potential restoration of riparian forests mangroves and seagrass	Map degraded riparian forests, mangroves and seagrass, prioritizing areas for potential restoration with estimated costs	1	CZMAI
Lack of financial incentives for private parties and NGOs to restore degraded areas	Design of a national Payment-for-Ecosystem Services (PFES) scheme, providing regular payments for investing on arrangements with higher level of carbon storage	3	CZMAI
Increasing stock of 'abandoned' degraded areas of riparian forests, mangroves and seagrass, amenable to restoration with the right actions.	Investment on a public restoration program for degraded 'wet forests' (riparian forests, mangroves and seagrass) without clear ownership, in partnership with international NGOs	2	CZMAI

Source: Vivid Economics and Lucid Solutions analysis

Improved governance also seems critical for improved prevention and control of forest fires. This includes more clarity of risk areas, improved governance structure of National and regional firefighting agencies, updating the regulatory framework to restrict burning activities, and expanding forest fire stations network and associated staff (Figure 75).

Figure 75 FOLU Action Plan: 5. Improved prevention and control of forest fires; 6. Reforestation (secondary broad-leaf) inside/ outside protected areas

Mitigation Option	Sub Option	Target Parameter	BAU 2030	VHA 2050
5. Improved prevention and control of forest fires.	5.1. Reduced forest area consumed by fire through prevention and control	Reduction of forest fires (% of 2020 level)	0%	88%
6. Reforestation (secondary broad-leaf forests) inside and outside protected areas	6.1. Reforestation of areas from annual cropland	Area reforested (ha) from annual cropland	-	33,000
	6.2. Reforestation of areas from grassland	Area reforested (ha) from grassland	-	33,000
	6.3. Reforestation of areas from set-aside land	Area reforested (ha) from set-aside land	-	33,000
	6.4. Reforestation of areas from degraded cropland	Area reforested (ha) from degraded land	-	33,000

Key Barriers/ Challenges	LEDS High-Level Interventions	Time frame	Leading entity
Uncertainty over areas of higher risk and resources required	National map of fire risk, prioritizing areas and estimating resources required for prevention and resource per area	1	National Fire Service
Lack of coordinated strategies in disaster planning among public authorities. Burning control enforcement is left at local level fire stations, with no subsidies.	Improve governance structure of National and regional firefighting agencies, with public-private participation and coordination with existing NGO and volunteers.	1	National Fire Service
Majority of fires have human origin and the enforcement/ control of burning activities is deficient. Law enforcement lacks authority to intervene	Update regulatory frameworks for restricting burning activities, authorizing action by law enforcement agents, strengthening enforcement and penalties	1	Consultant
Lack of technical resources and manpower for fire fighting	Expansion of forest fire stations network and associated staff	1	National Fire Service
Lack of clarity on stock of areas for potential reforestation	Detailed mapping of deforested and degraded areas across the country, prioritizing areas for potential reforestation with associated estimated costs	1	Forestry Dept / NGOs
Lack of financial incentives for private owners to reforest degraded areas	Design of a national Payment-for-Ecosystem Services (PFES) scheme, providing regular payments for investing on arrangements with higher level of carbon storage	3	Forestry Dept, .
Annual taxes for land use incentive conversion on 'unproductive' land	Revise Land Tenure Act and associated taxes so to establish min. forest reserve requirements and increasing taxes with degradation	1	Forestry Dept, .
Increasing stock of 'abandoned' degraded cropland/ pastures, amenable to restoration with the right actions.	investment on a public reforestation program or degraded areas without clear ownership, in partnership with international NGOs	2	Forestry Dept, .
Lack of manpower to plant the trees	Develop public awareness campaign to get volunteers to plant trees	1	NGOs

Source: Vivid Economics and Lucid Solutions analysis

Leading entities responsible for the implementation vary according to the mitigation option considered. While the Forest Department has a critical role on deforestation (option 1), restoration of riparian forests (option 2), and restoration of regular forests (option 6), the Department of Environment plays an important role in avoiding extraction of mangroves (option 3). The CZMAI is the relevant body responsible for the restoration of mangroves (option 4), and the National Fire services are essential for prevention and control of forest fires (option 5). A single or cooperative of Non-government Organizations (NGOs) and/ or a public private partnership will serve as the leading entity regarding activities related to identifying and prioritizing areas for increased enforcement, and the development of governance committees and public restoration projects. Where regulatory updates are called for, support as a key implementer is needed from the Ministryof Legal Affairs, but the corresponding department would develop the proposed framework. Similarly, it is assumed that the Economic Development Council is a key entity for fiscal based interventions.

6.3 Agriculture

Interventions identified across LEDS Agriculture actions fall into three key areas which include the development or revision of regulatory frameworks, developing and implementing financing and incentivization schemes, and implementing long-term oversight committees, and research and education partnerships and programs. Regulatory developments are called for to establish frameworks for implementing incentives and penalties, standard practices, restrictions on specific practices such as slash andburn, and prioritizing land restoration and other land use related goals shared with the FOLU sector. A lack ofknowledge regarding certain sustainable production techniques, such as coconut waste management, agroforestry and agronomics practices, and advanced irrigation were identified as a barrier.

Financing is particularly relevant for sustainable livestock management, as improvements require significant upfront investment. While techniques such as improved breeding and pasture recovery are very intensive in terms of capital expenditure, probiotics, improved feeding and manure management are accompanied by increased operational costs throughout the cattle life cycle, even though increased productivity and revenues more than compensate for the higher costs. The application of all these initiatives requires effective technical assistance and support for assuring the implementation is optimized to the conditions of individual producers (Figure 76).

Figure 76 Agriculture Action Plan: 1. Increasing sustainable livestock management

Mitigation Option	Sub Option	Target Parameter	BAU 2030	VHA 2050
1. Increasing sustainable livestock management	1,1, Reduction of land dedicated to pastures	Average cattle stocking rate (heads/ ha)	1.00	4.00
	1.2. Reduction of time required to cattle maturity	Average cattle slaughtering age (months)	60.00	44.00
	1.3 Reduction of emissions from enteric fermentation due to improved cattle feeding and probiotics	Reduction of emissions from enteric fermentation (% of total)	0.00	0.30
	1.4 Capture, store and treat animal manures sustainably, including probiotics	Reduction of emissions from manure (% 2020 level)	0.00	0.25

Key Barriers/ Challenges	LEDS High-Level Interventions	Time frame	Leading entity
Lack of knowledge on sustainable increase of stocking rate, feeding practices and manure management	Partnership with NGOs to provide training and a handbook to farmers on sustainable livestock practices	1	Dept of Agriculture
Lack of financial resources for investing on sustainable feeding, breeding, pasture recovery and manure mgmt. practices	Implement financing schemes to farmers investing on sustainable livestock practices	2	Dept of Agriculture
No existing regulatory framework to control stocking rate or pasture conversion on private lands	Develop Regulatory Framework to establish rates, incentives, and penalties forconversion of forests to pastures	1	Dept of Agriculture
Risk of overgrazed pastures in near future	Formalize long term oversight committee for monitoring livestock practices, natural resources, regulatory enforcement, and resource access	1	Dept of Agriculture
Lack of recognition to sustainable livestock practices	Creation of a national certification and award scheme for sustainable livestock practices	3	Dept of Agriculture
Possible increase in feeding costs for ranchers.	Implement financing schemes to farmers investing on sustainable livestock practices	2	Dept of Agriculture
Possibly difficult to access probiotics or certain feed	Partnership with the industry to increase availability of most advanced feeding inputs	2	Dept of Agriculture
Cost and difficulty of collecting highly dispersed manure from	Undertake a research project to assess the feasibility of collecting, storing and treating	1	Dept of Agriculture

Source: Vivid Economics and Lucid Solutions analysis

For intercropping (option 2), improved agronomic practices (option 3), improvement of flooded rice (option 6), introducing agroforestry systems (option 7), and sustainable practices in coconut production (option 9) the combination of financing and technical assistance is critical. On the one hand, restriction of financial resources requires the implementation of financing schemes to assure adoption. On the other, a partnershipwith NGOs to provide training and a handbook for farmers on best practices is critical to the effective implementation. In many cases, the presence of co-op structures may support the implementation, helping to reduce risk and disseminate knowledge (Figure 77, Figure 78 and Figure 79).

Figure 77 Agriculture Action Plan: 2. Encouraging intercropping of annual cropland with agroforestry; 3. Introduction of improved agronomic practices to annual croplands

Mitigation Option	Sub Option	Target Parameter	BAU 2030	VHA 2050
2. Encouraging intercropping of annual cropland with agroforestry	2.1. Cover crop/ Intercropping in the coconut industry	Area of cover crop/ intercropping within coconut production (ha)	0.00	5,000
	2.2. Agroforestry systems (hedgerows) introduced to other conventional annual cropland	Area of intercropping (hedgerows) within annual cropland (ha)	0.00	16,000
3. Introduction of improved agronomic practices to annual croplands, including soil analysis, water/ nutrient management, and fertilization (e.g. biofertilizers)	3.1. Improved agronomic practices on crops (corn, RK beans and soybeans)	Area of crops with improved soil and water practices (ha)	0.00	25,000
	3.2. Improved agronomic practices on vegetables and potatoes	Area of vegetables with improved soil and water practices (ha)	0.00	640
	3.3. Improved agronomic practices on sugarcane	Area of sugar land with improved soil and water practices (ha)	0.00	65,000

Key Barriers/ Challenges	LEDS High-Level Interventions	Time frame	Leading entity
Lack of knowledge of how to implement/ manage coconut intercropping	Partnership with NGOs to provide training and a handbook to farmers	1	Dept of Agriculture
Lack of financial resources for investing on sustainable coconut practices	Implement financing schemes to farmers adopting sustainable coconut practices and co-op structure	2	Dept of Agriculture
Lack of knowledge of how to manage hedgerows and select hedgerow crops.	Partnership with NGOs to provide training and a handbook to farmers on best practices for implementation	1	Dept of Agriculture
Lack of incentive to change farming systems to something new.	Implement financing schemes to farmers adopting intercropping/ hedgerows and co-op structure	2	Dept of Agriculture
Lack of guidelines and recognition for organic farming, and high certification costs	Develop Regulatory Framework that standardizes practice and supports organic certifications	1	Dept of Agriculture
Lack of knowledge by some farmers of how to use these farming systems.	Partnership with NGOs to provide training and a handbook to farmers on improved agronomic practices	1	Dept of Agriculture
Small farmer disadvantages and lack of financial resources for investing on improved practices	Implement financing schemes to farmers adopting co-op structure	2	Dept of Agriculture
Lack of knowledge regarding how to apply systems in sugarcane production.	Partnership with Sugar Associations to provide training and a handbook to farmers on improved sugarcane agronomic practices	1	Dept of Agriculture
Lack of financial resources for investing on improved sugarcane agronomic practices	Implement financing schemes to farmers in partnership with Sugar Associations	2	Dept of Agriculture

Source: Vivid Economics and Lucid Solutions analysis

For sugar lands, collaboration with the sugarcane associations may support the implementation of green mechanical harvesting (option 4) and restoration of degraded land (option 5). For green mechanical harvesting, a combination of regulatory adjustments (restriction of slash-and-burning practices) and support (design of an equipment sharing scheme) may be effective. For restoration, sugarcane associations may support the implementation of a program of gradual land restoration, including a package of incentives and financing.

Figure 78 Agriculture Action Plan: 4,5,6,7. Green Mechanical Harvesting, Restoration of Degraded Sugar Land,Improvement of Flooded Rice, and Integrated Landscape Management

Mitigation Option	Sub Option	Target Parameter	BAU 2030	VHA 2050	Key Barriers/ Challenges	LEDS High-Level Interventions	Time frame	Leading entity
4. Promotion of green mechanical harvesting in northern Belize	4.1. Conversion of residue burning to retention of sugarcane cropland	Area with residue retention on sugar cropland - elimination of 2nd burning (ha)	0.00	65,000	High implementation and equipment costs with no financial support	Design a equipment sharing scheme, in partnership with Sugarcane associations	3	Dept of Agriculture
					Possible cultural restrictions for farmers to abandon burning practices	Develop Regulatory Framework for restricting slash-and-burning practices	1	Dept of Agriculture
5. Restoration of degraded sugar land	5.1. Restoration of arable sugar land	Area of sugar land restored (ha)	0.00	65,000	Short-term revenues losses and financial investments required to land restoration	Design a program for gradual land restoration in conjunction with Sugar Associations, including prioritizations of areas, incentives/ subsidies and associated financing	2	Dept of Agriculture
6. Improvement to flooded rice	6.1. Conversion of irrigated rice from continuously flooded to intermittently flooded	Area of rice converted from continuously to intermittently flooded (ha)	0.00	3,600	Lack of knowledge on how to improve rice irrigation schemes	Partnership with NGOs to provide training and a handbook to farmers on improved rice irrigation techniques	1	Dept of Agriculture
					Limited financial resources for investing on improved irrigation	Implement financing schemes to farmers adopting co-op structure	2	Dept of Agriculture
7. Integrated landscape forest management	7.1. Conversion of annual croplands into multistate agroforestry systems	Area of annual croplands converted into multistate agroforestry systems (ha)	0.00	13,500	Lack of knowledge of how to manage an agroforestry farm.	Partnership with NGOs to provide training and a handbook to farmers on agroforestry systems	1	Dept of Agriculture
					Limited financial resources for investing on agroforestry systems	Implement financing schemes to farmers adopting co-op structure	2	Dept of Agriculture
					Limited maturity on distribution of agroforestry products	Partnership with NGOs to support for international marketing of high value agroforestry crops	2	Dept of Agriculture

Source: Vivid Economics and Lucid Solutions analysis

The introduction of silvopasture and silvoarable agroforestry (option 8) may need additional investments. In addition to needing upfront investments for land conversion, this mitigation option may not be profitable in many circumstances initially since they divert land from traditional croplands, requiring additional support to break-even. In this context, the design of a Payment-for-Ecosystems Services (PFES) that provides payments for higher carbon storage practices may be helpful to stimulate producer adoption, as was the case in the FOLU sector.

Figure 79 Agriculture Action Plan: 8. Introduction of sustainable land management in production systems; 9. Sustainable practices in coconut production

Mitigation Option	Sub Option	Target Parameter	BAU 2030	VHA 2050	Key Barriers/ Challenges	LEDS High-Level Interventions	Timeframe	Leading entity
8. Introduction of sustainable land management in production systems	8.1. Silvopasture systems introduced to non-degraded grasslands	Area of non-degraded grasslands converted to silvopasture (ha)	0.00	10,000	There is an initial cost (investment cost) to transition e to silvopasture and silvoarable systems.	Implement financing schemes to farmers adopting co-op structure	2	Dept of Agriculture
					Training will be needed on how to implement & manage this type of system.	Partnership with NGOs to provide training and a handbook to farmers on silvopasture and sivoarable systems	1	Dept of Agriculture
	8.2. Restoration of moderately degraded grasslands	Area of moderately degraded grasslands converted to silvopasture (ha)	0.00	10,000	Lack of financial incentives for farmers to convert to silvoarable and silvopasture systems	Design of a national Payment-for-Ecosystem Services (PFES) scheme, which will provide payments for investing on arrangement with higher level of carbon storage	3	Dept of Agriculture
	8.3. Introduction of silvoarable agroforestry systems on set aside land	Area of set aside land converted to silvoarable agroforestry (ha)	0.00	10,000	Cultural resistance to invest on silvoarable systems on set-aside land	Revise regulation to establish minimum environmental requirements and reduce fee/ taxes on set-aside land	1	Dept of Agriculture
9. Sustainable practices in coconut production	9.1. Coconut waste management (biochar, composting, biofabrics)	Volume of coconut waste managed sustainably (tonnes)	0.00	800,000	Lack of knowledge on techniques for coconut waste management	Partnership with NGOs to provide training and a handbook to farmers on sustainable coconut practices	1	Dept of Ag, Coconut farmers
					Lack of coordination among coconut farmers and limited financial resources for investing on infrastructure and equipment to manage waste.	Implement financing schemes to farmers investing on sustainable coconut practices and adopting co-op structure	2	Dept of Agriculture
					High cost of transporting / distributing coconut waste	Partnership with NGOs to provide coconut waste logistical support to farmers	2	Dept of Ag, Coconut farmers

Source: Vivid Economics and Lucid Solutions analysis

The Department of Agriculture was prescribed as the leading entity for all LEDS Agriculture sub-actions except for two actions in sustainable coconut production, which require robust participation of existing commercial coconut farmers. However, partnering stakeholders identified across Agriculture goals include some of the broadest representation of any sector including the Economic Development Council, MarketingCorporations, NGOs, and varied industry associations.

