United Nations
Framework Convention on
Climate Change

Training Handbook on Mitigation Assessment for Non-Annex I Parties

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Contents

Part 1: Mitigation Assessment for NAI Countries

BACKGROUND 3

Regional Hands-on Training Workshop 3
Structure of this Handbook 4

MODULE A: MITIGATION ASSESSMENT 5

Module A1: State of Knowledge on Climate Change 5
Module A2: GHG Emissions: Sources, Sinks, and Sectors 6
Module A3: Mitigation Actions, Potential Benefits, and Sustainable Development 6

MODULE B: MITIGATION IN THE CONTEXT OF REPORTING 7

Module B1: Reporting and the Mitigation Components 7
Module B2: Experience and Lessons Learned with Mitigation Components 7
Module B3: Recent Developments Related to Mitigation 7

MODULE C: MITIGATION ASSESSMENT: CONCEPTS, STRUCTURE AND STEPS 8

Module C1: Purposes and Objectives of a Mitigation Assessment 8
Module C2: Steps for Conducting a Mitigation Assessment 9
Translating Mitigation Assessments into National Climate Plans 9

MODULE D: MITIGATION OPTIONS, ISSUES AND BARRIERS BY SECTOR 10

Module D1: General Considerations for Mitigation Strategies 11
Module D2: Sectorial Review and Discussion 11

MODULE E: MITIGATION ANALYSIS: METHODS AND TOOLS 15

E1: Selecting an Assessment Approach 15
E2: Methods and Tools for Mitigation Assessment in the Energy Sector 15
E3: Examples of Energy Sector Modelling Tools 15

MODULE F: REPORTING MITIGATION IN NATIONAL COMMUNICATIONS AND BIENNIAL UPDATE REPORTS 18

Reporting Commitments and Guidelines 18
Suggestions for Reporting 19

MODULE G: BUILDING NATIONAL ARRANGEMENTS FOR MITIGATION ASSESSMENT 20

Part 2: Hands-on Exercises for Mitigation Assessment

Part 1: Mitigation Assessment for NAI Countries

Background

The Consultative Group of Experts (CGE) is a constituted expert body under the Convention with the overall goal of improving the process of, and preparation of, national communications and biennial update reports by providing technical advice and support to non-Annex I (NAI) Parties.

At COP24 in Katowice, Poland it was decided that the mandate of the CGE will be extended for eight years, from 1 January 2019 to 31 December 2026.

In addition to assisting NAI Parties fulfil their reporting requirements under the Convention, the CGE will also support the implementation of the enhanced transparency framework under Article 13 of the Paris Agreement.

This includes facilitating the provision of technical advice and support to developing country Parties to prepare their biennial transparency reports and providing technical advice to the secretariat on the implementation of the training of technical expert review teams.

The information contained in this third iteration of this document has been refreshed in line with the above mandates so that it remains current and relevant.

Regional Hands-on Training Workshop

The CGE has developed materials for use in their regional hands-on training workshops which are designed to assist experts in NAI Parties in preparing the mitigation section of their national communications and or biennial update reports and in future biennial transparency reports through training on a wide range of mitigation assessment approaches, methods and tools, and information on their relative strengths and weaknesses in different analytical contexts.

This handbook is intended to complement the materials presented at these workshops. It is intended to serve as a succinct guide or "road map" to the various issues addressed in the workshops and is intended to be read in conjunction with the PowerPoint slides presented at the workshops. Both this handbook and the accompanying slides are available online at the web address https://unfccc.int/process-and-meetings/bodies/constituted-bodies/consultative-group-of-experts/cge-training-materials/cge-training-materials-for-the-preparation-of-national-communications, and are intended to make the materials delivered at the workshops accessible to those unable to physically attend.

Structure of this Handbook

This handbook, similar to the workshops upon which it is based, is divided into two main parts:

- **Part 1** presents a guide to the lecture materials presented in the workshop, which contain information on mitigation assessment for NAI Parties and is divided into six modules as follows: there are 7 modules below.

