Initiative for Climate Action Transparency
Antigua & Barbuda Project

Mitigation Analysis Project Output Scope Report

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The Government of Antigua & Barbuda

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Table of Contents

List of tables /figures

ACRONYMS

BTR	Biennial Transparency Report
BUR	Biennial Update Report
CCMRVH	Caribbean Cooperative Measurement, Reporting and Verification Hub
GACMO	Greenhouse gas Abatement Cost Model
ICAT	Initiative for Climate Action Transparency
LEAP	Low Emissions Analysis Platform
MRV	Measuring Reporting and Verification
PROSPECT+	Policy-Related Overall and Sectoral Projections of Emission Curves and Time Series) Tool
SDG	Sustainable Development Goals
GHG	Greenhouse Gas
NC	National Communications
NC4	Fourth National Communications
NDC	Nationally Determined Contribution

1.0 Introduction

Antigua & Barbuda is a sovereign Small Island Developing State (SIDS) in the Eastern Caribbean. The island is committed to implementing measures to grow its economy in a low carbon and sustainable manner. To assist in achieving this, the country is participating in the Initiative for Climate Action Transparency (ICAT) project.

The Initiative for Climate Action Transparency (ICAT) aims to help countries better assess the impacts of their climate policies and actions and fulfil their transparency commitments. This is executed by increasing the overall transparency capacities of countries, including the capacity to assess the contribution of climate policies and actions on countries' development objectives, and providing appropriate methodological information and tools to support evidence-based policymaking. ICAT capacity development efforts are established to reinforce existing climate measurement, reporting and verification (MRV) systems and knowledge within countries and complement previous or on-going activities by other initiatives.

The focus of the Antigua & Barbuda ICAT project is to establish a sustainable national economy-wide GHG emission projection and mitigation analysis modelling capability. As a result of this focus, one of the first activities in this project is to develop a modelling framework and select an appropriate modelling tool for Antigua & Barbuda's mitigation assessment. The modelling tools assessed were GACMO, LEAP and PROPSPECTS+ and extensive stakeholder consultations were executed to guide the development of the modelling framework. The analytical need for mitigation analysis, projections and MRV was carefully elaborated and the scope of the project was further defined as described in this report through the following Chapters:

- Chapter 2 – Initial Scoping Overview;
- Chapter 3 – Scope Development;
- Chapter 4 – Development and Implementation of Stakeholder Consultations;
- Chapter 5 – Project Output Scope Definition using the feedback from stakeholders;
- Chapter 6 – Stakeholder Validation and follow-up; and
- Chapter 7 – Conclusions.

2.0 Initial Scoping Overview

The current GHG data collection process in Antigua & Barbuda can be improved with the integration of systemic institutional and legislative arrangements. In response and as part of their ongoing effort to improve data collection and reporting, the Government of Antigua & Barbuda is developing regulations around MRV tracking. The envisioned MRV system seeks to monitor both mitigation and adaptation actions including loss and damage tracking and response, received climate support including climate finance, technology transfer, capacity building and GHG emissions. This ICAT project is one of several projects geared towards the effective design and deployment of this MRV system.

This project is focused on establishing a sustainable nation economy-wide GHG emission projection and mitigation analysis modelling capability. The project aims to:

- develop national modelling framework(s) and an underlying input data set for Antigua & Barbuda that can be used to assess GHG, other sustainable development (SD) impacts, targeted policies and actions to support the updating and tracking of its current and future NDCs; and
- to strengthen the capacity of the Antigua & Barbuda government to maintain, use, and improve their national mitigation modelling capabilities for future analyses.

The project focusses on the development and application of one or more of three potential modelling tools for preparing mitigation analysis scenarios for Antigua & Barbuda in support of its NDC and related policy making processes, these are:

- GACMO (Greenhouse gas Abatement Cost Model);
- PROSPECTS+ (Policy-Related Overall and Sectoral Projections of Emission Curves and Time Series) Tool; and
- LEAP (Low Emissions Analysis Platform) System.

Overall, the project will support the evaluation of mitigation, starting with a *baseline scenario* that reflects future socio-economic, energy sector, and GHG emission trajectories for the country that are likely to occur in the absence of implementing mitigation actions and *planned policy scenarios* and to assess key existing and planned mitigation policies and actions. In keeping with its NDC, a thorough assessment of climate change mitigation policies, programs, plans and projects of concern for Antigua & Barbuda will be undertaken to facilitate the development of planned policy scenarios.

3.0 Scope Development

3.1 Understanding the sectoral, technological and temporal scope and resolution

The quantitative representation of GHG source and sinks categories can be used as an important management tool to assess mitigation actions and policies, both into the future (*ex-ante*) and for their historical effectiveness (*ex-post*). However, for these to be done, this quantitative representation must be projected into the future and/or counterfactual past (for all scenarios, baseline and planned mitigation alike). These scenario projections are usually what is referred to as the modelling and this can have varying detail levels based on the desired functional output and national circumstances (amongst others). It is therefore important to define the project scope and output based on these desires and circumstances. This process requires defining many important aspects of the model, including sectoral, technological and temporal scope, and resolution. A general explanation for each of these are presenting below.

3.1.1 Sectoral scope and resolution

The sectoral scope of a mitigation assessment refers to the sectors being represented in the model. For example, some models can be specific to the energy sector, whereas others can be economy wide (representing all sectors). The sectoral scope of this project was already well defined in the initial project scope, as presented in Chapter 2 and reinforced in Appendix 1. Explicit mention is made for an economy wide model (energy and non-energy sectors), but with more detailed representation of energy sources and demand.