Partnering public and private entities with NGOs is a key intervention which will enable goals across diverse LEDS Agriculture actions including logistical coordination, and education programs and printed guides. In addition to support for initiating public-private and non-profit initiatives, investing in the adoption of a sustainable co-op will support several LEDs actions which coordinate shared resources from equipment to market assistance. Investment financing schemes are also needed to support infrastructure development for agricultural waste handling, and the development of a National Payment for Ecosystem Services (PFES), a framework goal shared with the FOLU sector. Stakeholders determined that the establishment of the prescribed partnerships should be pursued as a very short-term goal, as this was considered one of the easiest interventions to implement while also having a broad and immediate effect, especially in enabling certification programs which may be executed well in advance of regulatory updates that will likely take longer.

6.4 Energy

New hydropower (option 1) installations face severe implementation obstacles that constrain future installations. Despite current relevance of the source, sector stakeholders expressed doubts about future expansion and project a future growth of only 40% in the next 3 decades, the majority in the short-term. Future challenges involve an integrated approach on management of water resources, feasibility studies for new locations and environmental impact studies to assess and address potential negative consequences.

For grid-solar power (option 2) and wind power (option 4), location and grid optimization are critical. The country expects an accelerated growth in installed capacity, leading to challenges on how to execute such an ambitious expansion in an effective manner. In this regard, identifying optimal locations for investment and assessing smart solutions to address production variability through grid optimization are priority interventions.

Figure 80 Energy Action Plan: 1. Expansion of hydropower capacity; 2. Expansion of grid solar power (utility-scale)

Mitigation Option	Sub Option	Target Parameter	BAU 2030	VHA 2050	Key Barriers/ Challenges	LEDS High-Level Interventions	Timeframe	Leading entity
1. Expansion of hydropower capacity	1.1. Installing new hydropower capacity	Installed hydropower capacity (MW)	55	74	Existing and future uncertainties in water availability due to climate change	Revise and implement National Integrated Management and National Water Plan	1	Energy Unit
					Uncertainty on locations with the highest potential	Undertake feasibility study to ascertain the best locations for hydropower plants in the country	1	Energy Unit/ BEL
					High local environmental impact, especially due to dam construction	Assessing the environmental impact of the locations recommended in the feasibility study	1	Energy Unit
					Limited current capacity on renewables	Construct new hydropower plants	1	BEL
2. Expansion of grid solar power (utility-scale)	2.1. Installing utility-scale solar power capacity	Installed grid solar power capacity (MW)	15	225	Uncertainty on locations with the highest potential	Undertake feasibility study to ascertain the best locations for solar farms in the country	1	Energy Unit/ BEL
					Limited current capacity on renewables	Build utility-scale solar farms	2	BEL
					Lack of data regarding the overall maximum potential and ability to manage the variability.	Develop an electric grid optimization study to ascertain the level of MW of solar power to be installed	1	Energy Unit
					Limited incentives for installing solar PV panels	Reduce taxes on imported solar PV panels and study the possibility of a feed in tariff to pay solar PV owners for their contribution to the electricity grid	1	Energy Unit

Source: Vivid Economics and Lucid Solutions analysis

Adoption of distributed solar power (option 3) demands net metering regulation. The bulk of expansion of distributed solar power should come from users currently connected to the grid and wishing to reduce electricity bills. In this context, the most relevant challenge to address is to ensure a productive relationship with the utility company that incentivizes individual investment in solar panel systems. In addition, financing schemes that spread expenditure over the lifetime of the system should also help to make the investment case more obvious to willing consumers.

Figure 81 Energy Action Plan: 3. Expansion of distributed solar power generation

Mitigation Option	Sub Option	Target Parameter	BAU 2030	VHA 2050	Key Barriers/ Challenges	LEDS High-Level Interventions	Timeframe	Leading entity
3. Expansion of distributed solar power generation	3.1. Deploying off-grid solar PV and battery storage in rural villages without access to the national grid	Share of population dependent on off-grid diesel generators (% of total)	8%	0%	Uncertainty on priority locations for off-grid systems	Study priority locations for investment	1	Energy Unit
					Lack of technical expertise to install solar panels and operations/ maintenance challenges of rural areas	Provide training programs to local technicians on rural communities	1	Energy Unit
					Many rural communities are not connected to the national grid and are dependent on fossil fuel generators	Install off-grid solar systems on prioritized rural communities	2	Energy Unit
	3.2. installing residential/ commercial solar panels, with support of net metering hardware and feebates	Number of urban household and commercial accounts utilizing solar installations	-	24,000	Lack of financial resources and incentives for owners to invest	Update regulatory frameworks to accommodate net metering and incentivize uptake through feebates and taxes	1	Energy Unit
					Condition of existing meter equipment and transformers do not accommodate net metering	Upgrade transformers and metering infrastructure for net metering	2	BEL
					High level of upfront investments	Implement financing schemes to households investing on solar systems	2	Energy Unit

Source: Vivid Economics and Lucid Solutions analysis

Upgrading existing diesel-fueled plans (option 5) requires natural gas distribution. Investing in upgrading existing diesel-fueled to also accept natural gas (NG) looks like a relatively straight-forward choice: it allows a reduction of operational costs, reduction of GHG emissions, increased fuel flexibility and it is a relatively inexpensive investment. The challenge to address, however, is to create the means to deliver NG to the plant in a cost-effective fashion. The implementation of an NG distribution network will also allow the installation of new NG plants and may have positive spillovers on the overall economy, allowing expanding usage of the fuel across residential and commercial user segments.

Figure 82 Energy Action Plan: 4. Introduction of wind power generation; 5. Increasing Natural Gas power generation as transition energy

Mitigation Option	Sub Option	Target Parameter	BAU 2030	VHA 2050
4. Introduction of wind power generation	4.1. Installing new onshore wind power	Installed onshore wind power capacity (MW)	-	75
	4.2. Installing new offshore wind power	Installed offshore wind power capacity (MW)	-	-
5. Increasing Natural Gas power generation as transition energy	5.1. Upgrading diesel-fueled power plants to accept natural gas	Diesel-fueled power capacity upgraded to natural gas (MW)	-	24
	5.2. New capacity in natural gas generation	Installed natural gas power capacity (MW)	21	27

Key Barriers/ Challenges	LEDS High-Level Interventions	Time frame	Leading entity
Lack of information on the best locations for installing onshore wind power	Complete current USTDA-funded solar and wind resource assessments in coordination with hydro met	1	Energy Unit
Limited current capacity on renewables	Build utility-scale onshore wind power plants	2	BEL
Lack of technical expertise to install wind turbines and connect them to the grid	Identify technical knowledge and a training programme to share knowledge	1	BEL
Limited current capacity on renewables	Build utility-scale offshore wind power plants	3	BEL
perceived and real concerns regarding environmental impact	Assessing the environmental impact of the locations recommended in the feasibility study	1	Energy Unit
NG cannot come in through common port area and there are doubts of feasibility of pipeline construction	Design for efficient and safe NG distribution	1	BEL
Current diesel-fueled power plants have higher than needed annual OPEX and GHG emissions	Install upgrade equipment in existing plants	1	BEL
Current diesel-fueled power plants have higher than needed annual OPEX and GHG emissions	Construct new NG power plants	3	BEL

a better coordination between plants and sugarcane producers and through an increase in the productivity of the industry itself (higher ratios of tons/ ha harvested).

Figure 83 Energy Action Plan: 6. Expansion and improvement of electricity generation from biomass

Mitigation Option	Sub Option	Target Parameter	BAU 2030	VHA 2050
6. Expansion and improvement of electricity generation from biomass	6.1. Expansion of usage of bagasse to electricity generation	Increase in biomass combusted for energy (tons)	-	600,000
	6.2. Conversion of Biochar to electricity generation	Volume of coconut waste (tonnes)	-	100,000
	6.3. Reduction of bagasse humidity content	Reduce emissions/ ton of biomass combusted (% of 2020 level)	0	20
	6.4. Electricity generation from biomass of agricultural residues	Electricity generating capacity from biogas (MW)	0	7

Key Barriers/ Challenges	LEDS High-Level Interventions	Time frame	Leading entity
Limited biomass production, dependent on the market status of sugarcane	Expanding productivity of sugarcane production (from around 50 to 70 ton/ ha), in partnership with Sugar Associations	2	Energy Unit
Uncertainty on environmental impact of biomass generation	Evaluation of impact of fire on soils' physical, chemical and biological properties in sugarcane and assessment of ground water availability	1	Energy Unit
Current Biomass generation infrastructure is maxed out	Identify investors and construct additional facilities (either modular design or the use of mini pyrolysis plants could be considered)	3	BEL
Regulatory framework interferes with direct sales, reducing availability of biomass	Update regulatory framework so that producers can sell biomass directly to power plants	1	Energy Unit
Needs strengthened distribution infrastructure for agricultural byproduct	Building a logistical system for sugarcane biomass, biochar, and agriculture residues	2	BEL
Limited coordination between agriculture and power sectors reduces availability of sugarcane biomass, biochar and agriculture residues	Expand and formalize coordination mechanism between BEL and agriculture	1	Energy Unit
Current biomass generation infrastructure is focused on sugarcane and maxed out	Installment of pyrolysis plants for converting biochar and agriculture residues in electricity	3	BEL
Limited usage of equipment for drying bagasse, resulting in lower energy generation and higher utilization of fossil fuels for co-	Expanding availability of equipment for drying bagasse	2	BEL

Source: Vivid Economics and Lucid Solutions analysis

Upgrading regulation may accelerate energy efficiency in buildings (option 8). Revising the National Building Code is a long-standing challenge for Belizean construction industry and should include proactive climatic tiered standards that allow for quantification of energy efficiency in buildings. This should be combined with programs to appropriately manage building efficiency performance.

Incentivization programs are critical for energy efficiency in buildings (option 8), efficiency improvement in water heating (option 9), and energy efficiency in appliances (option 11). The relatively high levels of CAPEX required to implement energy efficiency can be addressed both by incentivization programs that reduce total burden as well as financing schemes that spread expenditure across the lifetime of the investment.

Figure 84 Energy Action Plan: 8. Improve energy efficiency in Buildings; 9. Efficiency improvement on water heating

Mitigation Option	Sub Option	Target Parameter	BAU 2030	VHA 2050
8. Improve energy efficiency in Buildings	8.1 Improving energy efficiency on space cooling in residential and commercial sectors	Reduction of electricity consumption on residential and commercial sector (% of BAU)	0%	50%
	8.2 Improving energy efficiency on space cooling in the public sector	Reduction of electricity consumption on public buildings (% of BAU)	0%	50%
9. Efficiency improvement on water heating	9.1 to 9.4. Commercial/ Residential - Switching away from LPG Boilers to electric and solar/heat pump	Share LPG boilers (% total)	70%	0%
		Share Electric heaters (% total)	30%	0%
		Share Solar Thermal (% total)	0%	80%
		Share Heat Pumps (% total)	0%	20%

Key Barriers/ Challenges	LEDS High-Level Interventions	Time frame	Leading entity
Lack of national building code inhibits climate-based design building programs (high performance buildings)	Finalize National Building Code to include tier for climatic design construction and EIU measures	1	Dept of Housing, Consortium or Consultant
Limited expertise on quantifiable high performance building measures	Develop incentivization programs for high performing building design and construction and EE products	1	Consortium, Dept of Housing, Energy Unit
Existing standard code enforcement needs reformation and no qualified personnel to train certifiers for high performance tiers.	Program to manage building performance and training of officials and high-performance certifiers, and to manage qualified product programs.	1	Consortium, Dept of Housing, Energy Unit
Billing framework for public buildings disincentivizes consumption reduction measures	Adjust framework moving responsibility and budgeting of energy consumption costs to department level	1	Energy Unit
Uncertainty on EE of appliances	Establish appliance rating programs, defining EE standards and labeling EE for appliances leading sales on each category	1	Energy Unit
Lack of incentives for the population to buy energy efficient appliances	Develop incentives for households to buy more efficient appliances - e.g., sales taxes and import duties reductions according to energy efficiency	3	Energy Unit
High cost for equipment and installation	Develop a financing program focused on replacement of cooling and water heating equipment with higher EE.	3	Energy Unit
Lack of consumer awareness on EE of appliances	Public education campaign focusing on high efficiency cooling and water heating equipment, exploring potential savings.	1	Energy Unit

Source: Vivid Economics and Lucid Solutions analysis

Reduction of transmission and distribution losses (option 7) and fuel wood consumption (option 12) have been harder than initially expected. Both mitigation options were considered in Belize's 2016 NDC with relatively ambitious targets, but progress has been slower than initially thought. In both cases, the measures are still considered, but implementation targets have been adjusted and/ or postponed. In the first case, reduction of losses will demand hard work to upgrade existing under designed lines and interconnections and to add new lines, which, in both cases, will require significant capital expenditures and expansion of BEL's workforce. For the second case, in the absence of a LPG distribution network in rural zones, the transformation will also require investments in more efficient appliances (e.g., solar cooks), which, in turn, will require strong incentivization programs as well as public awareness campaigns to change consumer's habits and behaviors.

Support to public-private partnerships may accelerate street lighting transition (option 10). Converting street lighting to LED (and solar, in specific, off-grid regions) is a profitable investment due to its much-reduced operational costs and, therefore, it is a well-suited area for private investment. In this context, the national government can support municipalities in designing and launching concession initiatives for the provision of street-lighting services, reducing overall public investment requirements.