    A. Mitigating Climate Change
    B. Mitigation in Context of reporting
    C. Mitigation Assessment: Concepts, Structure and Steps
    D. Mitigation Options, Issues and Barriers by Sector
    E. Mitigation Analysis: Methods and Tools
    F. Reporting Mitigation in National Communications.
    G. Building National Arrangements for the Mitigation Assessment

- **Part 2** introduces the two hands-on training exercises that were conducted during the workshops. The hands-on computer exercises are designed to introduce some of the basic techniques used in a GHG mitigation assessment.

Part 1: Mitigating Climate Change

Module A: Mitigation Assessment

The objective of this module is to provide the participants with an introduction to mitigation in the context of climate change, sustainable development and the framework of the Convention and the Paris Agreement. It introduces key concepts and sets the stage for the subsequent modules. It is oriented around scientific findings and general issues and trends, motivating participants on the rationale and urgency associated with global GHG mitigation, the benefits of mitigation actions, and how they can fit with other national priorities. The module contains following sections:

- State of Knowledge on Climate Change
- GHG Emissions: Sources, Sinks, and Sectors
- Mitigation Actions, Potential Benefits, and Sustainable Development

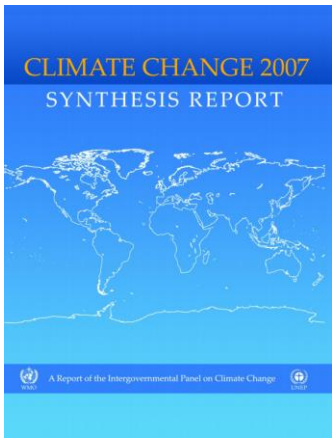
The slides for this module are contained in PowerPoint file: **ModuleA.ppt**

Module A1: State of Knowledge on Climate Change

This section provides a brief introduction to the science of climate change. It summarizes:

- Ways in which the atmosphere is changing;
- Some expected impacts of climate change;
- How the developing countries are likely to be the most vulnerable to climate change;
- The potential and limitations for adaptation to climate change;
- Approximately what levels of emissions reductions would correspond to different levels of stabilization of atmospheric concentrations of carbon dioxide (CO_2);
- Current and likely future sources of GHGs by region, sector and gas;
- Attributes of key GHGs.

The Intergovernmental Panel on Climate Change (IPCC) has three working groups:



- WG I to assess the Science of climate change;
- WG II to assess Impacts, adaptation and vulnerability;
- WG III to assess Mitigation of climate change.

Much of the material presented in this handbook and the accompanying slides are based on the above IPCC reports, all available from the link below. This information is summarized in the following report.

- IPCC (2007) *Climate Change 2007: Synthesis Report.*

Available online in Arabic, Chinese, English, French, Spanish and Russian from:
http://www.ipcc.ch/publications_and_data/publications_and_data_reports.shtml

Module A2: GHG Emissions: Sources, Sinks, and Sectors

This section provides a review of the causes of climate change, and in particular, the sources and sectors of greenhouse gas emissions that will be the focus of mitigation assessment in this handbook. It reviews:

- The basics of GHG inventory reporting;
- Definitions of basic terminology;
- Baseline emissions trends by fuel, sector and GHG;
- Global mitigation potential by sector.

Module A3: Mitigation Actions, Potential Benefits, and Sustainable Development

The slides in this section introduce the topic of mitigation actions, benefits of GHG mitigation and the interactions between mitigation and development. The section includes:

- Key mitigation instruments, policies and practices;
- Sectoral approaches to mitigation technologies and practices;
- The scope of potential benefits of mitigation;
- Impacts of mitigation on gross domestic product (GDP) growth;
- Integrating mitigation and adaptation: synergies and trade-offs;
- Interactions between the dual challenges of mitigation and development;
- Integrating mitigation in development planning.

Module B: Mitigation in the Context of Reporting

The objective of this module is to discuss the mitigation components of national communications and biennial update reports, experiences with mitigation assessments and recent developments related to mitigation.

The slides for this module are contained in PowerPoint file: **ModuleB.ppt**

Module B1: Reporting and the Mitigation Components

This section builds on the introduction of Module A by focusing more specifically on the mitigation requirements for NA1 countries within national communications. It includes:

- Reporting requirements for NA1 countries as per relevant articles of the Convention, COP decisions and subsequent guidelines;
- Structure and timetable for national communications;
- Principle objectives of national communications;
- Benefits of the national communication process.