The sectoral resolution is the level of detail for any given sector and is usually guided by the nature of mitigation actions (or technologies) to be incorporated. Though the sectoral scope was inherited to be economy wide, the sectoral resolution needed was not previously determined. Stakeholder consultations were conducted for this question and related questions. The feedback received during these consultations are outlined in Chapter 4.

The modelling framework(s) developed under this project will be used to provide a quantitative representation of all source and sink categories of GHGs from both the energy and non-energy sectors in Antigua & Barbuda, including a detailed representation of all sources of energy demand and supply. They should also address other environmental impacts (e.g., air pollution) and social impacts (e.g., macroeconomic effects) identified as policy priorities by the government of Antigua & Barbuda. The representation of each category and sector shall be in keeping with the NDC and other policy priorities of the country.

3.1.2 Temporal scope and resolution of the desired modelling capabilities

The temporal scope refers to the timelines associated with the analysis and projections. Some tools afford the ability to perform these projections sub-annually (as with LEAP), annually (as with PROSPECTS+ and LEAP), or in larger temporal scope (as with GACMO with 5 years cycles up to 2030 and then straight to 2050). Based on the level of detail required in the modelling, for any sub-sectors that are seasonally dynamic (as with electrical supply and demand), sub-annual details or time slices

can be useful. The time slices are a representation of the temporal resolution of the modelling. Stakeholder consultations were conducted to inform the temporal scope and resolution for this project. In Chapter 4, the questions asked and feedback received during these consultations are outlined.

3.1.3 Non-GHG Emissions and Other Sustainable Development Goals (SDG)

In addition to sectoral & temporal scope and resolution, there exists an opportunity (more so with some modelling tools over others) to s the models so that they can analyse areas beyond GHG reduction (such as non-GHG emissions, abatement cost, impact on employment *etc.*). These broader aspects of Sustainable Development Goals (SDGs) can be important when a more holistic sustainable developmental approach is needed, particularly to assess how some GHG mitigation actions can affect other parameters that may also be important to the developmental pathways of a country. This additional level is normally present in very detailed models that are developed over time. When a model is being formulated for the first time in a country, it can be good practice to limit these "additional levels," especially when the focus is on NDC formulation and implementation and then update and add other SDGs later on. Notwithstanding this, stakeholder consultations were conducted to assess some of these important (non-GHG and SDG) additions for this project. In Chapter 4, the questions and feedback received during these consultations are outlined.

4.0 Development and Implementation of the stakeholder consultations

Formal and informal stakeholder consultations were executed. Informal bilateral stakeholder consultations were managed and facilitated mainly through the country coordination team (consisting of the in-country project coordinator and project associates), with information being fed to the larger project team (including the mitigation model developer and mitigation analysis research associate, both of the CCMRVH). For the formal bilateral outreach, three main workshop platforms were used as listed:

- The inception workshop on December 14th, 2020. This workshop had thirty-nine (39) attendees including the consultants and national coordinating team with twenty-three (23) females and sixteen (16) males.
- Further bilateral outreach with energy sector stakeholders on January 12th, 2021, with six (6) attendees including the national coordinating team, three (3) male and three (3) females; and
- A stakeholder Engagement Workshop on February 12th, 2021 (used as a validation platform for the project output scope and is elaborated upon in Chapter 6). This workshop had thirty-two attendees including the consultants and national coordinating team with fifteen (15) females and seventeen (17) males.

The reports for the inception and stakeholder engagement workshop are attached in Annex 1 and 2 respectively. Due to the Covid-19 pandemic and the related restrictions on travel and associated guidelines, these were all conducted virtually using Microsoft Teams. As the audience was large, the project team decided to use an online real-time survey platform (Mentimeter) during these consultations to generate structured and strategic feedback from the stakeholders.

Mentimeter is an easy-to-use presentation software that is based on an audience response system allowing for immediate and integrative responses to a presenter.

4.1 Project Output Scope Questions Asked

The following project output scope-defining questions were asked using the Mentimeter platform during the inception workshop (with a wide cross-section of stakeholders) and further bilateral outreach with the energy stakeholders.

- What sectors would you recommend to be modelled in more detail?
- What mitigation actions would you recommend to be analysed for your sector?
- If you had to pick only one timeframe (from amongst 2030, 2050 and 2100) for this analysis/modelling, which one would you choose?
- What policies apart from the NDCs should the mitigation assessment consider?
- What other sustainable development impacts (from amongst air pollution, job impacts, resilience to extreme weather events, national productivity and economic growth, social impact) should be analysed in addition to GHG emissions?
- For the modelling, when do you need to see the impacts (from amongst seasonally, annually, every 5 years)?

- Which in your opinion is the highest priority for Antigua & Barbuda (from amongst achieving NDC targets, reducing non-GHG pollution, energy security, building resilience, economic analysis, social impact assessment)?

In addition to these specific questions, the stakeholders were allowed the opportunity to provide general feedback and thoughts to guide the formulation of the project output scope.