Figure 85 Energy Action Plan: 7, 10, 11, 12 – Transmissions & Distribution Losses, Lighting, Efficiency on Appliances, Fuel Wood Cooking

Mitigation Option	Sub Option	Target Parameter	BAU 2030	VHA 2050	Key Barriers/ Challenges	LEDS High-Level Interventions	Time frame	Leading entity
7. Reduction in transmission and distribution losses	7.1. Reduction in losses from electricity transmission and distribution	Transmission and distribution losses (% of energy produced)	12%	8%	Limited interconnection design and restrictions on transmission capacity increase transmission and distribution losses	Upgrade existing under designed lines / interconnections and add new lines	1	BEL
					Lack of human resources to perform construction	Expand and train transmission and distribution workforce	1	BEL
10. Efficiency improvement on lighting	10.1. Replacing incandescent streetlights to LED	Share of streetlights upgraded to LED (%)	0%	100%	High cost for mass purchasing and installation	Design a centralized concession program for street lighting services in largest urban zones of Belize, focusing on LED/ solar lighting and in partnership with municipalities	1	Energy Unit
	10.2 to 10.4. Commercial/ Residential - switching away from incandescent and fluorescent to LED	Share Incandescent (% total)	60%	0%	Lack of design guidance (adherence to international stds) and education	Revise regulation and standards to further restrict low efficiency lighting	1	Energy Unit
		Share Fluorescent (% total)	40%	20%	Limited diversity/ accessibility of product and lack of incentivization schemes	Revise sales tax and import duties, reducing tax burden for high efficient equipment	1	Energy Unit
		Share LED (% total)	0%	80%	Transition under way, but further work required to have 100% uptake of LEDs	Develop public awareness campaign of the pay back time for LEDs	1	Energy Unit
11. Energy Efficiency on commercial, residential and public sector appliances	11.1. Reduction on appliances consumption due to EE standards, labels and feebates	Reduction of consumption on residential, commercial and public sector (% of BAU)	0%	48%	Lack of consumer awareness on EE of appliances	Establish appliance rating programs, defining EE standards and labeling EE for appliances leading sales on each category	1	Energy Unit
					Lack of incentives for the population to buy energy efficient appliances	Develop incentives for households to buy more efficient appliances - e.g., sales taxes and import duties reductions aligned to efficiency	2	Energy Unit
12. Reduction of fuel wood consumption through clean cook stoves	12.1. Replacing wood for cooking by LPG, electricity, solar or other cleaner alternatives	Reduction of fuel wood consumption (% of 2020 level)	0%	50%	Lack of desire for households to switch to cleaner fuels	Develop a public awareness campaign on the harmful air pollution effects of wood burning on open fires and maintaining woodlands	1	Energy Unit
					Cost of purchasing clean cook stoves	Incentivize households to buy clean book stoves (e.g. tax exemptions, subsidies)	3	Energy Unit

Source: Vivid Economics and Lucid Solutions analysis

Belize Electricity Limited (BEL) and the Energy Unit are identified as the leading implementer across all LEDS Energy sector activities. BEL is the primary implementer not only for all power production activities, but also for improvements to and management of the national power grid, and for upgrades needed at the distribution points such as infrastructure to support net metering. The Energy Unit is the guiding implementer for all other actions, except in cases where additional studies and coordination are needed in cooperation with BEL, and activities supporting the improvement of energy efficiency in buildings, where ongoing external support is required.

6.5 Transport

The optimization of the transit system requires several coordinated actions (option 1.1). Current concessions to private operators are not systematically designed, resulting in inefficient design of routes and bus stops, and inadequate portfolio of vehicles in operation. The National Government can support municipalities building a coordinated scheme of concessions, as well as attractive financing schemes that support the investment of private operators to upgrade their fleet of vehicles.

Figure 86 Transport Action Plan: 1. Reduction of fuel emissions in the public transit system (part. 1)

Mitigation Option	Sub Option	Target Parameter	BAU 2030	VHA 2050	Key Barriers/ Challenges	LEDS High-Level nterventions	Time frame	Leading entity
1.Reduction of fuel emissions in the public transit system	1.1. Optimization of transit system: redesign of routes, replacement of larger buses by minibuses/ vans	Reduction in fuel consumption / Passenger for regular buses (% 2020 level)	-	5%	Inefficient bus system, with overlap of routes and vehicles not optimized for each route	Revision of system design, including bus routes, timetables and vehicle allocation (e.g.,vans/ minibuses)	1	Energy Unit
					Lack of incentive and cooperation across varied privately run lines	Coordinated scheme of concessions of bus services to private operators, with competitive fare structure	1	Dept of Logistics / Economic Dev Council
					New fuel-efficient minibuses / vans required	Attractive financing schemes to purchase new minibuses and vans	1	Dept of Logistics / Economic Dev Council
					Significant number unofficial bus stops and bus operators	Adjustment of bus stops to the revised system and enforcement of revised concession services	1	
					Individuals continuing to use their private cars rather than taking public transport	Develop a public education campaign to encourage use of the new system	1	Dept Transportation
					Limited park and ride schemes on the edge of towns / cities.	Build Park and ride schemes to reduce amounts of traffic entering cities and towns	2	Public Utilities Commission
	1.2. Increasing fuel efficiency and fleet renewal	Reduction in fuel consumption / Passenger for regular buses (% 2020 level)	-	15%	No existing infrastructure for tracking fleet fuel consumption and passenger volume	Implement third party vehicle inspection program and fare collection database	1	Energy Unit
					Inconsistent qualifications for permit granting, and irregular license timeframes disincentivize competition and financing fleet upgrades	Reform permit application and granting framework, and align licensing timeframes	1	Dept of Logistics
					Lack of financing for private route owners to upgrade fleet	Implement financing frameworks aligned with licensing timeframes	1	Dept of Logistics / Economic Dev Council

Source: Vivid Economics and Lucid Solutions analysis

Adoption of electrical buses (options 1.3 and 1.4) require coordination of licensing, financing and incentives. Although electrical vehicles can be an attractive proposition to private bus operators due to much lower operational costs, transition is complicated by still high initial upfront investments per units, as well as lack of appropriate infrastructure (especially charging stations). Offering appropriate fiscal incentives, and financing schemes aligned and coordinated with licensing timeframes are needed to foster accelerated adoption, as well as public investment support for installing a charging infrastructure.

Figure 87 Transport Action Plan: 1. Reduction of fuel emissions in the public transit system (part. 2)

Mitigation Option	Sub Option	Target Parameter	BAU 2030	VHA 2050	Key Barriers/ Challenges	LEDS High-Level nterventions	Time frame	Leading entity
1.Reduction of fuel emissions in the public transit system	1.3 Replacement of conventional buses with electric buses (intra district)	Share of intra-district electric buses (% of total)	0%	35%	Lack of cash flow and/or financing for private route owners to afford electric buses and import costs	Implement financing frameworks aligned with licensing timeframes	2	Dept of Logistics / Economic Dev Council
					Permitting timeframes may disincentive finance commitments	Reform licensing timeframes, and permit application and granting framework	1	Dept of Logistics
	1.4 Replacement of conventional buses with electric buses (inter district)	Share of inter-district electric buses (% of total)	0%	60%	Lack of incentives for operators to upgrade buses	Incentivize upgrade to EV through decreased sales and duty taxes.	2	Energy Unit
					No existing charging station infrastructure	Install electric vehicle charging points in bus stations	2	Energy Unit
	1.5. Attracting individual commuters to public transportation	Share of car drivers that switch to public transport (% of total)	0%	20%	Lack of comfort, convenience, and consistency needed to lure private vehicle owners to use the bus.	Implement bus line performance based incentivization	1	Dept of Transportation
					Transitions/ schedules of bus services not coordinated and information not clear and accessible to public	Optimize and mainstream information on coordinated routes (trip plans)	1	Energy Unit
					Passengers need to have cash for using the bus	Develop an online app for payments	1	Energy Unit

Source: Vivid Economics and Lucid Solutions analysis

An attractive incentivization and financing program can accelerate transition of light vehicles (option 2). Similarly to buses, electrical vehicles can be an attractive proposition to individuals due to much lower running costs, but vehicle costs are still higher, which complicates the transition. Government can facilitate transition by reducing overall burden through incentivization and financing schemes.

Increasing fuel efficiency in light vehicles (option 2.1), fuels (option 3.3), and freight transportation (option 4) requires regulatory adjustments. Current Belizean regulations do not provide adequate incentives for reducing fuel emissions through investments in newer, more efficient vehicles or transition from combustionengines to electrical vehicles. The introduction of gradually tightening fuel economy standards with associated taxation structures should also be an important lever to accelerate transition.

Figure 88 Transport Action Plan: 2. Reduction of fuel emissions on private/ commercial light vehicles (part. 1)

Mitigation Option	Sub Option	Target Parameter	BAU	VHA	Key Barriers/ Challenges	LEDS High-Level nterventions	Time frame	Leading entity
2. Reduction of fuel emissions across private and commercial light vehicles	2.1. Reducing the energy consumption in light vehicles (including taxis) through fuel economy standards, fuel economy labels and tax incentives	Reduction of ICE cars fuel consumption (% 2020 level)	-	20%	No fuel economy standards or existing emissions testing	Update regulatory framework to include fuel economy standards and emissions testing database	1	Energy Unit
					Limited regulations on vehicle imports	Update regulatory framework to phase out low fuel economy vehicles (Import limits/ emissions testing)	1	Energy Unit
					New or newer vehicles with improved fuel efficiency are expensive to import and purchase	incentivize higher fuel economy vehicles through tiered GST and import duty tax structures	1	Dept. Logistics / Economic Dev Council
					Taxi fleet is old and needs upgrading	Set up an incentivization scheme for taxi drivers to purchase new fuel-efficient vehicles	1	Energy Unit
	2.2. Replacing combustion cars with electric via import incentives	Share of electric cars (% of total)	1%	90%	No fuel economy standards or existing emissions testing	Update regulatory framework to include fuel economy standards and emissions testing database	2	Energy Unit
					No existing tiered import duty tax, electric vehicles are expensive to purchase	incentivize electric vehicles through zero GST and import duty tax	1	Energy Unit
					Majority of most likely buyers don't qualify for in-country financing	Implement financing schemes to include eligibility for all drivers	3	Dept. Logistics / Economic Dev Council
					Lack of public electric vehicle charging points in the country	Set up a network of electric vehicle charging points	3	Energy Unit
					Lack of home electric vehicle charging points	Roll out subsidies to encourage homeowners to install electric vehicle charging points	2	Dept. Logistics / Economic Dev Council

Source: Vivid Economics and Lucid Solutions analysis

Figure 89 Transport Action Plan: 2. Reduction of fuel emissions on private/ commercial light vehicles (part. 2)

Mitigation Option	Sub Option	Target Parameter	BAU	VHA	Key Barriers/ Challenges	LEDS High-Level nterventions	Time frame	Leading entity
2. Reduction of fuel emissions across private and commercial light vehicles	2.3. Replacing combustion motorcycles with electric via import incentives	Share of electric scooters/ motorcycles (% of total)	0%	75%	No fuel economy standards or existing emissions testing	Update regulatory framework to include fuel economy standards and emissions testing database	2	Energy Unit
					Lower financial resources of typical motorcycle buyer	Implement financing schemes to include eligibility for all drivers	3	Dept of Logistics / Economic Dev Council
					No existing tiered import duty tax, electric vehicles are expensive to purchase	incentivize electric vehicles through zero GST and import duty tax	1	Energy Unit
	2.4 Replacing combustion boats with electric hybrid via import incentives.	Share of electric/ hybrid boat motors (% of total)			Electric boats are more expensive to purchase than regular boats	Set up an incentivization scheme to subsidize the tax paid on the purchasing and importing of electric boats	3	Energy Unit

Source: Vivid Economics and Lucid Solutions analysis

Introducing biofuels (option 3) requires adjustments in the production value chain. Belize does not currently possess an appropriate value chain for the production of ethanol and biodiesel, which are the most commonly used biofuels for blending with regular fuels. Building this value chain will require supporting the production of raw inputs (which is more challenging for biodiesel than ethanol, given the established sugarcane industry) and attracting investors to the processing facilities.

Figure 90 Transport Action Plan: 3. Improvement of fuel standards

Mitigation Option	Sub Option	Target Parameter	BAU	VHA	Key Barriers/ Challenges	LEDS High-Level nterventions	Timeframe	Leading entity
3. Improvement of fuel standards	3.1. Blend of biodiesel in regular diesel	Share of diesel replaced by biodiesel (blend %)	0%	10%	Biodiesel is usually more expensive than regular diesel	Revise fuel standards to incorporate increasing blending targets for biofuel	2	Energy Unit
					Inexistence of biodiesel production facilities in the country	Design a program to attract biodiesel investors through guaranteed sales contracts, concessional financing and tax incentives	2	Beltraide
					Limited production of biodiesel raw inputs (e.g., soybeans)	Implement financing schemes to farmers on raw inputs	2	Dept of Logistics / Economic Dev Council
	3.2. Blend of ethanol in regular gasoline	Share of gasoline replaced by ethanol (blend %)	0%	25%	No protocols on adding ethanol	Revise fuel standards to incorporate increasing blending targets for biofuel	1	Energy Unit
					Lack of ethanol production facilities in the country	Design a program to attract ethanol investors through guaranteed sales contracts, concessional financing and tax incentives	2	Beltraide
	3.3. Introduction of fuel standards in diesel and gasoline	Reduction of fuel emissions (% 2020 level)	0%	5%	Need for clear standards and strong neutral enforcement	Establish fuel standards for blended and non-blended fuels	1	Energy Unit
					Lack of enforcement structure for fuel standards and blending	Create enforcement unit for regular inspections on fuel wholesalers and gas stations	1	Energy Unit

Source: Vivid Economics and Lucid Solutions analysis

Adoption of last mile urban transportation (option 5) requires cultural change on both golf carts and bicycle usage. In the case of the former, although golf carts are already commonly used in many parts of the country, the vehicles usually run-on regular fuel due to higher upfront investments and limited autonomy ofelectrical models; transition will require a combination of incentivization programs and adjustments in the regulatory framework. On the latter, the challenge is the current low adoption rate, which can be overcomethrough a combination of higher convenience (e.g., segregated bike lanes and bike renting schemes) and public awareness campaigns.

Figure 91 Transport Action Plan: 4. Reduction of fuel emissions in freight transportation; 5. Improving efficiency of last-mile urban transportation

Mitigation Option	Sub Option	Target Parameter	BAU	VHA	Key Barriers/ Challenges	LEDS High-Level nterventions	Timeframe	Leading entity
4. Reduction of fuel emissions in freight transportation	4.1 Implementing regulations and standards for road freight vehicles	Reduction of trucks fuel consumption (% 2020 level)	0%	15%	No fuel economy standards or existing emissions testing	Update regulatory framework to include fuel economy standards and emissions testing database	1	Energy Unit
					New or newer vehicles with improved fuel efficiency are expensive to import and purchase	incentivize more fuel-efficient freight vehicles through tiered GST and import duty tax structures	1	Dept of Logistics / Economic Dev Council
					No existing infrastructure for tracking fleet fuel consumption	Implement third party vehicle inspection program	1	Energy Unit
5. Improving efficiency of last-mile urban transportation	5.1. Increased uptake of bikes for urban transportation	Share of passenger travels switched to bike (% total)	0%	10%	Travel by bike not appealing due to unsafe conditions and congestion of urban roads	Design and build segregated bike lanes	2	Dept Transportation
					Limitation on travel distances reduce convenience of bike travel	Design and set up bike hire schemes, aligned with other transportation modes	1	Dept Transportation
					Lack of awareness of the benefits of cycling	Development of a publicity campaign to encourage cycling for last mile transportation	1	DoT and Public Service
	5.2. Adoption of electric golf carts	Share of electric golf carts (% golf carts)	1%	75%	Higher autonomy and convenience of combustion golf carts	Update regulatory framework to include fuel economy standards (phase out combustion engine golf carts)	1	Energy Unit
					Electric golf carts are still expensive to purchase	incentivize electric golf carts through zero GST and import duty tax	3	Energy Unit

Source: Vivid Economics and Lucid Solutions analysis

Fragmentation of responsibilities may be a challenge to the implementation of a coherent and integrated strategy. As it is possible to see from previous figures, responsibility for the interventions is spread across a range of entities, including Department of Transportation, Department of Logistics and the Energy Unit. Increasing coordination on strategy definition and implementation may require revising responsibilities and/ or creating governance structures (e.g., a transportation and logistics committee) for decision-making and implementation monitoring.