Module B2: Experience and Lessons Learned with Mitigation Components

This section introduces high-level advice and lessons to be applied to mitigation , including the following topics:

- How to design the mitigation assessment;
- How to implement mitigation assessments;
- How to communicate results.

Module B3: Recent Developments Related to Mitigation

This section details recent decisions, reports and infrastructure that further informs the discussion on global mitigation, including:

- New reporting methods for national communications and National Appropriate Mitigation Actions (NAMAs);
- Related key decisions and guidelines from recent COP meetings:
    - Biennial update reports (BURs);
    - NAMA registry;
    - International Consultation and Analysis (ICA).

Module C: Mitigation Assessment: Concepts, Structure and Steps

The objective of this module is to provide an in-depth understanding of the concepts, structure and steps involved in conducting a mitigation assessment, including a description of how to identify and prioritize technologies and policies in a mitigation assessment.

The slides for this module are contained in PowerPoint file: **ModuleC.ppt**

Most of this module is based on two important sources:

- Sathaye J and Meyers S. 1995. *Greenhouse Gas Mitigation Assessment: A Guidebook.* Published in complete book form by Kluwer Academic Publishers, Netherlands or available online (minus tables and charts) from: http://ies.lbl.gov/iespubs/iesgpubs.html;
- Halsnaes K, Callaway JM, and Meyer HJ. 1999. *Economics of Greenhouse Gas Limitations: Methodological Guidelines.* UNEP Collaborating Centre on Energy and Environment, Denmark. Available online from: http://uneprisoe.org/EconomicsGHG.

Module C1: Purposes and Objectives of a Mitigation Assessment

This subsection explores the overall rationale for, and benefits of, mitigation assessment. It includes:

- Why do a mitigation assessment?
- How to link a GHG inventory with a mitigation assessment?
- How to link a mitigation assessment with the policy and planning process?

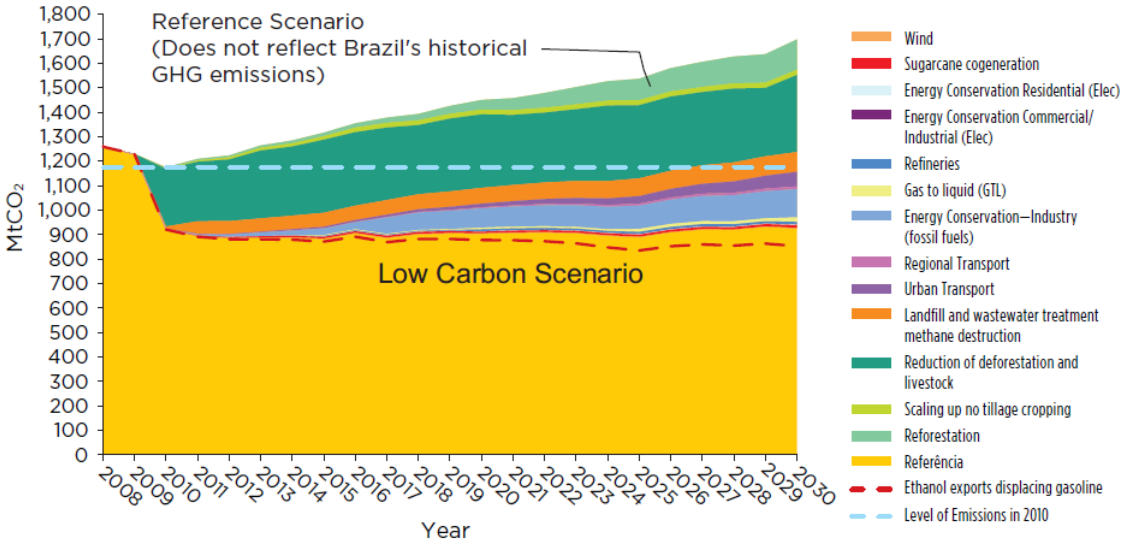


Figure 1: A low-carbon scenario for Brazil (ESMAP 2010)

Module C2: Steps for Conducting a Mitigation Assessment

This subsection introduces a detailed step-wise approach to conducting a mitigation assessment. The steps are:

Step 1: Assess situation and organize process
Step 2: Define scope
Step 3: Design methodology
Step 4: Collect and calibrate data
Step 5: Develop baseline scenario(s)
Step 6: Identify and screen mitigation options
Step 7: Develop and assess mitigation scenario(s).