4.2 Summary of the Feedback from Stakeholder Consultations

The detailed results are presented in Appendix 2, however a summary of the findings are:

- a desire to model all sectors with energy (electricity and transport) and waste being most popular;
- a desire to include a broad spectrum of mitigation technologies with renewable energy and electric vehicles being most popular;
- a strong desire for annual time slices with a minority desire for sub-annual time slices;
- a strong desire for projections up to 2030, with a minority desire for projections up to 2050;
- a desire for assessing the cost associated with the selected GHG mitigation options;
- a strong desire for assessing non-climate impacts such as reducing non-GHG air pollution, resilience to extreme weather events, job impacts and national productivity and growth; and
- a majority of stakeholders outlined that building resilience, achieving NDC targets and energy security should be the highest priorities for Antigua & Barbuda.

Succinctly, the stakeholders desired an economy wide model, with a broad spectrum of mitigation actions/technologies (displaying emphasis on the electricity and transport sub-sectors), with an annual display of results (but sub-annual time slices for electricity) and projections first up to 2030 (for NDC focus) and then thereafter to 2050. Additionally, the impact of associated costs and non-GHG pollutants was desired to be integrated with the possibility of optimization functionality within the electrical sector for energy security.

5.0 Project Output Scope Definition Using the Feedback from Stakeholders

Being a country driven project, the stakeholders' feedback was critical and used appropriately to define the project output scope. However, these were not used in isolation as the project team looked at some major policies, reforms and targets for Antigua & Barbuda to assist with the project output scope definition. A summary of the major ones can be found in Table 1.

Table 1: Major GHG Policy, Reforms and Targets for Antigua and Barbuda

AREA	National Energy Policy (2011)	National Determined Contributions (2016)	National GHG Reduction Strategy (2020) – Revised NDC Considerations
Energy Efficiency	Targeted efficiency and conservation measures designed to reduce the overall energy intensity of the economy within ten years by 10% below the 2010 baseline.	By 2020, establish efficiency standards for the importation of all vehicles and appliances.	To phase-out the use of internal combustion vehicles by 2040.
Renewable Energy	Reformed market framework and mandated targets to achieve 15% renewable energy in the electricity supply by 2030.	By 2030, achieve an energy matrix with 50 MW of electricity from renewable sources both on and off-grid in the public and private sectors.	To phase-out the use of fossil fuels in the power sector by 2030.
		By 2020, finalize the technical studies with the intention to construct and operationalize a waste to energy (WTE) plant by 2025.	
Land Use, Land Use Change and Forestry		By 2030, all remaining wetlands and watershed areas with carbon sequestration potential are protected as carbon sinks.	

It should be noted that these targets are not all that should be considered in a mitigation analysis, as a further elaboration of GHG mitigation actions/technologies and parameters (together with the associated data structures) is one of the next steps in the project. However, to appropriately define the project output scope, this initial assessment was needed to be integrated with the stakeholders' feedback. Overall, a high level of consistency and continuity were seen.

5.1 Proposed Project Output Scope

Based on the feedback received from stakeholders, an outline of the proposed project output scope is now presented.

- To include two baseline scenarios:
    - one scenario reflecting current trends with existing measures for ALL sectors, and
    - one scenario reflecting a baseline without measures, useful for showing the impact of existing policies and measures.
- To include non-energy sector emissions (historical and projections) to make modeling results comparable to most recent GHG inventories.
- To include modelling of individual policies, reforms and targets for the energy supply and energy demand sectors (including transport) and to include the WTE target from the NDC.
- To have individual policies, reforms and targets implemented as individual scenarios and used for generation of Marginal Abatement Cost Curves (MACCs) to assess cost impacts.
- To combine individual measures in different combinations to create representations of overall integrated strategies for policy planning, including:
    - one integrative mitigation scenario reflecting NDC targets, and
    - one integrative mitigation scenario reflecting a more ambitious target.
- To be forward-looking, created to 2050, with focus on 2030 results (for NDC)
- To be available in future to be used and improved by Antigua & Barbuda agencies (e.g., for next NDCs/BURs/NCs/BTR – *ex-ante* analysis) or for monitoring the effectiveness of policy measures (e*x-post*).

5.2 Selection of Modelling Tools

Three modelling tools (GACMO, LEAP, and PROSPECTS+) were considered for this project (as outlined in Chapter 2). An important aspect of the project was to ascertain the suitability of these tools (based on the desired modelling scope and resolution outlined in Chapters 4.2 and 5.1). To do this, a model suitability framework was created using Excel. This associated workbook can be found in Annex 1 and consists of the following worksheets:

- input data worksheet giving an idea of the metadata required for each tool;
- typical pictorial output worksheet giving an idea of some of the output capabilities for each tool;
- tool comparisons worksheet comparing the tools qualitatively based on functionality, accessibility, analytical options and reporting;
- score sheet worksheet assessing the suitability of the tools to Antigua & Barbuda; and
- a high level decision making worksheet which can be used to accommodate for any "must have" based on the functional and analytical capabilities of the tools.

A summary of the three tools (based on functionality) follows.

GACMO is an excel based GHG modelling tool, capable of covering all sectors with a wide variety of mitigation actions. It is open access and very useful for quantifying emission reduction and cost for selected mitigation actions. Projections pathways are exogenous to the model, with little energy supply/demand linkages in the model outputs.

LEAP is a windows based GHG modelling tool, capable of covering all sectors with a wide variety of mitigation actions (more detailed for the energy sector). Though not open access, it has been offered free to Antigua & Barbuda for this project. Projection pathways are endogenous to the model (by linking with GHG emission drivers) and there can be detailed energy supply/demand linkages in the model outputs, allowing for optimization functionality in the Electricity Sector. LEAP can also model cost impacts and assessment of non-climate GHG impacts.