6.6 Waste

Improved waste collection (option 1) depends on a combination of regulatory adjustments and expansion of services. Waste collection services face a range of regulatory challenges, including uncoordinated municipal collection rules, inconsistent waste fees structures and open dumpsites. Adjusting the regulatory frameworks and expanding services to smaller villages and rural zones should incentivize transformation towards universal collection.

Figure 92 Waste Action Plan: 1. Waste collection and management

Mitigation Option	Sub Option	Target Parameter	BAU 2030	2050 VHA
1. Improved waste collection and management	1.1. Expansion of National Landfill, absorbing waste from the capital's metropolitan area	Share of Belize City solid waste collected to the Landfill (% of total)	80%	95%
	1.2. Expansion of collection from other urban areas to the National Landfill	Share of solid waste of other urban areas collected to the Landfill (% of total)	70%	90%
	1.3. Installing disposal sites in villages and start collecting rural waste	Share of solid waste of rural areas collected to the Landfill (% of total)	0%	65%

Key Barriers/ Challenges	LEDS High-Level Interventions	Time frame	Leading entity
Capacity limitation at the National Landfill	Expansion of National Landfill	1	BSWaMA
Limited reach of waste collection services	Expansion of waste collection services	1	Ministry of Local Government
Collected waste deviated to open dumps due lower distances	Close open dumpsites near San Ignacio/Santa Elena, Caye Caulker, San Pedro Ambergris Caye, and other towns	1	BSWaMA
Poverty levels diminish the effectiveness of fee based or tax-based collection for costs. Waste is not collected from some households due to non-payment of waste fees	Revision of waste fee and collection regulations so to assure universal collections	1	Ministry of Local Government
Waste collection trucks are not the most appropriate for longer distances	Building regional facilities for processing and consolidating waste	1	BSWaMA
Uncoordinated and inconsistent municipal charging/ collection frameworks incentivize dumping	Establish enforceable cost collection and minimum regulations across municipalities	1	Ministry of Local Government
Disseminated culture of open burning	Disincentivize open burning practice	1	Ministry of Local Government

Source: Vivid Economics and Lucid Solutions analysis

Improved methane emissions management (option 2) is critical to reducing solid waste emissions. Methane production on the landfill is the most relevant emissions source for Belize. Significant investment will be required to adopt flaring in the short-term and moves towards biogas usage in the medium term.

Figure 93 Waste Action Plan: 2. Reduction of methane generation at the National Landfill

Mitigation Option	Sub Option	Target Parameter	BAU 2030	VHA 2050	Key Barriers/ Challenges	LEDS High-Level Interventions	Time frame	Leading entity
2. Reduction of methane generation at the National Landfill	2.1. Flaring methane on National Landfill to reduce emissions	Share of Landfill methane flared (% of total)	0%	30%	Methane generated by the National Landfill is dispersed into the atmosphere	Install wells/ piping required to direct the gas to a central point where it can be processed and flared in the National Landfill	2	BSWaMA
	2.2. Using methane of solid waste for biogas energy	Share of Landfill methane turned to biogas and sold (% of total)	0%	20%	Collected methane is wasted through flaring	Build facility to process methane into biogas and prepare for distribution	3	BSWaMA

Source: Vivid Economics and Lucid Solutions analysis

Expanding recycling and composting (option 3) require significant logistical investment. Belize currently does not have adequate collection structure and processing facilities for both, recycling and composting. Building this value chain should require relevant investments, which could be potentially shared with the private sector through public-private partnerships.

Figure 94 Waste Action Plan: 3. Reduction of solid waste volume by recycling and composting

Mitigation Option	Sub Option	Target Parameter	BAU 2030	VHA 2050	Key Barriers/ Challenges	LEDS High-Level Interventions	Time frame	Leading entity
3. Reduction of solid waste volume by recycling and composting	3.1. Collection and exporting of PET waste	Share of PET/ aluminum collected and exported (% of total)	3%	40%	Lack of structure for collecting recyclables	Building infrastructure for collecting recyclables	1	BSWaMA / Ministry of Local Government
					Lack of incentives for recycling and protocols for white waste	Update regulatory frameworks for incentivize recycling	1	BSWaMA
	3.2. Installing recycling facilities at the National Landfill, at Transfer stations and site collection	Share of waste collected for recycling (% of recyclables)	3%	30%	Lack of capacity of processing and separating recyclables	Building recycling center within National Landfill	2	BSWaMA
					Lack of recycling culture	Public educ. campaign to encourage recycling	1	BSWaMA
	3.3. Collecting and composting agriculture residues and green waste	Share of total waste collected for composting (% of non-recyclables)	0%	50%	Lack of infrastructure for collecting agriculture residues and household green waste	Building infrastructure for collecting agriculture residues and household green waste	1	Ministry of Agriculture
					Lack of incentives for composting	Update regulatory frameworks for incentivize composting	1	Ministry of Agriculture
					Lack of capacity of processing wet waste and composting	Building composting center within National Landfill	2	BSWaMA
					Lack of knowledge on the benefits of home composting for gardens	Public education campaign to encourage home composting	1	BSWaMA

Source: Vivid Economics and Lucid Solutions analysis

Reducing wastewater emissions (option 4) require a combination of pipes expansion and incentives to appropriate septic tanks. The sewage pipe network is currently limited to central districts of Belmopan, Belize City and San Pedro. Although the expansion of the collection services is always the ideal solution, it should require heavy investments from BWS for expanding both, collection network and treatment facilities.For the remainder of the country, adoption of appropriate septic tanks (e.g., several users have bottomless tanks to avoid sludge collection costs) should require offering attractive sludge collection services and regulatory adjustments.

Figure 95 Waste Action Plan: 4. Reduction of GHG emissions in wastewater

Mitigation Option	Sub Option	Target Parameter	BAU 2030	VHA 2050	Key Barriers/ Challenges	LEDS High-Level Interventions	Time frame	Leading entity
4. Reduction of GHG emissions in wastewater	4.1. Upgrading treatment systems (Belmopan)	Reduction of methane emissions from collected wastewater (% 2020 level)	0	20	Limited efficiency and higher level of GHG emissions at the treatment station	Upgrade treatment plant and equipment	1	BWS
	4.2. Incentivizing residential connection to centralized sewage systems (CAPITAL)	Share of the wastewater collected and treated by pipe in Belmopan, Belize City, San Pedro (% of total)	20%	50%	Limited reach wastewater pipelines	Expanding wastewater household and commercial collection network	2	BWS
	4.3. Incentivizing the adoption of appropriate septic tanks, for wastewater not connected to pipes (CAPITAL)	Share of wastewater NOT collected in centralized system that is disposed in septic tanks in Belmopan, Belize City and San Pedro (% of total)	50%	90%	Lack of infrastructure for collecting septic tank sludge	Building infrastructure for collecting sludge	1	BWS
					Lack of incentives for adopting septic tanks. User poverty precludes payment of tax and the usefulness of incentivizing through tax structures.	Update regulatory frameworks for incentivize adopting septic tanks	1	BWS
					Many households have inadequate septic tanks (e.g. bottomless)	Establish National standards for septic tank installation and maintenance	1	BWS
					Many households are unaware of benefits of septic tanks	Public education campaign to encourage adoption of septic tanks	1	BWS
	4.4. Incentivizing residential connection to centralized sewage systems (OTHER AREAS)	Share of the wastewater collected and treated by centralized systems (pipe) in other areas (% of total)	0%	30%	No wastewater treatment capacity outside central zones	Building new treatment plants and equipment	3	BWS
					No wastewater pipelines outside central zones	Building wastewater household and commercial collection network	3	BWS
	4.5. Incentivizing the adoption of appropriate septic tanks not connected to pipes (OTHER AREAS)	Share of wastewater NOT collected in centralized system that is disposed in septic tanks in other areas (% of total)	70%	90%	Lack of infrastructure for collecting septic tank sludge	Building infrastructure for collecting sludge	1	BWS
					Lack of incentives for adopting septic tanks	Update regulatory frameworks for incentivize adopting septic tanks	1	Public Utilities Commission

Source: Vivid Economics and Lucid Solutions analysis

The leading institutions in Waste are the Belize Solid Waste Management Authority (BSWaMA), the Ministry of Local Government and the Belize Water Services (BWS). On solid waste, responsibilities are usually shared between BSWaMA and the Ministry of Local Government, which should closely coordinate efforts to ensure coherent implementation. On wastewater, responsibilities fall mostly on BWS, which should embed actions into its strategic plan to ensure effective implementation.

7 Interaction of the LEDS with other policies and strategies

This chapter explores the interactions of the LEDS with other national policies and strategies, including other climate policy frameworks, national development strategies, sector-specific policies and strategies. We discuss functions of different instruments, and how they complement and feed upon each. More importantly, we assess the level of alignment of proposed LEDS options with existing instruments, highlighting aspects to proactively consider in next policy revisions.

7.1 The interaction of the LEDS with other national policies and strategies

In addition to the LEDS, the two other critical climate policy frameworks in Belize are the National Climate Change Strategy and Action Plan (NCCSAP), and the Nationally Determined Contributions (NDC):

- The Nationally Determined Contribution (NDC) (National Climate Change Office, 2016b) presents an action-based approach that is dependent on cost effective technology, capacity building and adequate financial support. The activities mentioned cover multiple sectors including forestry, energy, waste and transport. In terms of adaptation, the main actions aim at increasing resilience and reducing vulnerability of livelihoods with respect to critical infrastructure, tourism, food security, sustainable forest management, protected areas management, coastal and marine resources, water scarcity, energy security and health. Belize's first NDC was published in 2016 and an updated version was completed in 2021.

- The National Climate Change Policy, Strategy and Action Plan 2015-2020 (NCCPSAP) (Caribbean Community Climate Change Centre, 2015) gives the general short-term approach of the government of Belize with respect to climate change adaptation and mitigation. The document includes a Climate Change Action Plan, which is a five-year programme covering adaptation and mitigation, and provides guidance for the development of an appropriate administrative and legislative framework for low-carbon development, in line with sectoral policies. The initial plan was developed based on the integrated Vulnerability and Adaptation Assessment (produced in 2014) and on the results of the First and Second National Communications to the UNFCCC, which identified a number of priority sectors for climate change mitigation and adaptation efforts, including: coastal zone, human settlement, fisheries and aquaculture, agriculture, forestry, tourism, water, energy and health. An updated NCCPSAP (5-year period) was completed in 2021.

The climate policy frameworks have complementary objectives, scopes and timeframes. In contrast with the LEDS, which has a long-term timeframe (3 decades) and focuses only on mitigation, the NCCPSAP is very short-term, and it encompasses both mitigation and adaptation. The NDC has a scope similar to the NCCPSAP, but its timeframe is longer and it focuses only on commitments with the international community. Figure 96 explores further the differences among these instruments.

Figure 96 Climate poly frameworks in Belize: summary of overall objectives, scope and timeframes

Low Emissions Development Strategy (LEDS)

- Intended to help advance national climate change and development policy in a more coordinated, coherent, and strategic manner.
- Focused exclusively on mitigation, exploring pathways to reduce GHG emissions.
- Long-term perspective, with analysis and projections for the next 3 decades (2020-50 period).

National Climate Change Policy, Strategy and Action Plan (NCCPSAP)

- It provides guidance for the development of an appropriate administrative and legislative framework for low-carbon development, in line with sectoral policies.
- Includes a five-year Climate Change Action Plan, covering adaptation and mitigation.
- The last version was published in 2015, including coastal zone, human settlement, fisheries and aquaculture, agriculture, forestry, tourism, water, energy and health.

Nationally Determined Contribution (NDC)

- It presents an action-based approach that is dependent on cost effective technology, capacity building and adequate financial support.
- The last version was published in 2016, covering sectors for mitigation (forestry, electricity, waste and transport) and adaptation (infrastructure, tourism, food security, forest management, protected areas, coastal/ marine resources, water scarcity, energy security and health).
- The version to be published covers a decade (2020-30 period).

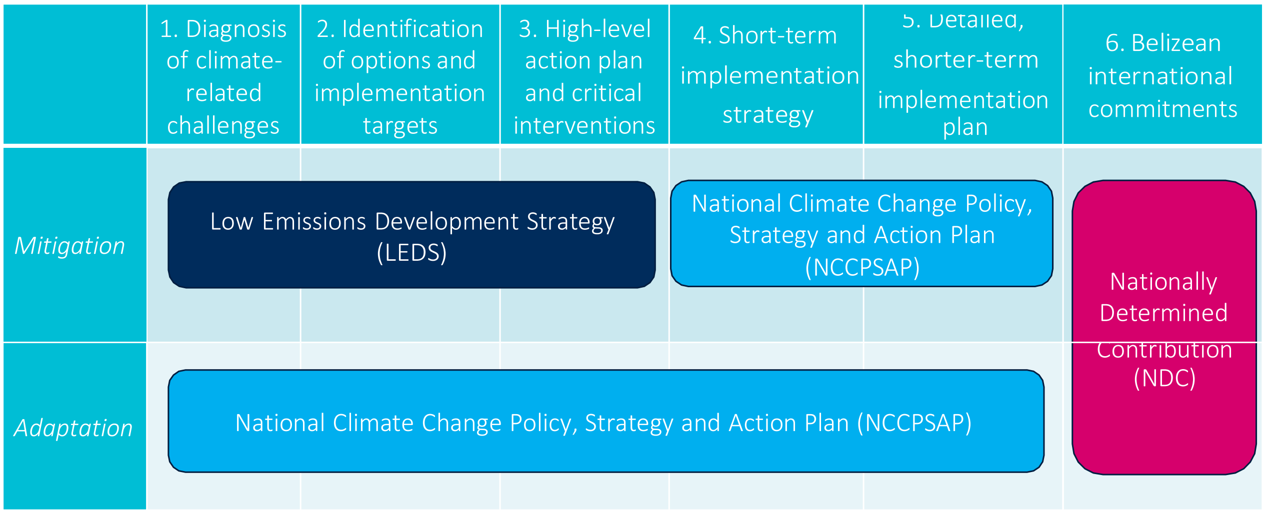
Source: Vivid Economics

Facing different challenges, a holistic climate policy approach needs to perform a variety of functions, from which the most important are:

1. Diagnosis of climate-related challenges
2. Identification of options and agreement on long-term implementation targets
3. Proposal of a high-level action plan and critical interventions required
4. Short-term implementation strategy
5. Detailed, shorter-term implementation plan
6. Statement of public/ international commitments of the Belizean Government

Together, the three main climate policy frameworks should fulfil all six roles. Both the LEDS (for mitigation only) and the NCCPSAP (also includes adaptation) perform a diagnostic of climate change policies, identifying options to address them and deliver a high-level action plan to deliver these options. The NCCPSAP also deploys both these high-level action plans in a shorter-term strategy and implementation plan. Finally, the NDC focuses on the public commitments of the Belizean government to the international community. This coverage of functions can be better appreciated in Figure 97.