Reviewing and communicating findings, as well as integration into national reports and plans, is also discussed.

Translating Mitigation Assessments into National Climate Plans

This section includes:

- A discussion of key issues related to developing national action plans;
- An introduction to integrating mitigation assessments with GHG inventories and vulnerability and adaptation (V&A) assessments.

Module D: Mitigation Options, Issues and Barriers by Sector

The objective of this module is to provide an overview of the various technologies and options that might be appropriate for mitigating GHGs within critical sectors, as well as the types of policies and measures that can promote the implementation of those options. This module is based extensively on the report of IPCC Working Group III on Mitigation in the Fourth Assessment Report, covering energy supply, transportation, buildings, industry, agriculture, forestry, waste management, and cross-cutting mitigation options. It also incorporates a discussion of the barriers to mitigation and how they might be overcome.

The module is divided into sections, each of which addresses different energy and non-energy sectors.

The slides for this module are contained in PowerPoint file: **ModuleD.ppt**

The sectors included in the module are:

- Energy supply (electricity generation);
- Transport;
- Buildings;
- Industry;
- Agriculture;
- Forestry;
- Waste management.

Note that geological sequestration is not covered in this module but is a potential longer-term mitigation option.

The following can be consulted for additional information

- IPCC. 2007. *Climate Change 2007: Mitigation of Climate Change. Contribution of Working Group III to the Third Assessment Report of the Intergovernmental Panel on Climate Change.* Available online in Arabic, Chinese, English, French, Spanish and Russian from:
- https://www.ipcc.ch/reports/;
- IPCC. 1996 *Technologies, Policies and Measures for Mitigating Climate Change.* Watson RT, Zinyowera MC and Moss RH (eds). Available online from:
- https://www.ipcc.ch/reports/;
- UNDP. 2000. *World Energy Assessment: Energy and the Challenge of Sustainability.* Goldemberg J (ed.) United Nations Development Programme, United Nations Department of Economic and Social Affairs, World Energy Council. Available online from:
- https://www.undp.org/content/dam/aplaws/publication/en/publications/environment-energy/www-ee-library/sustainable-energy/world-energy-assessment-energy-and-the-challenge-of-sustainability/World%20Energy%20Assessment-2000.pdf

Module D1: General Considerations for Mitigation Strategies

This section introduces the topic of mitigation options by discussing:

- The fundamental distinction between technologies/practices and policies/ instruments;
- Mitigation potential and barriers;
- Facilitation of energy efficiency.

Source: Courtesy of Emerson Process Management

Module D2: Sectorial Review and Discussion

A: Energy supply

The energy supply sector includes those industries involved in the extraction of primary energy, those that transform energy supplies from primary fuels into secondary fuels and those that are involved in transporting energy. It includes modern sectors such as electric generation, oil refining, ethanol production, coal mining and oil production, as well as traditional sectors such as charcoal making. This section describes:

- Past trends in global energy supply;
- How to address energy supply in a mitigation assessment;
- Technical options for reducing GHGs in the energy supply sector. These include options such as switching to lower carbon fuels including biomass and renewable energy forms, and increasing energy efficiency;
- Policy measures for promoting the adoption of GHG reducing technologies in the energy supply sector, such as market instruments, regulations, voluntary agreements, etc;
- Key barriers to energy supply and methods of overcoming them.

B: Transport

This section describes:

- The importance of the transport sector in terms of its future energy use and contribution to GHG emissions;
- Technical options for reducing GHGs in the transport sector. These include efficiency improvements, fuel-switching,

Source: Guangzhou BRT, www.gzbrt.org

mode shifts and transport demand management;
- Policy measures for promoting the adoption of GHG reducing technologies in the transport sector;
- Key barriers in the transport sector and methods of overcoming them.