PROSPECTS+ is an excel based modelling tool, covering all sectors with more detailed representation of the building and transport sector. Though it can do some economic impact modelling, it does not represent cost of mitigation actions, nor can it be used for optimization functionality within the electrical sector. There are "plug in" tools that works with PROSPECTS+ to perform more detailed SDG and air pollution analysis for the electrical sector

The score sheet from the model selection workbook in Annex 1 is perhaps the most important sheet to assess the suitability of these tools for this Antigua & Barbuda project. In this sheet, two things are declared by the user, the intensity weightings for the areas assessed (based on the importance to Antigua & Barbuda) and the associated ranking for each tool. The sum of the intensities for all the areas are limited to 100 and the associated rankings are on a scale of 1-3, based on the following:

- Low/No Capability – 1;
- Mid Capability/Capability with Modifications – 2; and
- High Capability – 3.

It should be noted that meetings were held with the developers for all three tools to ensure that we had all the information needed before assigning these respective rankings.

Based on the evolving project output scope, the LEAP tool was selected as the most suitable for this project, having the capability to perform all the required functionality outlined in Chapters 4.2 and 5.1. However, for the purpose of comparing and contrasting (and possibly validation), the GACMO tool was also selected, mainly because it appeared to have a simpler format than PROSPECTS + and could do the costing aspects.

6.0 Stakeholder Validation and Follow-Up

On February 12th, 2021 further stakeholder workshops were conducted using the same virtual format (due to the pandemic). This workshop was used as a validation workshop for the process that was initially conducted and to gather any concerns and issues from stakeholders on the proposed format. During this workshop, the following questions below were asked through the Mentimeter platform:

The first question posed to stakeholders was, whether there were any other policy documents that should be considered in the assessments apart from the National Energy Policy, the Nationally

Determined Contributions and National GHG Reduction Strategy (2020) – Revised NDC Considerations which were presented during the workshop.

Stakeholders identified nine (9) additional documents for consideration in the project. These include:

- Biennial Update Report;
- Land Use Policy;
- Renewable Energy Roadmap;
- Electricity Act 2015,
- Renewable Energy Act;
- The National Interconnection policy;
- Energy Balances 2015;
- Development of a Regional Sub-policy, Strategy and Action Plan on Energy Efficiency for the Caribbean Community, Econoler Report 2019;
- Medium Term Development Strategy;
- Sustainable Island Resource Management Zoning Plan (SIRMZP); and
- The Environmental Protection Management Act (2019) – identified in the initial consultation meeting.

The second question posed to stakeholders was, whether there were any specific GHG mitigation projects (ongoing or planned) that should be considered in the assessment?

The stakeholders indicated that the Department of Environment has a list of ongoing projects that would be submitted for the project consideration, in addition there were some projects in the development phase such as the Green Climate Fund (GCF) Readiness projects and projects which are planned but require funding - the Energy Efficiency in Public Building. Stakeholders also provided two other projects which are the Sustainable Low Emission Island Mobility Project and the Transformation of the Water and Health Sector (International Renewable Energy Agency (IRENA)/ Abu Dhabi Fund for Development (ADFD)) projects.

The third question and final question posed to stakeholders asked how they felt about the proposed output scope which was presented during the workshop. The Mentimeter graphical response to the final question is presented in Figure 1 below.

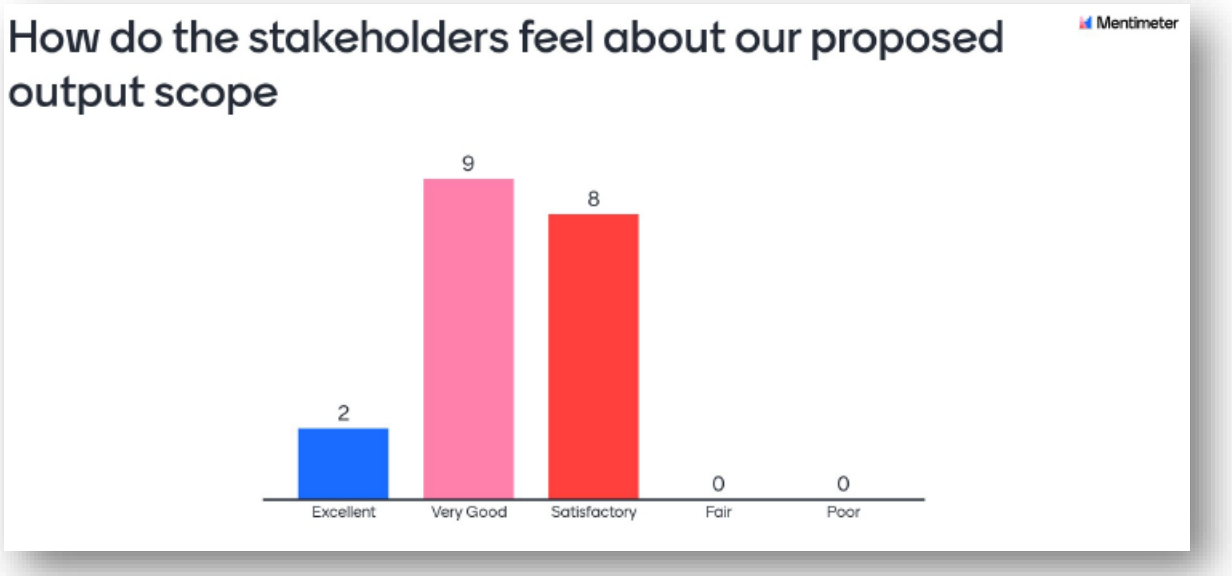


Figure 1: Result of question posed to stakeholders on their opinion of the proposed scope presented

This feedback validated the proposed project output scope with 100% being at least satisfied. Amongst those, 58% thought it was either very good or excellent. One stakeholder further suggested to include a scenario which compared existing policies against the new ones, this as was explained is similar to the baseline scenario in section 5.2 current trends with existing measures for ALL sectors which will be compared to the new scenarios. Stakeholders were further encouraged to continuously submit feedback through the project coordination team.