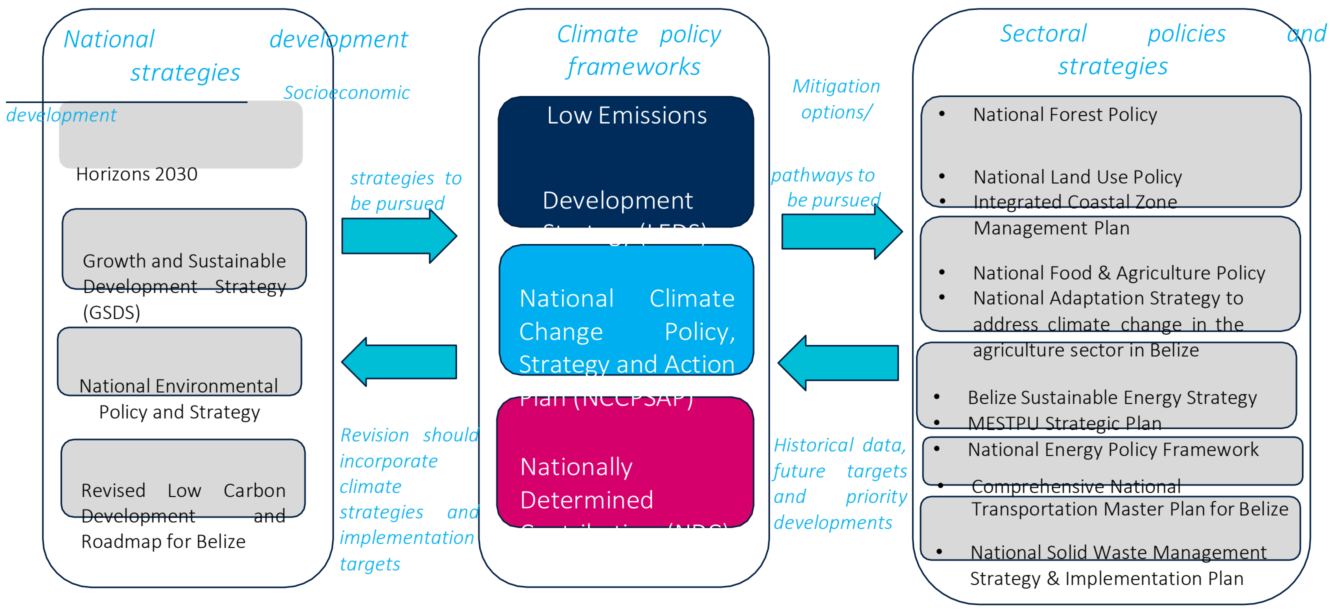
Figure 97 Overview of coverage of climate policy frameworks



Source: Vivid Economics

The climate policy frameworks also interact with other national development, and sectoral policies and strategies. While national development strategies guide climate policy frameworks in terms of the socioeconomic development policies that the country wishes to pursue, those frameworks feed the national development approach with climate-specific strategies and implementation strategies. In addition, climate policy frameworks inform sectoral policies on mitigation and adaptation options that could be pursued, but also feed upon sector-specific data, targets and priorities. These relations are illustrated in Figure 98.

Figure 98 Summary of interactions of climate policy frameworks with national development, and sectoral policies and strategies



Source: Vivid Economics

A coherent approach from Belizean government depends on these strategies and policies working in an integrated and harmonic fashion. In order to understand the existing level of alignment, the policies and strategies were analyzed against the goals and mitigation options proposed in the LEDS in the following sections. In addition to assessing the explicit and implicit policy coverage for each sub-action proposed, scoring considered coverage of the barriers and interventions that were identified throughout stakeholder engagement. Ultimately, as those policies were all drafted prior to the LEDS, a direct one to one relationship to specific LEDS sub-actions within a policy is uncommon. For instance, a policy may provide an advance level of robust foundational support for LEDS implementation but may not explicitly mention specific LEDS actions or sub-actions.

Some sectors are also analyzed through the lens of required enabling conditions. For instance, “precursory interventions” relates to identified barriers, which may require external or high-level support in order to progress with many of the sector actions. In Energy, we see that building efficiency, for instance, may have a limited coverage in terms of explicitly stated actions, but policy revisions may address longer-term goals of quantifying building energy performance in the context of finalizing the country’s building code. Similarly in Transport, necessary precursory goals such as cross sectoral coordination for long term infrastructure planning indirectly supports “last mile transport” options, a LEDS Transportation sub-action not addressed in the National Master Transportation Policy.

We have converted explicit and implicit coverage of LEDS actions into a scale, based on the overall policy narrative. This scale has been converted visually into “moons” representing the alignment of each sector, ranging from no alignment (empty moon) to full alignment (full moon). The sector-level analyses represent an average of the scores across all sub-actions within each sector. Therefore, these assessments provide a comparable basis for high-level decision making, in terms of recommendations for future policy development.

This chapter is focused on the analysis of LEDS alignment with climate policy frameworks and national development strategies. Section 7.2 assesses LEDS alignment with the most relevant climate policy frameworks, the NDC and the NCCPSAP. In section 7.3., LEDS alignment with critical national development strategies is analyses, including Horizon 2030, the GSDS, the National Energy policy and Strategy, the NCRIP, and the LCD Roadmap. Further analysis on LEDS alignment with sectoral policies and Strategies can be found in the Annex A.

7.2 Assessment of alignment with climate policy frameworks

For the NDC, the current level of alignment with LEDS mitigation options is high. The draft used for reference in this analysis was the version officially presented to the Cabinet in June 2021. This revision is relatively recent, and its drafting timeframe partially overlapped with the timeframe for the elaboration of the LEDS itself. As a result, the sectors considered and associated mitigation strategies are broadly aligned, as shown in Table 1.

Table 1 NDC: Assessment of coverage alignment of current version with the LEDS

Sector	Coverage Alignment	Priorities on future policy revision
FOLU		➢ Specific targets for forest fire and reforestation by land type. ➢ Prioritize expanding, improving, and making “live” the monitoring system. ➢ Prioritize legislative updates.
Agriculture		➢ Specific targets for measuring agricultural waste by end use and soil quality grades. ➢ Prioritize expanding, improving and making “live” the monitoring system.
Energy		➢ Targets for renewable energy disaggregated by source type. ➢ Target for frameworks supporting the evaluation of building stock by EUI. ➢ Sector alignment /or data collection of the reduction of fuel wood consumption.
Transport		➢ Targets for emissions testing, auto registration and public transport use data. ➢ Targets for fuel economy by transportation use type.
Waste		➢ Targets for mitigation actions executed at the national landfill. ➢ Specific targets for recycling and composting by collection pathway.

Source: Vivid Economics and Lucid Solutions

For the next release, more detailed targets could be considered, ensuring consistency of sector alignment to specific sub-actions. Future revisions of the NDC should consider further disaggregating targets (outlined under the sector assessments herein) within the implementation and the MRV frameworks, as well as aligning these targets with the medium-term sector plan outlined in “legal frameworks for implementing Horizon 2030”. Sector specific updates for the next NDC include prioritizing support for the forestation monitoring system and establishing the necessary frameworks for net-metering and the future evaluation ofbuilding stock by EUI. Next revisions should also include specific targets for forest fire, reforestation by land type (including cropland and grassland), measuring agricultural waste by end use, formalizing soil quality grades, renewable energy disaggregated by source type (including wind and distributed solar), fuel economyby transportation use type, recycling and composting by collection pathway, and mitigation actions executedat the national landfill. Further exploration should be given to enhance goals for improvements in flooded rice, sustainable coconut production, improving coordination of last mile transportation, and detailed wastewater infrastructure planning.

For the NCCPSAP, while the alignment on sector diagnostics is reasonable, the alignment of actual mitigation options is limited. The current version of the Policy was drafted in 2014 and its revision was just launched at the date the LEDS was completed. The current version has a high-level scope, intended to mainstream Climate Change into its national development processes and mechanisms and to define the appropriate level of governance architecture required for the management of Climate Change. Within a largely diagnostic approach, the LEDS sectors are relatively well covered in terms of foundational support, especially in the FOLU and Waste sectors; nevertheless, in terms of LEDS mitigation options, only fuel wood (energy) is explicitly mentioned. Various associations across sectors are highlighted, such as between flaring and pollution challenges, environmental threats imposed by the transport of fuel, and noting the transport sector as the largest contributor of pollution, but rarely are specific targets stated.

Table 2 NCCPSAP: Assessment of coverage alignment of current version with the LEDS

Sector	Coverage Alignment	Priorities on future policy revision
FOLU	◐	➢ Outline proposed legislative revisions. ➢ Clarify goals for strengthening enforcement. ➢ Align specific goals with LEDS targets.
Agriculture	◔	➢ Outline proposed legislative revisions. ➢ Align specific goals with LEDS targets.
Energy	◔	➢ Clarify position on natural gas. ➢ Propose public/ private frameworks supporting future goals. ➢ Outline proposed legislative revisions. ➢ Align specific goals with LEDS targets.
Transport	◔	➢ Outline frameworks for data collection and incentivization mechanisms. ➢ Outline frameworks for urban planning coordination. ➢ Align specific goals with LEDS targets.
Waste	◐	➢ Assign obligations within decentralized authorities. ➢ Incorporate wastewater policy and objectives. ➢ Align specific goals with LEDS targets.

Source: Vivid Economics and Lucid Solutions

While pursuing original analysis for adaptation strategies, the revision of the NCCPSAP should extensively reference LEDS on mitigation. The new draft of the NCCPSAP will need to update the analysis of climate change scenarios for incoming decades, including scenarios of temperature and precipitation trends, as well as increased risk for natural hazards. Based on these scenarios, the NCCPSAP will identify specific climate challenges and devise sector-appropriate adaptation strategies and actions. It is, however, beyond the scope of the NCCPSAP to perform detailed analysis of sectoral GHG emission trends and high-level mitigation options, areas that are sufficiently covered by this LEDS. In this context, it is recommended the new NCCPSAP build upon the mitigation options and high-level action plan proposed by this LEDS, focusing instead on detailing the required interventions within the policy's short-term timeframe (5 years). Sector specific updates include formalizing public/ private frameworks which will support future goals, incentivization mechanisms, instituting frameworks for net-metering, and implementing electric vehicles, in the Energy sector.

Particular attention should be paid to pursuing refinement of legislative and regulatory instruments. For the long-term, prioritizing legislative revisions that democratize land use authority, establishing public transparency in land tenure, and assuring continuity of governance architecture by binding successive government to emission reduction targets, are the most critical policy update for effective climate change implementation across sectors. The instruments specifically highlighted throughout stakeholder engagement, and where revision recommendations will be most impactful within the NCCSAP include all Lands related Acts to democratize authority, the EIA Act and the Forest and Mangrove Regulations, to increase transparency and democracy in permitting.

7.3 Assessment of alignment with national development strategies

Despite some positive highlights, the alignment of LEDS mitigation options with national development strategies is relatively limited. The Horizon 2030 and the National Environment Policy present some level of alignment on specific sectors: FOLU and Agriculture for the former and FOLU and Waste for the latter. For all other strategies, the level of alignment of current drafts of the strategies can be considered low. Therefore, this LEDS may serve as useful guidance for updating these strategies regarding mitigation of GHG emissions, as further explored in the following sections.

7.3.1 Horizon 2030

The Horizon 2030: National Development Framework for Belize 2010-2030 (Barnett, Catzim and Barnett, 2011) is Belize's long term development strategy, outlining the critical success factors for national development to ensure a better quality of life for all Belizeans, living now and in the future. The Horizon 2030 (Barnett, Catzim and Barnett, 2011) was developed in 2010 in response to early discussions leading tothe Sustainable Development Goals (SDGs) and was the first development strategy to actively incorporate climate change elements. It is organized into five high level goals:

- *Democratic governance:* An effective governance framework that ensures (i) citizen participation and (ii) accountability of political leaders (iii) effective management of public resources to meet public needs.
- *Education for development:* Education is recognized as a basic human right for all children regardless of social status, ethnic background and cultural affiliation, place of residence (urban/rural) or religious faith and all children have access to quality education to at least the secondary level.
- *Build a resilient economy:* A resilient economy with a level playing field for all businesses and entrepreneurs using appropriate technology to increase productivity and competitiveness in an environmentally sustainable way.
- *Care for the natural environment:* Belizeans have a deep appreciation and love for Belize's natural resources and work collectively to protect the natural heritage and the economic value of these natural resources is quantified and officially recognized.
- *Healthy citizens throughout the life cycle:* Universal access to affordable and high-quality healthcare that provides citizens with preventative and curative health services throughout their lives.

The high-level goal *"Care for the natural environment"* lists several strategies directly or indirectly related to climate change, organized into three groups: *Incorporate environmental sustainability into development planning, Strengthen Protected Areas Management, and Promote Green Energy.*

The current overall level of alignment of Horizon 2030 with LEDS mitigation options is below ideal. Coverage is generally higher for mitigation options which overlap with the most visible environmental concerns, with FOLU options mostly aligned with LEDS, and Agriculture options partially aligned. Reforestation, for instance, is the only LEDS option where a specific measure is directly proposed. LEDS transport options associated with public health and access goals are covered indirectly. Two Waste options, reduction and recycling, are partially covered. Agriculture and Energy sector options are only implied under higher-level policy and strategy frameworks.

Table 3 Horizon 2030: Assessment of coverage alignment of current version with the LEDS

Sector	Coverage Alignment	Priorities on future policy revision
FOLU	◕	➢ Address forest fire prevention and control. ➢ Include LEDS and medium-term sector plans in pillars: key indicators.
Agriculture	◐	➢ Clarify long-term prioritization of actions as related to the three Horizon pillars. ➢ Propose long term strategy to address livestock challenges.
Energy	◔	➢ Clarify strategy and support for overall efficiency of the grid. ➢ Clarify strategy and support for building design and operation frameworks (EUI).
Transport	○	➢ Include transportation indicators from an energy and environmental perspective. ➢ Address strategy and frameworks for mitigation of fuel emissions.
Waste	◔	➢ Long term strategy for handling of methane at the landfill is covered implicitly under high level goals. ➢ Encompass wastewater goals and implementations.

Source: Vivid Economics and Lucid Solutions

The next revision of Horizon 2030 should focus on aligning the Horizon Implementation Framework and Pillar Indicators with LEDS interventions. Based on stakeholder feedback, it is clear that all LEDS mitigation targets may be impacted by, and should be considered under, each of the five high-level goals throughout the life cycle. More specifically, it may be necessary to outline specific targets and actively align with the proposed LEDS mitigation options s across all sectors in the next policy revision, with emphasis on the Energy, Transportation, and Waste sectors. It will also be important to introduce long-term prioritizations across options and relate them to the three policy's pillars, such as clarifying an approach to balancing environmentally detrimental and economically advantageous livestock outcomes and the phasing in of better options.

7.3.2 Growth and Sustainable Development Strategy (GSDS)

The Growth and Sustainable Development Strategy (GSDS) 2016-2019, (Ministry of Economic Development, 2016) is the medium-term development strategy for Belize, a development plan for 2016–2019 stemming from Horizon 2030. Released six years afterwards, it encompasses issues covered by Horizon 2030 and previous medium-term economic development plans, but also incorporates, for the first time, both poverty reduction and long-term sustainable development issues. It provides detailed guidance on priorities and on specific actions to be taken during the 2016-2020 period (extended from the initial 2019 timeframe). The GSDS also refers to and should be considered to include many other sectoral and ministerial planning documents. It is organized around four Critical Success Factors (CSF):

- *CSF1:* Optimal national income and investment;
- *CSF2:* Enhanced social cohesion and resilience (enhanced equity);
- *CSF3:* Sustained or improved health of natural, environmental, historical, and cultural assets;
- *CSF4:* Enhanced governance and citizen security.

Under the CSF3, "Sustained or improved health of natural, environmental, historical, and cultural assets" has 11 actions directly associated to "Sustainable Environmental Management". Out of those actions, only one, associated to historical and cultural sites, is not climate-change related.

The overall level of alignment is low, given its origins in parent initiatives and legacy goals, as well as, economic development emphasis. As the policy is positioned for societal impact, no explicit support for LEDSforestry and land use options is stated, and support for waste options is framed primarily around health and towards a general increase in capacity. Support for LEDS transportation option is limited to road infrastructure and is only evident as an economic lever. A foundational framework for the reduction of deforestation and mangrove extraction is implied primarily through focus on intersectoral linkages necessaryfor climate change resilience. Options explicitly noted include biofuel and an increase in export capacity. Thelatter focuses on reaching and diversifying crop-based targets and cattle export expansion, which is in contradiction to GHG mitigation goals. Alignment with LEDS is only visible in recommendations for strengthening coordination mechanisms, watchdog efforts, and political accountability.

Table 4 GSDS: Assessment of coverage alignment of current version with the LEDS

Sector	Coverage Alignment	Priorities on future policy revision
FOLU	○	➢ Propose frameworks to effectively align with LEDS goals moving forward. ➢ Further explore a balance between economic and climate change goals. ➢ Recommendations regarding the mutual impacts between agriculture and forestry.
Agriculture	◔	➢ Propose frameworks to effectively align with LEDS goals moving forward. ➢ Consider a cap on livestock export to better balance economic and climate change goals. ➢ Position regarding the mutual impacts between agriculture and forestry.
Energy	◔	➢ Propose structure of legislated authority and recommended training. ➢ Explore comparative economic and environmental balance of renewable energy types.
Transport	○	➢ Outline relationship between economics, tourism standards, and mitigation strategies. ➢ Incorporate LEDS actions and outline effective alignment with LEDS targets.
Waste	◔	➢ Align with LEDS goals in balance with country climate change goals. ➢ Expand and detail strategies for landfill methane and wastewater infrastructure.

Source: Vivid Economics and Lucid Solutions

The next revision might demonstrate a more concise and consistent alignment between GSDS prioritization strategy actions and LEDS targets. The policy outlines a requirement for mid-term sectoral plans which can be developed in alignment with projected NDC goals that evolve from LEDS. An updated draft could consider organizing proposed frameworks to more effectively align with LEDS goals across sectors and further consider the balance between economics, tourism standards and mitigations goals. This could include: moredetailed recommendations regarding the mutual impacts between agriculture and forestry; setting clear guidelines for sustainable livestock production; incorporating an explicit roadmap across energy, transport, and waste options; expanding on long term infrastructure plans; and proposing regulatory updates as indicated in LEDS interventions,

Another area to consider is regulatory requirement for midterm sector implementation plans and tracking the progress of the aforementioned and supporting policy initiatives. Effective approaches towards that end may include integrating data and tables from the "Revised LCD roadmap 2016" (see 7.3.5), structured to align with 2020 NDC/ LEDS MRV database.

7.3.3 National Environmental Policy and Strategy

The National Environmental Policy and Strategy 2014 – 2024 (Department of the Environment Belize (DoE), 2014) outlines a set of priorities, action plans and anticipated results for 2014-2024 based on a clear assessment of existing environmental challenges and resources as well as institutional framework and capacities to address them. It is organized to serve as a control panel of critical environmental challenges, and it is structured around 12 environmental issues and presents 41 indicators/ targets, most of them climate related. It includes considerations on climate change challenges.

Although a reasonable foundation is presented for most LEDS sectors, the coverage of specific mitigation options is limited. The National Environmental Policy and Strategy can be understood as both a policy review and diagnostic, and a strategy set forth with accompanying targets. The assessment of LEDS alignment considers both elements. Within the diagnostic scope and legacy policy review of the document, sector alignment is reasonable, covering critical LEDS sectors. However, as the policy is also intended "to be used as an operational/management tool for the mobilization of resources, development of capacity", the assessment presented below gives higher weight to goals accompanied by specific targets.

Table 5 National Environment Policy and Strategy: Assessment of coverage alignment with the LEDS

Sector	Coverage Alignment	Priorities on future policy revision
FOLU	◑	➢ Incorporate seagrass meadows alongside mangrove restoration. ➢ Distinguish forest types in alignment with LEDS and updated country mapping.
Agriculture	◔	➢ Address livestock management and/or cap long term. ➢ Incorporate sustainable tech and management (flooded rice, mechanical harvest). ➢ Cross-sector coordination for agricultural residuals (waste/Energy/Transportation).
Energy	◔	➢ Outline incentivization strategies across dependent LEDS actions. ➢ Fuel wood is the only option explicitly mentioned. ➢ Incorporate specific LEDS actions and outline relative strategies.
Transport	◔	➢ Incorporate all LEDS Transport actions and outline relative strategies. ➢ Address long-term, collaborative urban planning.
Waste	◑	➢ Address long term strategy for methane at landfill. ➢ Address cross sector coordination with energy and Agriculture Waste.

Source: Vivid Economics and Lucid Solutions

The subsequent revision should expand the level of detail in 'Strategic Results" goals and targets allowing closer alignment with LEDS goals and targets across all sectors. A thorough analyses should be performed to determine how best to align LEDS goals both within the document and to enhance harmonization of national policies. In most cases a LEDS action will be closely associated to one or more existing policy "Issues" across the "strategic clusters". Some key items to incorporate in the next revision include: specific goals for training in agriculture and energy, and clarifying long-term strategies for collaborative urban planning, methane at the landfill, and biofuels and fuel standards.

The existing policy calls for of "precepts ... for effective environmental governance" and is also intended "as an operational and management tool for the mobilization of resources and capacity development". As such, it is critical for the next revision of the National Environmental Policy and Strategy to also address coordination frameworks and regulatory needs, two high priority LEDS interventions that are shared across sectors. Several new climate change actions proposed require strong cross-sectoral coordination especially in supporting initiatives related to biofuel, composting, fuel wood initiatives, and building energy consumption. There is also a critical need across sectors for regulatory proposals which aim to construct more democratic, transparent, and effective legislation for the effective implementation of climate change actions, especially in regard to land tenure, grading, and utilization and in support of incentivization programs. The next revision should consider updating goal "Green Belize" 3.1 to reflect a more current proposal.

7.3.4 National Climate Resilience Investment Plan (NCRIP)

The National Climate Resilience Investment Plan (NCRIP) (Government of Belize, 2013) provides the framework for an efficient, productive and strategic approach to building economic and social resilience and development. The NCRIP identifies both physical and non-physical intervention areas that take into account current and future risks posed by existing and future climate variability. NCRIP's objective is to improve the resilience of citizens with a focus on infrastructure that is at risk of failure from hazards and extreme climatic events.

Although some LEDS sector goals are reasonably framed for increased future support, few are explicitly mentioned, and none of the latter are presented with targets:

- Only steep slope reforestation is explicitly mentioned in the FOLU sector.
- LEDS actions regarding sustainable agroforestry and management are implied but not explicitly mentioned. The vulnerability of livestock due to climate change is noted but does not address related environmental impacts or targets.
- LEDS energy actions regarding fuel wood, power grid, and building efficiency are the only options explicitly mentioned.
- The policy notes the vulnerability of wastewater systems due to climate change but does not address emissions related outcomes, but only wastewater and waste collection are implicitly covered LEDS options in the sector.
- While transportation is noted as having the highest demand side energy consumption, none of the LEDS transportation actions are explicitly mentioned.

Table 6 NCRIP: Assessment of coverage alignment of current version with the LEDS

Sector	Coverage Alignment	Priorities on future policy revision
FOLU	○	➢ Only LEDS actions regarding steep slope reforestation are explicitly mentioned. ➢ Pursue continued development of full-bodied GIS database and management capability. ➢ Support stakeholders in the management of their physical assets and programmes.
Agriculture	○	➢ Sustainable agroforestry and management are implied but not explicitly mentioned. ➢ Explore and acknowledge balance between resilience and mitigation. ➢ Pursue continued development of full-bodied GIS database and management capability.
Energy	◔	➢ LEDS fuel wood, power grid resilience, and building efficiency are explicitly mentioned. ➢ Align grid resilience strategy with long-term (power grid) renewables management plan.
Transport	◔	➢ None of the LEDS transportation actions are explicitly mentioned. ➢ Clarify emissions reducing transportation goals more specifically.
Waste	○	➢ No explicit coverage of emissions related goals or targets. ➢ Explore impacts of recycling, composting, and methane handling at landfill.

Source: Vivid Economics and Lucid Solutions

Subsequent revisions should also seek to express LEDS options within NCRIP interventions and demonstrable alignment to long-term LEDS targets where reasonable, across all sectors. Investment on management capability supporting the various stakeholders on their physical assets and programmes is critical. On Energy, it will also be important to clarify the country's position on natural gas, and to continue addressing the need for balancing renewables management within the power grid, as well as for reducing transmission and distribution losses. On Transport sector, investments for increased electrification should be clarified. On Waste, expansion on both, waste and wastewater collection will demand relevant capital expenditures, as well as reducing landfill methane emissions. On agriculture, funding efforts should aim financial schemes to support producer investment on sustainable practices. Finally, on FOLU, next revision should also pursue reforestation initiatives, as well as continued development of deforestation monitoring tools.

NCRIP revision should also consider mapping existing and proposed governance structures supporting intersectoral policy updates and country goals, establishing a robust, overarching framework that mainstreams climate change. This includes support to provide progress reports/ MRV on the status of the development of key supporting instruments (i.e., equitable access to spatial data) and to expand spatial data goals to include a publicly shared database with a land tenure layer.

7.3.5 Revised Low Carbon Development Roadmap for Belize

The first version of the Low Carbon Development (LCD) Roadmap (Miguel Chavarría, 2016) was designed in 2015 in order to guide the development of decisive actions for a lower carbon and more resilient future. The second version, released in 2016, integrates fundamental elements of the GSDS, in addition to elements of other public policy instruments that provide insights about specific sectors. The second version includes specific action datasheets (including responsible entity, start and duration, outputs and estimated costs. It is organized across 27 actions, grouped in 6 different areas: enabling environment (5 actions), policy instruments (10 actions), mobilization of resources (3 actions), capacity building (4 actions), disclosure (2 actions), and GHG emissions MRV and M&E (3 actions).

Coverage of specific LEDS actions across all sectors is low. However, actions proposed within the "Revised Low Carbon Strategy" indirectly support LEDS goals through capacity building, funding, and regulatory reform actions, which in most cases align with interventions necessary to achieve goals as documented by stakeholder feedback. Regarding specific sectors:

- Of the LEDS Agriculture options, only the general concept of sustainable agricultural practices is covered. There is no explicit reference to LEDS sub-action targets, but the policy proposes education and technological training for farms which aligns with high-level interventions identified in LEDS through stakeholder engagement.
- Of the LEDS Energy options, grid optimization is an explicitly stated priority. In addition, some coverage exists for wind and hydro power as suggested options for RE replacements of fossil fuel use. Distributed solar is covered indirectly although solely via prioritized recommendations toward electricity regulatory reform necessary to achieve LEDS goals. Building related actions are partially covered within a proposed actions to prioritize a high-level urban /rural land use reform. There is no explicit reference to LEDS sub-action targets, but the policy prioritizes regulatory reforms, education, and fiscal preparedness which aligns with high-level interventions identified in LEDS through stakeholder engagement.
- The policy bears no explicit reference to LEDS Waste options or sub-actions and targets. The policy scoring reflects where coverage of LEDS sub-actions is implied through proposed fiscal and regulatory actions specific to carrying out the existing Solid Waste Management Plan, which demonstrates alignment with LEDS for those sub-actions.

Table 7 LCD Roadmap: Assessment of coverage alignment of current version with the LEDS

Sector	Coverage Alignment	Priorities on future policy revision
FOLU	◔	➢ Only the reduction of forestation is covered, no explicit reference to LEDS targets. ➢ No revision recommended.
Agriculture	○	➢ Only the general concept of sustainable agricultural practices is covered. ➢ No revision recommendations.
Energy	◔	➢ Grid optimization is an explicitly stated priority. ➢ some coverage for wind, hydro power, distributed solar, and building related actions. ➢ No revision recommendations.
Transport	◔	➢ No LEDS options are explicitly stated, but capacity building interventions may be of value. ➢ Implied support for fuel standards and reduced fuel emissions across vehicle types. ➢ No revision recommendations are proposed for this policy.
Waste	◔	➢ No explicit reference to LEDS Waste options or sub-actions and targets. ➢ No revision recommendations are proposed for this policy.

Source: Vivid Economics and Lucid Solutions

No revision is planned for this policy, as for the most part the policy is superseded by LEDS. However, it may be beneficial to cross-compare proposed regulatory changes, funding sources, and MRV implementations from the policy into the next revision of the GSDS.

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Annex A: Assessment of LEDS alignment with sectoral policies and strategies

A.1 FOLU: National Forest Policy

The National Forest Policy (Government of Belize, 2015) consists of 11 guiding principles and 15 policy statements, each with a set of strategies for the implementation of the policy statement. One of the policy statements looks at mainstreaming adaptation and mitigation to climate change into the management objectives of government's national forest program.

The policy proposes high-level strategies which generally align with interventions identified by LEDS stakeholder engagement, and all the FOLU actions are outlined within the policy. Policy scores for integrated and sustainable land management actions reflect strong coverage of land use management and policy harmonization, although the LEDS actions are not explicitly stated. The remaining LEDS actions are also not explicitly stated but are generally supported through the outlining of "key issues", where scoring reflects the level of specificity in correlation to the specific support needs discovered through LEDS stakeholder feedback. Only the LEDS action for reduction of fuel wood consumption is supported within thepolicy framework.

Table 8 National Forest Policy: Assessment of coverage alignment of current version with the LEDS

Sector	Coverage Alignment	Priorities on future policy revision
FOLU	●	➢ All of the FOLU actions are outlined within the policy. ➢ Include specific targets for the regulatory and coordination mechanisms proposed. ➢ Define forest typologies and their association with land grade and land use policy.
Agriculture	◐	➢ Strong coverage of land use management and policy harmonization. ➢ LEDS actions are not explicitly stated. ➢ Set targets for the regulatory and framework first steps set outlined in both documents. ➢ Detail implementations which are aligned with both agriculture and FOLU targets.
Energy	○	➢ Only the reduction of fuel wood consumption is supported within the policy framework. ➢ Coordination of land use mapping with Renewable Power Grid opportunities.
Transport	○	➢ None of the LEDS transportation actions are explicitly covered ➢ Outline impacts of transport strategies on LEDS actions
Waste	◔	➢ None of the LEDS waste sector actions are explicitly covered. ➢ Define guidance regarding waste sector goals within forest policy strategies.

Source: Vivid Economics and Lucid Solutions

Next revisions should emphasize recommendations to ensure harmonization between related sectors. To support cross-sectoral agendas, it will first be necessary to further define land typologies and areas which forestry has authority over. More specifically, their association with land grade and land use policy. While improving forestation protections in FOLU, the exercise will also clarify guidelines and regulations in natural resource management that are needed to address feasibility studies and plans for renewable applications in the Energy sector. Correlations should also be outlined to other LEDS sector actions that are dependent on land use regulation, such as: “energy generated by biogas” and “energy efficiency in buildings” in the Energy sector; road development related to agriculture sector goals regarding market access, and biofuels production and transportation; and for guidelines aligned between the FOLU and Waster sectors for the efficient use of organic matter as an energy resource.

The next update also presents an important opportunity to streamline government policies by aligning policy programs and goals with corresponding LEDS timeframes and targets, as well as with corresponding policies such as the National Forest Program (NFP). To further streamline government policies, subsequent revisions should include specific targets for the regulatory and coordination goals within the NPF and other sector documents, allowing for a broad alignment of LEDS targets across the varied policy statements. Emphasis should be given to increasing the stability of cross-sectoral democratic management of natural resources, regardless of changes in political structure.