7.0 Conclusions

As this project is country driven, the modelling framework and project output scope were developed based on feedback from in-country stakeholders. Details of this scope are presented in Chapter 5.1 and makes allowances for ex-ante and ex-post analysis so that Antigua and Barbuda can utilize and develop for use in the next NDCs/BURs – ex-ante analysis or for monitoring the effectiveness of policy measures.

Based on the output scope, the GACMO and LEAP tools will be used, with LEAP being used extensively and GACMO being used for comparisons and validation purposes. Training will be conducted on both modelling tools. The initial or introductory training for the tools is currently scheduled for the first half of the month of March and will hopefully identify a core team of model experts for Antigua & Barbuda.

Data collection is a continuous process and has been initiated with some data collected to assist in the development of the modelling with these tools.

8.0 List of Annexes

The following Annexes accompany this report:

Annex 1 – Inception workshop Report;

Annex 2 – Stakeholder Engagement Report; and
Annex 3 – Model Selection Workbook.

APPENDIX 1

Expected Outcomes and Scope of Works

Expected Outcomes

The technical support provided to Antigua & Barbuda by the project is expected to contribute to the following outcomes:

- Antigua & Barbuda has sustainable capacity to conduct economy-wide GHG emission projections and mitigation analysis modelling to support an effective national MRV/transparency system to measure the performance of the targeted climate policies and actions related to reporting under the Enhanced Transparency Framework of the Paris Agreement;
- Antigua & Barbuda has the capacity to apply good practice and tools that integrate transparency of climate policies and actions with evidence-based policymaking, assessing the impacts of policies and measures (in terms of GHG emissions and other sustainable development factors) included in or being considered for its current and future NDCs; and
- Policymakers in the country are well equipped to identify domestic benefits and synergies from enhanced climate action and policy transparency, including in mobilizing finance.

Objectives and Scope of Work

Project Objectives

The project will focus on establishing a sustainable national economy-wide GHG emission projections and mitigation analysis modelling capability. The following project objectives have been identified to meet the Scope of Work:

1) To develop national modelling framework(s) and an underlying input dataset for Antigua & Barbuda that can be used to assess the GHG and other sustainable development (SD) impact targeted policies and actions to support the updating and tracking of its current and future NDCs;
2) To prioritise and parameterise GHG mitigation policies and actions for analysis with stakeholders that are appropriate for Antigua & Barbuda;
3) To analyse the GHG emission reductions and other selected SD impacts of prioritised mitigation policies and actions, including a focus on air quality impacts; and
4) To strengthen the capacity of the Antigua & Barbuda government to maintain, use, and improve their national mitigation modelling capabilities for future analyses.

Scope of Work

The scope of work for the project is expected to focus on development and application of one or more of the following three potential modelling tools for preparing mitigation analysis scenarios for Antigua & Barbuda in support of its NDC and related policy making processes:

- GACMO (Greenhouse gas Abatement Cost MOdel) https://unepdtu.org/publications/the-greenhouse-gas-abatement-cost-model-gacmo/
- PROSPECTS+ https://newclimate.org/2018/11/30/prospects-plus-tool/
- Long-range Energy Alternatives Planning (LEAP) System https://leap.sei.org/default.asp?action=home

The modelling framework(s) developed under the project will be used to provide a quantitative representation of all source and sink categories of GHGs from both the energy and non-energy sectors in Antigua & Barbuda, including a detailed representation of all sources of energy demand and supply. They should also address other environmental impacts (e.g., air pollution) and social impacts (e.g., macroeconomic effects) identified as policy priorities by the government of Antigua & Barbuda.[1] The representation of each category and sector shall be in keeping with the NDC and other policy priorities of the country.

Overall, the project will support the evaluation of mitigation starting with a *baseline scenario* that reflects future socio-economic, energy sector, and GHG emission trajectories for the country that are likely to occur in the absence of implementing mitigation actions and *planned policy scenarios* to assess key existing and planned mitigation policies and actions. In keeping with its NDC, a thorough assessment of climate change mitigation policies, programs, plans and projects of concern for Antigua & Barbuda will be undertaken to facilitate the development of planned policy scenarios.

The scope of work of the project will include the following specific activities:

Activity 0. Conduct inception phase

Engagement with stakeholders for the project will cut across all activities. And, regular consultations with the DOE will be conducted throughout the project. At the project inception, key stakeholders will be confirmed and contacted, with a focus on those from government ministries, key industrial and transportation organizations, academia, and NGOs in Antigua & Barbuda and select regional organizations relevant to the implementation and institutionalisation of the project outputs.

During the inception workshop, the initial views and concerns of stakeholders will be elicited to guide the development of the modelling frameworks and desired outputs. This consultation will help guide the prioritisation modelling tools to develop for Antigua & Barbuda, as well as begin to explore model assumptions, methods, and likely data providers. It will help ensure that the technical outputs from later activities in terms of mitigation scenario analyses address the needs of stakeholders.