*It should be noted that the Belize National REDD+ Strategy work is a responsible for a great deal of the country’s progress towards combatting deforestation. However, it was not possible to include the milestone policy in this evaluation as the completion of the first working draft coincided with the conclusion of the LEDS Action Plan.

A.2 FOLU: National Land Use Policy

For the Land Use Policy Framework (Ministry of Natural Resources, 2019) a draft updated policy has been developed. This update considers how the Government’s climate change targets can be delivered in alignment with sector-specific needs. Policy commitments include the creation of green and recreational areas in urban centers, incorporation of change analysis into all national agricultural strategies and the cessation of development in vulnerable environments.

Overall alignment is limited largely due to a lack of processes that allow for the effective implementation of LEDS goals. Policy recommendations provide a strong foundation for LEDS forestation interventions across sectors. Specifically, the focus on land tenure transparency, cadastral information, and increased natural resource coordination is well aligned with steps needed to support the incentivization and implementation of LEDS FOLU goals. While specific agriculture actions are not covered, policy recommendations provide strong foundation for LEDS agriculture interventions by outlining land tenure transparency, soil quality, land grading, and natural resource coordination goals all of which are imperative in achieving effective LEDS implementations. The majority of current LEDS Transport and Waste mitigation options are unrelated to land use. LEDS targets that are related to land use policy will be primarily impacted through development and infrastructure planning strategies.

Table 9 Land Use Policy Framework: Assessment of coverage alignment with the LEDS

Sector	Coverage Alignment	Priorities on future policy revision
FOLU	◐	➢ Support for specific FOLU mitigation actions is implicit only. ➢ Land tenure transparency and cadastral information is well aligned. ➢ Land tenure, monitoring, and enforcement Legislation revisions. ➢ Quantifiable natural resource measures with public-private oversight.
Agriculture	◔	➢ Support for specific agriculture mitigation actions is implicit only. ➢ Increase coordination between agencies, sectors, land use regulation, and enforcement.
Energy	○	➢ No actions or targets explicitly covered. ➢ Ensure public access of GIS and Land Tenure database for incentivization programs.
Transport	○	➢ Only targets related to development and infrastructure planning are presently relevant. ➢ Enforcement of legislated town development, planning guidelines and SOPs. ➢ Ensure mid-term sector plans are aligned between land policy and LEDS targets.
Waste	○	➢ Only targets related to development and infrastructure planning are presently relevant. ➢ Enforcement of legislated town development, planning guidelines and SOPs. ➢ Ensure mid-term sector plans are aligned between land policy and LEDS targets.

Source: Vivid Economics and Lucid Solutions

Next policy revisions should outline objectives for achieving legislative updates that that democratize department authority and ensure transparency of cadastral data and lands department processes. The existing policy provides a foundation for land tenure transparency in the context of agricultural and natural resource protections. However, throughout LEDS stakeholder engagement, a lack of transparent cadastral data was identified as a key barrier to a much broader set of GHG reduction goals across sectors, with a lack of democratic governance over department processes identified as the formative variable. The next revisions of National Land Policies should outline an alternative diverse and democratic authoritative body to displace the discretion of a single authority, and move to grant public access to country wide GIS and land tenure data. It would also be effective. It will also be necessary to streamline policy timelines to ensure mid- term sector plans are executed as outlined in National Strategies and apply quantifiable measures to naturalresources. Implementation proposals within the next revision should aim to further define formal coordination mechanisms between agencies, sector policies, and land use regulation and enforcements (to include livestock). For the Transport and Waste sectors specifically, next revisions should focus on effective and democratic collaboration toward comprehensive, long-term infrastructure plans, and enhancing the enforceability of legislated town and village protocols.

A.3 FOLU: Integrated Coastal Zone Management Plan (CZMP)

The Integrate Coastal Zone Management Plan (2016) outlines a vision and implementation plan for sustainable use of coastal resources, supports an integrated approach to development planning and adapting to Climate Change. The Plan contains critical measures for Climate Change adaptation relevant to this sector, which includes the identification of short, medium and long-term strategies to address the threats of Climate Change on coastal communities as well as coastal and marine resources. The management plan also takes into consideration the necessary adaptive measures to mitigate projected Climate Change impacts and recommends that all developments within the coastal areas of Belize include an adaptation strategy to mitigate the effects of Climate Change. It also recommends the prioritization of ecosystem-based adaptation as it builds resilience and reduces the vulnerability of local communities to Climate Change.

LEDS actions are generally well covered across sectors where appropriate. As would be expected, LEDS FOLU actions regarding broad leaf forestation and forest fire are not specifically addressed under the ICZMP but the policy covers the other LEDS FOLU actions relatively well. LEDS agriculture actions which are related to water quality and coastal agriculture are well covered. In general, scoring across LEDS energy sector actions reflects the robust coverage of cross sectoral, regulatory and coordination goals toward GHG reduction and biodiversity. LEDS energy actions related to water, wood fuel, and green waste management scored higher, where the policy outlines specific actions supporting goals in those areas. In general, scoring across LEDS Waste and Energy sector actions reflects the robust coverage of cross sectoral, regulatory and coordination goals toward GHG reduction and biodiversity. LEDS energy actions related to water, wood fuel, and green waste management scored higher, where the policy outlines specific actions supporting goals in those areas. Waste sector actions scored highest where policy outlines specific actions for dealing with the illegal release of hazardous liquid and solid waste into coastal waters. Policy coverage is low regarding current LEDS transportation actions. While there is no specific target set in LEDS, the broad coverage of maritime transportation within the policy is a good precursor for long term LEDS actions which require maritime data collection as a first step.

Table 10 CZMP: Assessment of coverage alignment of current version with the LEDS

Sector	Coverage Alignment	Priorities on future policy revision
FOLU		➢ Update status and set targets for shared GIS, monitoring, and regulatory changes. ➢ Align LEDS and NDC action targets to specific policy interventions.
Agriculture		➢ Water quality and coastal agriculture are well covered. ➢ Need targets and implementations for regulatory instruments monitoring improvements.
Energy		➢ Robust coverage of cross sectoral, regulatory and coordination goals. ➢ Define relationships of LEDS goals to water, wood fuel, & green waste strategies.
Transport		➢ Policy coverage is low regarding current LEDS transportation actions. ➢ maritime transportation within the policy is good. ➢ Expand maritime transportation to include database for future GHG reduction goals.
Waste		➢ Robust coverage of cross sectoral, regulatory and coordination goals. ➢ Define relationships of LEDS actions to waste related CZMAI goals.

Source: Vivid Economics and Lucid Solutions

Next revisions should ensure alignment with prioritized interventions such as updating regulatory frameworks and improving monitoring systems and information sharing. It will be imperative to adhere to policy update schemas, ensuring that medium-term sector policies are executed as proposed under Horizon 2030, and that they incorporate LEDS targets while aligning with both national and regional coastal community policies. The next revision of the policy should update the status of the monitoring system and proposed regulatory revisions and set targets for tracking the progress of both high priority interventions. Subsequently, it would be helpful to align LEDS and NDC targets to specific policy interventions. It would alsobe prudent to expand and leverage the existing coverage of maritime transportation for future GHG reduction goals by setting targets for the collection and sharing of data regarding maritime vessel registration, use, and routes.

A.4 Agriculture: National Food and Agriculture Policy

The Revised National Food and Agriculture Policy 2015 to 2030 (Belize, 2015) promotes the diversification of agriculture to increase the income of the rural sector, actively promoting market/trade expansion, increasing the efficiency, profitability, and competitiveness of the sector, as well as improving and conserving the natural resources to ensure long-term sustainable productivity and viability. It makes no direct reference to climate change adaptation measures relevant to this sector. However, the policy highlights the agriculture sector's vulnerability to economic shocks, diseases, natural disasters, and climate change that can create serious challenges.

While the policy good coverage of barriers and interventions, very few LEDS actions are specifically outlined. Among the Agricultural LEDS actions, the policy only covers the investment and growth of markets and the implementations proposed center on economic impacts, which could undermine the achievement of LEDS targets, especially in regard to livestock where a production cap is proposed. The second highest scores for Agriculture actions are based on general recommendations regarding soil analysis and conservation, which provide indirect support for agronomic practices and sustainable land management. None of the LEDS Energy, Transportation or Waste sub-actions are specifically covered. However, some scoring reflects implied coverage of fuel standards via proposals to strengthen the efficiency of bio-fuel production, market readiness infrastructures, renewable energy policies for farming. In the FOLU sector, only the LEDS action regarding forest fire reduction is explicitly mentioned. Scores for LEDS forestation related actions, which are not explicitly outlined, reflect the implied coverage of those actions based on the policy's support for carbon market and sequestration measures.

Table 11 National Food and Agriculture Policy: Assessment of coverage alignment with the LEDS

Sector	Coverage Alignment	Priorities on future policy revision
FOLU	◐	➢ Only implied coverage of actions for agricultural related carbon market & sequestration.
Agriculture	◔	➢ Expand to encompass all LEDS Agriculture Actions and targets. ➢ Continue to explore export alternatives to livestock.
Energy	◔	➢ Align to Energy Sector MRV. ➢ Detail coordination strategies with grid scale renewable implementations and outcomes.
Transport	○	➢ Outline coordination strategies between Transportation and Agriculture. ➢ Align with MRV targets (fuel blending, standards, and freight transportation).
Waste	○	➢ Outline coordination strategies between Waste and Agriculture. ➢ Align with MRV targets (agricultural waste).

Source: Vivid Economics and Lucid Solutions

Next revisions should explore opportunities to integrate all LEDS actions and targets, aligning policy strategies with LEDS interventions and NDC MRV data points. It is also important to align a framework across all agriculture impacting policies and legislation that supports the implementation of standardized agricultural practices and organic certifications with the formal coordination mechanisms between FOLU and Agriculture. While the policy covers years through 2030, it is recommended a next revision be prioritized earlier and outline coordination strategies between Agriculture, Waste, and Energy. It should also aim to accommodate MRV data collection and include LEDS targets specifically for fuel blending and standards, freight transportation, and agricultural waste. It would be beneficial to further detail the coordination strategies regarding solar, wind, and especially hydropower and biomass implementations and continue to explore export alternatives to livestock.

A.5 Agriculture: National Adaptation Strategy to address climate change in the agriculture sector in Belize

The National Adaptation Strategy to address climate change in the agriculture sector in Belize (CCCC, Ministry of Forestry, 2015) sets out a strategy to address the current and projected impacts of climate change on the agriculture sector in Belize. It introduces measures to address the detrimental effects of climate change such as: direct effects from rainfall changes (excess, shortage and variability), direct effects from temperature increase, indirect effects of rainfall and temperature changes (greater than changes in pests and diseases status) and indirect effects of rainfall and temperature changes (greater than changes in soil fertility).

There is no explicit coverage of LEDS validated actions or sub-actions. Across sectors scoring is based primarily on the level of contextual support in the policy for LEDS actions. In that regard, there is reasonable coverage of improved practices in rice farming, especially in addressing water as a prioritized natural resource and through proposals regarding land use and grading, which would make sustainable land and livestock management more feasible. Actions with implicit coverage in the Energy FOLU and Waste sectors include biomass processing, mangrove extraction avoidance, aquaculture facilities resilience, renewable energy water pumps, and lowering electricity costs to farmers. The policy specifically covers measures to collect and compost agriculture residues and green waste. However, no other LEDS Waste options are directly or indirectly covered.

Table 12 National Adaptation Strategy for Agriculture: Assessment of coverage alignment with the LEDS

Sector	Coverage Alignment	Priorities on future policy revision
FOLU	○	➢ No explicit coverage.
Agriculture	◐	➢ Detailed coverage of improved practices in rice farming. ➢ Good coverage of water as a critical natural resource. ➢ implied support based on a secondary benefits of land use and grading.
Energy	○	➢ No explicit coverage.
Transport	○	➢ No explicit coverage.
Waste	○	➢ No explicit coverage.

Source: Vivid Economics and Lucid Solutions

It is believed that the majority of mitigation actions proposed in the existing document have been integrated into the correlating sector policy and that no revision is expected for this document. However, expanding to include detailed implementations is an option should a next revision take place. As the document is largely a technical risk assessment. ensuring that GHG reducing measures across sectors are highlighted in future sector policies would be a more effective use of resources,

A.6 Energy: Belize Sustainable Energy Strategy (SES)

The Sustainable Energy Action Plan: Belize 2014-2030 is a tool to achieve Belize's renewable energy and energy efficiency potential while meeting the Government's economic social and environmental goals. It provides a framework of actions and tasks to overcome barriers to sustainable energy for the period 2014-2030.

Most energy sector LEDS actions are well covered as expected. Overall, the document provides robust economic projections and energy data with opportunity projections for Belize. The NSES provides good coverage of the primary barriers to implementation, which largely align with interventions identified within LEDS. Some highlights:

- The Strategy provide significant emphasis on 'stationary fuel use´ (use of fuel for electricity generation), providing a relevant discussion of technical viability of renewable energy sources.
- With a primary focus on the technical viability of renewable energy and potential savings, there is lower alignment on mitigation sub-options related to Natural Gas.
- A lower score was given to the reduction of wood fuel, due to the lack of associated tangible interventions supporting the theory.

Many non-energy sectors are partially covered, due to areas in which they that interact with energy somehow:

- The coverage of LEDS FOLU options is generally low as expected, given it is not the focus the document; nevertheless, scoring for some FOLU options reflects the broad discussion regarding land use and appropriation in general.
- The policy does not cover any LEDS agriculture options or related agricultural issues in general, but scores reflect some coverage based on strong support for biofuel goals related to sugar and even forestry waste.
- The policy acknowledges transportation sector impact on GHG emissions. A higher score was given for the inclusion of fuel standards improvement and the well covered topic of biofuels. No consideration was given to the use of electricity for transport.
- The policy does not mention any specific action proposed within LEDS for the waste sector, but it does suggest, however, the use of landfill gas as renewable energy, and generally supports the high-level steps needed to move toward LEDS targets.

Table 13 Belize Sustainable Energy Strategy: Assessment of coverage alignment with the LEDS

Sector	Coverage Alignment	Priorities on future policy revision
FOLU	◔	➢ The coverage of LEDS FOLU options is generally low as expected. ➢ Expanded 5.3.2 to strengthen permitting policies via transparent NEEP institution.
Agriculture	◐	➢ The policy does not cover any LEDS agriculture options. ➢ Carryover specific supporting data to NEPF.
Energy	◕	➢ Address long-term Natural Gas strategy. ➢ Carryover data to NEPF aligned as prescribed in the overall policy assessment.
Transport	◔	➢ Streamline data from (3) energy sector policies under the NEPF. ➢ Align carryover and MRV with cross sectoral goals/targets including all Transport actions.
Waste	○	➢ No coverage of specific action proposed within LEDS waste sector. ➢ Streamline data from (3) energy sector policies under the NEPF.

Source: Vivid Economics and Lucid Solutions

The next iteration of the SES should further detail the targets and implementation for highlighted actions and for the regulatory and technological interventions that impact multiple sectors. The sector has made good progress on many of the proposals in this policy, the majority of which have already been evaluated and integrated into sector plans, especially in renewable energy. However, some unresolved barriers remain for specific goals. Section 5.3.2 addresses a gap in legislative instruments prescribing the use of protected lands for renewable energy, and important licensing issues within electricity sales and PAs. Regulatory, technological, datacentric, and market readiness are discussed which are also interventions that overlap with the LEDS. Ideally the next revision would expand on the latter solutions, analyze the document for similar scenarios, outline the actions as supporting various sectors, and potentially include targets for the interventions themselves.

The SES has broader coverage of building efficiency goals than other policies but will but will require an even more in-depth examination of long-term, sustainable approaches. The next revision should include a broader set of potential approaches and further consider international supporting data regarding design and construction methodologies and building benchmarking programs. In addition, targets in section three will need to be updated for energy efficiency and renewable energy. In agriculture the next revision of the SES should further detail implementation processes shared with the waste, energy and transport sectors around biofuel production and distribution and update the supporting data. For the transport sector, the next revision will need to propose implementations and frameworks for integrating last mile transportation into publics transit. A comparative analyses of implementation timeframes of long-term roadway and public transportation design may be helpful for applying prioritization frameworks.

A.7 Energy: MESTPU Strategic Plan

The Ministry of Energy, Science & Technology and Public Utilities Strategic Plan 2012-2017 (PUC, 2012) provides the outline for the Sustainable Energy Strategy in the development of a low carbon economy 2012 – 2033. It identifies Science, Technology and Innovation (STI) strategic options and the technology needed to transition the energy sector and economy toward low carbon development. It also identifies strategic elements required to build resilience of the economy to climate change.

Coverage for LEDS options in the FOLU, Agriculture, Transportation, and Waste sectors is quite low. Across sectors a value was placed on contextual narratives which support various goals. For example, there is no direct reference to LEDS FOLU actions, but the policy expounds on deforestation, the advantages of developing a country wide lands assessment, and increasing the efficiency of land allocation, all of which correlate to high priority LEDS interventions identified by stakeholders. Similarly for agriculture, the policy includes high-level coverage of livestock and sustainable farming issues which support appropriate land management, and long-term solutions, such as public education, barriers stemming from traditional agricultural production, technological resources, fiscal arrangements, connectivity to export markets, and inter-sectoral synergies, especially for biofuel production. Regarding LEDS transportation options, high-level goals demonstrate a general alignment including the overall reduction of conventional fuel use and a broad examination of the use of waste streams and conversion technologies. A few LEDS sub-actions were lightly touched upon in the Waste sector as general discussions regarding composting and the upgrading of wastewater treatment. The expansion of natural gas is expectedly the least covered LEDS energy option, due to the contradiction of fossil fuel use. While building related implementations will require more detail to be in keeping with LEDS long-term goals, the existing policy provides good coverage of effective strategies.

Table 14 MESTPU Strategic Plan: Assessment of coverage alignment of current version with the LEDS

Sector	Coverage Alignment	Priorities on future policy revision
FOLU	○	➢ Assimilate country lands assessment coverage into next NEPF.
Agriculture	◔	➢ Good coverage of barriers, export market connectivity, and inter-sectoral synergies. ➢ Assimilate above and broad coverage of biofuel production into next NEPF.
Energy	●	➢ Assimilate building related strategies into next revision of NEPF. ➢ Assimilate coverage of barriers and novel strategic options into next revision of NEPF.
Transport	◑	➢ Expand on synergistic implementations of evolving LEDS w carbon transportation targets. ➢ Assimilate above and conversion technologies coverage into next release of the NEPF.
Waste	◔	➢ Expand Waste sector synergistic implementations of evolving LEDS low carbon waste. Assimilate above and examination of the use of waste streams into next NEPF.

Source: Vivid Economics and Lucid Solutions

It will be most impactive to define a systemic approach to disseminating MESTPU strategies into sector policies and align project and policy timeframes. One barrier identified throughout the development of LEDSis a lack of synergy between policies and policy development timeframes. In recent years much progress has been made in advancing the level of collaboration between government organizations, but additional work will be needed. The MESTPU strategic plan provides exceptional analysis of barriers and regulatory solutions that expand on many of the interventions identified in LEDS. For instance, it contains a broad examination of the use of waste streams which may not be directly expressed in the waste sector policy. Ultimately the proposals are only as useful as they are implementable via coordinated efforts. Systemic processes need be delineated for aligning with evolving sector strategies over time and for prioritizing the breadth of projects within a standard framework. The next revision of the MESTPU should define a pathway for integrating the “Strategic Options for Implementation” and “Technological Readiness” proposals (Ch 3.1 and 3.2) into sectorpolicies and evolving mid-term sector plans. As the purpose of the MESTPU is to integrate “energy, science and technology into national development planning” the next policy revision should propose technological solutions to cross-sectoral barriers, such as an electronic public GIS land tenure database, and centralizing the varying MRV systems currently under development.

A.8 Energy: National Energy Policy Framework

The National Energy Policy Framework (Tillett, 2011) aims to provide options to pursue energy efficiency, sustainability and resilience over the next 30 years. It provides a framework of actions and tasks to overcome barriers to sustainable energy. It also makes the link between sustainable energy and climate change, including consideration on risks and impacts.

Of all national energy policies, the NEPF has the greatest alignment with LEDS Energy Sector actions but the coverage for LEDS options in adjacent sectors is quite low. LEDS energy actions are well covered and primarily call for an update of supporting data. The moderate scores for FOLU reflect the document's coverage of synergistic approaches to cross sectoral relationships supporting deforestation in general, but noLEDS options are explicitly mentioned. The policy touches on the relationship between driving habits and fuel economy provides contextual support for the LEDS Transportation plan, but no specific actions or targets are not discussed. The same is true for LEDS agriculture actions, where a discussion of oil-based versus bio-based resources could be expanded upon to include more outcome-based narratives and GHG quantities. Regarding LEDS Waste actions, the policy outlines waste recovery from the perspective of the efficient capture and reuse of heat and steam waste for energy and solid Waste is touched on in data tables which support the assumptions and recommendations made. Also, while the flaring of methane is discussed, no direct reference is made to landfill or solid waste applications. Waste recovery for biofuel is covered in greater detail, but for LEDS and other projects, this falls under the agriculture and Waste sectors.

Table 15 National Energy Policy Framework: Assessment of coverage alignment with the LEDS

Sector	Coverage Alignment	Priorities on future policy revision
FOLU	◔	➢ Does not cover any specific LEDS options. ➢ Good coverage of synergistic, cross sectoral approaches supporting deforestation.
Agriculture	◑	➢ Expand oil vs. bio-based to include more outcome-based narratives and GHG targets. ➢ Outline specific frameworks for agriculture to energy biomass processing. ➢ Needs coordination frameworks to align energy and agriculture targets.
Energy	●	➢ NEPF has the greatest alignment with LEDS energy goals of all policies.
Transport	●	➢ Prescribe emissions testing, registration programs, and centralized data collection. ➢ Collect data demonstrating the relationship between driving habits and fuel economy. ➢ Update current and projected costs alongside original projections. ➢ Revise proposals to align updated projections and LEDS targets.
Waste	○	➢ The policy coverage of LEDS GHG reducing actions for the waste sector is less than ideal. ➢ Outline specific landfill or solid waste applications. ➢ Align coverage of Waste recovery for biofuel with agriculture and waste sectors.

Source: Vivid Economics and Lucid Solutions

Priorities for the next revision are to update frameworks and energy sector data and goals, and align timeframes between LEDS, NDC and related policies. Since the policy is intended as a road map for mid-term decision making, in some cases it will be necessary to expand on cross sectoral LEDS goals and outline collaborative processes and responsibilities for their implementation. For example, expanding biomass production will require streamlined efforts between the energy, agriculture, and waste administrations. Within the Transport sector the existing policy presents context relating several transport goals to energy, even discussing the relationship between driving habits and fuel economy. To support implementation across LEDS goals, it will be necessary to expand on the existing narrative and propose supporting frameworks such as: centralized and standardized data collection to support emissions testing and vehicle registration programs (including data for flex fuel and EV), and revised permitting, operational standards, and data collection systems for public transit, supporting the GHG benefits of optimizing bus routes, improved inter urban road conditions in collaboration with urban planning.

It will also be imperative to propose frameworks for energy objectives in building efficiency, some implementations of which are dependent on regulatory and standards reforms. Building certification programs, building code, and land tenure database legislation need to be developed. Toward that end, LEDS proposes planning for the use of the Energy Utilization Index (EUI) as the basis for quantifying the energy performance of buildings, and therefore incentivization mechanisms across the board. Regulations based on international standards and data collections are also needed to effectively administer appliance and lighting programs. LEDS outlines the utilization of an international energy consortium or consultant to simplify and optimize the long-term management and tracking of energy programs. It will be necessary to update the status of lighting retrofits, the estimated lighting consumptions by type, and align lighting and appliance programs to international benchmarks to avoid standards with common counter-productive outcomes due to low-quality products. In addition, specific data will need to be updated within the policy. Some notable examples include: expanding on oil-based versus bio-based resources to include GHG quantities and more outcome-based narratives, incorporating current and projected petrol and biofuel costs alongside original projections, and updating primary and secondary energy source projections and renewable energy source material costs. Ultimately, all NEPF "Plan Parameter" targets need be updated to align with LEDS targets across sectors (p 158).

A.9 Transport: Comprehensive National Transportation Master Plan (CNTMP) for Belize

In the Transport sector, the most relevant framework is the Comprehensive National Transportation Master Plan for Belize (Government of Belize, 2018b). It aims to facilitate sector planning as well as a more efficient and effective transport within Belize, and between Belize and its trading partners. The plan aims to foster the development of the national economy, particularly of the agriculture and tourism sectors. It also aims to build resilience of the transport sector to the impacts of climate change. It does not specifically address climate change mitigation options but rather more infrastructural plans. However, in its short, medium and long term and under its Environmental and Energy Action Plan it addresses energy efficiency in light duty vehicles and the adjustment of taxes applied to new and used vehicles based on emissions, age of vehicle or its fuel consumption.

The Transportation plan has the highest level of alignment with related LEDS actions of all sector plans. The National Transportation Master plan covers all but one of the LEDS actions for the sector, which is “Improving the efficiency of last-mile urban transportation.” The development of bus stops is well highlighted, but more detail is needed regarding park and ride scenarios. The same is true in the energy sector where electric vehicle options are covered but lack detail. The policy provides good context related to a minimal number of LEDS actions from each of the remaining sectors by providing broad coverage of transportation related considerations in agriculture as a major socioeconomic lever, conservative coverage of potential issues regarding the transport of hazardous materials and waste products resulting from new developments, and an approach to addressing erosion and infrastructure design efficiency in FOLU. For those reasons, LEDS actions for Integrating Forest and Sustainable Land Manage were scored slightly higher However, none of the LEDS actions for these sectors are specifically addressed.

Table 16 CNTMP: Assessment of coverage alignment of current version with the LEDS

Sector	Coverage Alignment	Priorities on future policy revision
FOLU	◔	➢ Only lightly covers erosion and infrastructure design efficiency. ➢ Incorporate provisions ensuring cross sectoral input to transport planning.
Agriculture	◔	➢ Agriculture actions are not explicitly covered. ➢ Broad coverage considerations of agriculture as a socioeconomic lever. ➢ Incorporate provisions ensuring cross sectoral input to transport planning.
Energy	◔	➢ Consider impact to LEDS Energy actions across infrastructure project portfolio. ➢ Needs proposed frameworks for
Transport	◕	➢ Coordination with urban planning regarding long-term and park and ride scenarios. ➢ Outline options and energy guidelines for electric vehicle (EV) infrastructure. ➢ Expand and share registration data and include maritime vessel registration.
Waste	◔	➢ Only addresses potential issues regarding the transport of hazard material and waste. ➢ Need to identify future infrastructure design impact on LEDS waste actions. ➢ Consider all potential methods for aligning with LEDS waste sector targets.

Source: Vivid Economics and Lucid Solutions

The next revision of the Master Transportation plan should propose regulatory revisions to introduce new standards, improve the enforceability of new and existing metrics, and support incentivization schemas. Some examples include setting operational standards for public transit to enhance ridership and tourism, developing regulatory proposals to align loan programs for public and private operators with licensing timeframes, and clarifying universal registration requirements that support new vehicle data collection processes.

It will be necessary streamline related policies and efforts and incorporate collaborative long-term planning to support the successful implementation of LEDS actions. Sector recommendations and new implementation plans should be structured to align with LEDS transportation targets. It will be necessary to identify collaborative opportunities for high-level goals such as updating and sharing DoT databases, including maritime data, incorporating the overall reduction of conventional fuel from the MESTPU policy, and outlining a collaborative process between Energy and Transportation to support the development of a vehicle charging infrastructure. The latter objective is especially significant for the implementation of last mile transportation. For instance, bus stops are well highlighted, but far more detail is needed regarding parkand ride scenarios including last mile transportation types such as bicycles, scooters, and golf carts. Cross sectoral collaboration with urban design and housing staff will be necessary to ensure a cohesive, and optimal long-term plan. Collaborative input may also be helpful in identifying the impacts of infrastructure design on Agriculture and Waste objectives.

A.10 Waste: National Solid Waste Management Strategy & Implementation Plan

In the Solid Waste Management sector, the most relevant framework is the National solid waste management policy (Belize Solid Waste Management, 2015). The policy was developed based on the resultsof the analysis of the sector, concluding that the existing system for solid waste management was environmentally and financially unsustainable. Climate change is not explicitly considered in this policy.

The SWM policy covers all LEDS Waste sector actions, but no correlations are noted to any of the LEDS actions for the FOLU, Agriculture, Energy, or Transport sectors. The policy addresses the potential hazardousand general increase in waste from traditional agricultural and land management practices and the potential resulting downstream outcomes. Based on that single context, select LEDS actions, including the promotion of green mechanical harvesting, sustainable land management, and biofuel production, were scored slightly higher. The SWM policy covers all LEDS Waste sector actions, but some LEDS wastewater options could be further defined.

Table 17 National Solid Waste Management Policy: Assessment of coverage alignment with the LEDS

Sector	Coverage Alignment	Priorities on future policy revision
FOLU	◔	➢ Consider the relationship of LEDS Waste targets to FOLU policy action plans. ➢ Outline the appropriate coordination frameworks for each.
Agriculture	◔	➢ Address increased hazardous waste from traditional agricultural and land management. ➢ Detail relationships between waste related LEDS agriculture actions and indicate targets.
Energy	◔	➢ None of the LEDS Energy actions are explicitly covered. ➢ Expand on the relationship between energy waste and LEDS actions.
Transport	◔	➢ None of the LEDS transportation actions are explicitly mentioned in the Policy. ➢ Consider waste related to phasing out combustion vehicles and biofuel production.
Waste	◕	➢ Regulatory and framework reforms are critical first steps for executing LEDS actions. ➢ Detail the relationships between LEDS and SWM Policy action items with LEDS targets. ➢ Ensure alignment with the National Energy Policy Framework.

Source: Vivid Economics and Lucid Solutions

Next revision of the policy should emphasize regulatory and framework reforms are identified as critical first steps and require implementation for waste plans to be executed effectively. Specifically ensuring that the policy is in alignment with LEDS, the National Energy Policy Framework, and the Sustainable Solid Waste Management Act (table 11), the latter of which may require regulatory proposals. Also, regulatory updates to resolve waste fee collection barriers at the municipal level, and to support implementation plans and incentivization schemes for wastewater actions, recycling, composting, and the phasing out of legacy products and combustion vehicles should take precedence.

It will also be necessary to harmonize efforts by outlining the relationships to specific LEDS targets within the "execution of NSWMSP Planned Actions" and by detailing the relationships between LEDS actions in FOLU, Agriculture, and Energy that are related to Waste, and outlining the appropriate coordination frameworks toimplement them. Some key sector actions to cover include waste outcomes of phasing out of combustion vehicles and the increased biofuel production.