[1] Air pollution impacts has already been identified by the Government as a priority, in addition to GHG impacts.

An inception report will be submitted which describes:

- The procedures and arrangements to be taken in the collection and compilation of data and information for use in mitigation modelling, and
- The work plan containing a schedule of meetings, training workshops, consultations, and other deliverables.

Activity 1. Define desired mitigation model output capabilities for Antigua & Barbuda to implement Paris Agreement

The analytical needs for mitigation analysis, projections, and MRV will be carefully elaborated as they relate to economy wide modelling capabilities. The scope of the project will be further defined, including the temporal scope and resolution of the desired modelling capabilities, the sectoral scope and resolution, the assessment scope for GHG emissions and other Sustainable Development Goals (SDGs), and the scope of social costs and benefits.[2]

Sharing of data can be a sensitive issue, so outreach and engagement with potential data providers will begin early. To this end, bilateral communications will be conducted with likely data providers and other key stakeholders to collect required data through formal and informal requests, including ad hoc meetings and calls, as necessary.

Activity 2. Elaborate baseline modelling framework(s) input data structure and parameters, collect data, and institutionalise collection processes

An objective of this activity is to create in the selected model(s) an accurate quantitative representation of all sources of GHG emissions, with a focus on energy demand and supply and other NDC aspects, for Antigua & Barbuda. For example, final energy demands will likely require segmentation by sector, subsector, and fuel, with energy end uses and technologies distinguished where appropriate for policy and action analysis. It is expected that energy use for transport and in buildings will be a focal area for mitigation in Antigua & Barbuda. For example, the selected modelling tool(s) may be asked to incorporate multiple vehicle classes and specific engine and drivetrain technologies within each class to analyse on-road mitigation actions such as efficiency improvements, mode and fuel shifting, and early retirements.

The baseline scenario projection typically comprises expected technological progress in the absence of identified mitigation policies and actions, such as changes in building energy efficiency codes, while reflecting existing already implemented actions and policies.

The activity will include the following components:

- Trainings will be conducted to teach how to use the selected modelling software tool(s), input datasets, and data collection procedures. The training will include a hands-on activity where participants design the model and the relevant scenarios and begin working with the model within the project scope (suggested 5 instructional days equivalent).

[2] For example, capital costs of energy-using and producing equipment, operating and maintenance (O&M) costs of energy-using and producing equipment, fuel costs, externality costs of air pollutants.

The format of trainings will be defined in keeping with the needs of the DOE, other stakeholders, and the enlisted national consultant. International experts will be enlisted to provide targeted training as appropriate, including virtual training engagements. The training would include a series of Question and Answer sessions in which, after a technical introduction, the participants could ask questions and receive technical support on the use of the modelling platform.

- A consultation workshop will be held with select stakeholders to elaborate the baseline scenario, with a focus on how to make the scenario as relevant, acceptable, and plausible as possible.
- Once modelling outputs and input data structures are elaborated, historical data will be collected and incorporated into the model(s). Data will be collected from various stakeholders as model inputs to develop an accurate representation of Antigua & Barbuda's GHG emitting activities, with a focus on its energy system. Baseline scenario data will be compared and calibrated with Antigua & Barbuda's latest GHG inventory data. Previous mitigation modelling activities for the country (e.g., using LEAP and GACMO) will be reviewed and built upon.

To address renewable and energy efficiency mitigation options for the electricity sector under consideration for Antigua & Barbuda's NDC, a bottom-up modelling capability is anticipated in which each type of generating plant and storage facility is separately represented with technical and cost parameters (heat rate/efficiency, capacity, availability factor, capital and O&M costs, and historical production) and paired with detailed specification of electrical load.

All data inputs and collection processes will be fully documented and archived.

Activity 3. Define mitigation policy scenarios/actions, MRV metrics, parameterise for model(s), and data collection

Working closely with the DOE and other key stakeholders, existing and planned mitigation policies and actions will be characterised under this activity, including specifying relevant quantitative assumptions and targets for each (e.g., technology penetration levels, price changes, target years). Depending on the policy or action, these policies and actions may be represented in a model as, for example, a change in technology deployment or utilization, energy intensity or efficiency, or activity levels. Planned policies and actions may be divided into a range of policy scenarios (e.g., firm planned and potential).[3]

Elaboration of policy scenarios will involve further and higher resolution data collection the cost and technical characteristics of mitigation policies and. A detailed documentation of national mitigation policies and actions to be modelled for Antigua & Barbuda using a structured format—including all relevant background information, assumptions, references, and approaches to model parametrisation—will be produced for the purpose of guiding further scenario and mitigation analysis model development. This data collection and elaboration will build upon previous and

[3] Potential policy scenarios may represent mitigation frontiers and greater ambition for Antiqua & Barbuda, in consultation with the international literature on deep mitigation pathways (e.g., the Intergovernmental Panel on Climate Change's [IPCC's] Fifth Assessment Report (IPCC, 2013), the IEA's Energy Technology Perspectives report (IEA, 2016) and the work of initiatives such as the Deep Decarbonization Pathways Project).

ongoing mitigation planning work for Antigua & Barbuda, including, but not limited to, analyses for the mitigation chapter of its fourth National Communications (NC4).

This activity will have the following components:

- More advanced training focusing on how to adapt and maintain the modelling tools being developed. In this activity, the participants will establish a thorough understanding of the modelling tools and their usage and have hands-on experience with deeper simulation techniques. Other advanced topics will likely include:
    - Interpreting model results;
    - Understanding model assumptions and limitations;
    - How to customize scenarios and alter assumptions and parameters; and
    - How to update, maintain, and expand the models as new information becomes available (e.g., annually adding new energy, population, and macroeconomic data).
- A scenario design workshop will be conducted for stakeholders to provide input to the elaboration and parameterisation of Antigua & Barbuda's NDC, mitigation policies, actions, and associated scenarios. A purpose of this workshop is for stakeholders to evaluate the plausibility and the desirability of the scenarios in the context of Antigua & Barbuda's climate strategies. This workshop will also address linkages between this modelling work under this project and the development of Antigua & Barbuda's broader MRV system.

Gender and Vulnerable Groups
Often energy planning focuses on supply, rather than the end-uses which tend to impact women and other vulnerable groups. Furthermore, women and men have different priorities and perceptions on the energy and environment and failing to account for these differences can lead to poor policies which can potentially negatively affect the environment. Gender and community issues will be considered during the development of mitigation options. Gender and vulnerable groups should be represented during the stakeholder consultations. Where possible and relevant, gender dimensions should be captured in mitigation analyses (e.g., equity, affordability, air pollution and energy access implications of mitigation options).

Activity 4. Perform scenario analyses

This activity will involve modelling the costs and selected SD impacts (Activity 1) of each ongoing, planned, and proposed GHG mitigation policy and action. To support Antigua & Barbuda's MRV system, each specified policy and action should be implemented in the selected model(s) as a separate mini-scenario that can then be combined with other mini-scenarios to construct the overall baseline and policy scenarios.

Where identified as a need by stakeholders, the costs and benefits of mitigation policies and actions will be used to construct economic marginal abatement cost curves (MACCs), which describe abatement potential and costs for the modelled mitigation scenarios and actions. Acceptable discount rates will be defined with stakeholders for annualizing costs. Each resulting proposed policy scenario should undergo an assessment of its technical, environmental, and financial viability. Alternate

projections of macroeconomic and demographic variables may also be incorporated in the scenario analysis through a sensitivity analyses of baseline and mitigation projections.

A mitigation analysis scenario report shall be drafted addressing results from the modelling work, including, but not limited to:

- Emission and other projections by policy and scenario, year, and gas
- Economic and financial cost-benefit analyses by scenario, sector, mitigation policy/action
- Investment requirements by year, sector, and scenario
- Other selected SD impacts (e.g., air pollution, employment) by scenario, sector, mitigation policy/action
- Comparisons of different scenarios with each other or reference-year values

Activity 5. Validate scenario outputs with stakeholders

A workshop will be held with select stakeholders, identified by DOE, to review and validate the results of the scenario modelling and consider a draft mitigation scenario report. At the completion of this workshop, the scenario report shall be revised and submitted to the DOE.

Activity 6. Document and institutionalise mitigation modelling capabilities for country

The results of project will be documented in a mitigation modelling final report, which can be used as input to Antigua & Barbuda's future NC, BUR, and BTR submissions, as well as support updating of its NDC and other policy making needs. This report shall include a separate section addressing steps already taken by the project team as well as next steps for integrating the modelling capability developed through this project into the emerging national MRV and NDC tracking system design for Antigua & Barbuda and the CCMRVH.

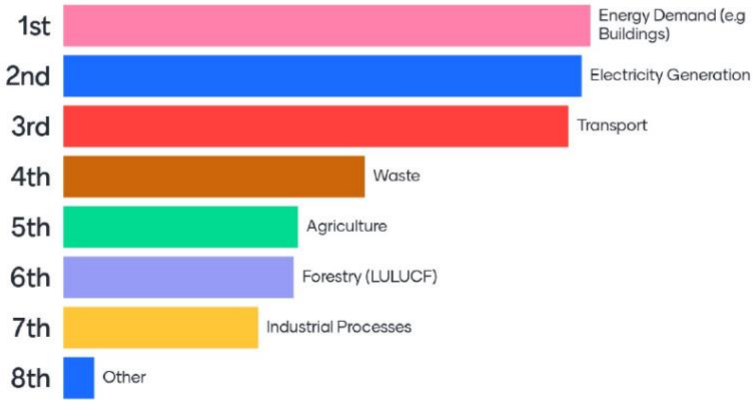
Detailed documentation and procedures manual for how to collect updated and new data for the modelling tool(s) shall also be included in report (e.g., as a report Annex). Lastly, core versions of all modelling tools shall be thoroughly documented within the software itself and properly archived for future use.

APPENDIX 2

Mentimeter Discussion for Inception Workshop

What sectors would you recommend to be modeled in more detail?

Mentimeter



Which mitigation actions would you recommend to be analysed for your sector?

Mentimeter

- Potential for "behind the meter" residential solar, and utility scale solar installations
- transition from fossil fuels to RE. Including just transition.
- Energy efficiency programs
- Personalized energy services
- Installation of RE power generation facilities, usage of more e-vehicles, protection and conservation of forested areas to include rehabilitation of watersheds
- Solar installation, and getting rid of all the unnecessary carbon dioxide.
- 100% EVs in transport, related charging infrastructure and incentive schemes
- charging of electric cars via fossil fuel vs re sources
- Transition to circular economy practices in the waste sector

Which mitigation actions would you recommend to be analysed for your sector?

Mentimeter

- solid waste management (methane avoidance and/or LFG capture and destruction))
- full life cycle GHG improvements with transition to Electric Vehicles. Including consideration of the importation of carbon intensive E vehicles and their parts.
- Renewable energy generationJust transition of the workforceWaste to Energy plantsEVs
- Tracking the reduced usage of fossil fuel in vehicles and comparing to the achievements/downfalls of the usages of electric vehicles
- I Would like to see more solar efficient home and businesses
- Support for Electric cars (charging stations, incentives)
- Switching to from ice vehicles to electric vehicles, whether powered by fossil fuel or renewable energy.
- Further adoptation of RE sources like solar, wind and hydro
- Further RE installations as opposed to fossil fuels. Agriculturally sustainable practices etc to combat climate change activities.

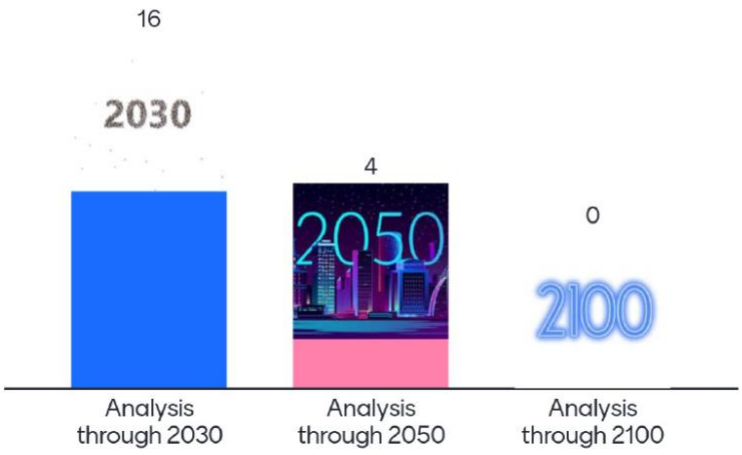
Which mitigation actions would you recommend to be analysed for your sector?

Mentimeter

- Programs to adopt best practices for refrigeration and air conditioning system mitigation (managing F gases)
- The impacts of implementing climate smart agriculture
- sustainable land use changes

If you had to pick only one time frame for this analysis/modelling, which one would you choose?

Mentimeter



What policies, apart from the NDCs , should the mitigation assessment consider?

Mentimeter

- NAP and actions that will have an impact on GHG emissions or removals.
- Practices for the reduction of air pollution
- Protected areas policies
- Circular economy
- Blue Economy
- Medium-Term Development Strategy, Sustainable Development Goals, Environmental Protection & Management Act, Sustainable Island Resource Management Zoning Plan and Local Area Plans, National Adaptation Plan
- protected areas policies, mechanisms to collect data for the SDGsand mid term plans.
- Environmental services and how those will be affected by various aspects of climate change within the respective timeframes
- Just Transition

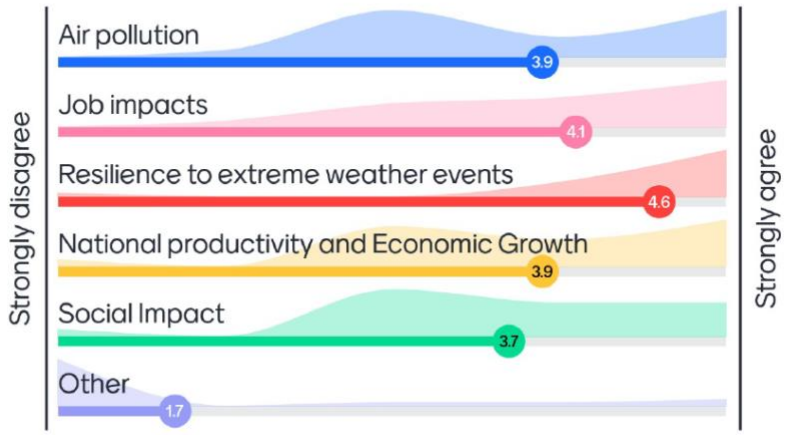
What policies, apart from the NDCs , should the mitigation assessment consider?

Mentimeter

- Serious consideration of wind resources
- policies to reduce internal combustion vehicle importation
- EPMA 2019
- Development of a prototype pumped hydro system to provide energystorage and balancing
- Incentives for renewable energy generation by independent power producers
- protected plan policy

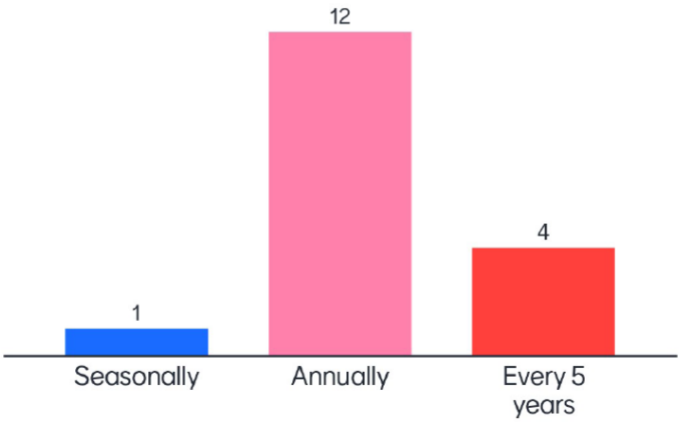
What other Sustainable Development impacts should be analysed in addition to GHGs?

Mentimeter



For the modelling, when do you need to see impacts?

Mentimeter



Which of the following, in your opinion, is the highest priority for Antigua and Barbuda?

Mentimeter