C: Buildings

The buildings sector covers both residential and commercial buildings. This section describes:

- Emissions sources, trends in energy use and drivers for the buildings sector;
- Technical options for reducing GHGs in the buildings sector;
- Policy measures for promoting the adoption of GHG reducing technologies in the buildings sector.

D: Industry

This section describes:

- Key challenges in the industrial sector;
- The importance of the industrial sector in terms of its contribution to global GHG emissions;
- Historical trends that show dramatic growth in the production of energy-intensive industrial goods;
- Technical options for reducing GHGs in the industrial sector;
- Policy options for promoting the adoption of GHG reducing technologies in the industrial sector;
- Key barriers in the industrial sector and methods of overcoming them.

E: Agriculture

This section describes:

- Key challenges within the agriculture sector, including uncertainty in long-term emissions due to dependencies on trends in socio-economic development, population, diet, etc;
- Emissions sources and drivers in GHG emissions within the agriculture sector;
- Agricultural trends and GHG implications;
- The challenge of regional variation;
- Technical options for reducing GHGs in the agriculture sector;
- Policy options for promoting the adoption of GHG reducing technologies in the agriculture sector;
- Key barriers in the agriculture sector and methods of overcoming them.

Source: IPCC AR4 WGIII, Chapter 8

F: Land Use, Land use Change and Forestry (LULUCF)

The LULUCF section describes:

- Key challenges in the LULUCF sector, including how to address drivers for deforestation and how to integrate climate mitigation into forestry policy;
- Trends in CO_2 emissions released through deforestation;
- Drivers of deforestation and degradations;
- Mitigation technologies and options to reduce CO_2 emissions and increase carbon sinks;
- Policy options for promoting the adoption of GHG reducing technologies in the LULUCF sector;
- Key barriers in the LULUCF sector and methods of overcoming them.

G: Waste Management

Solid waste management affects the release of GHGs in five major ways:

- Landfill emissions of methane (CH_4);
- Reductions in fossil fuel use by substituting for energy recovery from waste combustion;
- Reduction in energy consumption and process gas releases in extractive and manufacturing industries, as a result of recycling;
- Carbon sequestration in forests, caused by decreased demand for virgin paper, and;
- Energy used in the transport of waste for disposal or recycling.

This section describes:

- Key challenges in the waste sector;
- Emissions sources and drivers in waste management;
- Technical options for reducing GHGs in the solid waste sector;
- Policy measures for promoting the adoption of GHG reducing technologies in the solid waste sector;
- Key barriers in the waste sector and methods of overcoming them.

H: Mitigation from a Cross-Sectoral Perspective

This section covers various mitigation technologies that affect multiple sectors and other technologies that cannot be attributed to any particular sector. This section includes:

- Types of cross-sectoral mitigation technologies;
- Examples of cross-sectoral mitigation technologies;

- Linkages, synergies and trade-offs between measures with non-climate objectives and GHG mitigation.

Module E: Mitigation Analysis: Methods and Tools

The objective of this module is to introduce participants to commonly used methods and modelling tools that can be applied for mitigation assessment. The module discusses the advantages, limitations, data and technical requirements of each approach.

The module includes guidance on selecting an assessment approach, types of methods and tools for mitigation and examples of both integrated and sector-specific modelling tools.

The slides for this module are contained in PowerPoint file: **ModuleE.ppt.**

E1: Selecting an Assessment Approach

This section focuses on which methods are appropriate for mitigation assessment within the context of reporting and discusses various issues within mitigation assessment.

E2: Methods and Tools for Mitigation Assessment in the Energy Sector

Various approaches are available and appropriate for modelling the energy sector in a GHG mitigation assessment. Typically, the range of approaches can be divided into two basic approaches: top-down and bottom-up. This section discusses the following:

- Differences between top-down and bottom-up models;
- Advantages, disadvantages and categories of top-down models;
- Advantages, disadvantages and categories of bottom-up models;
- Introduction to integrated and sector-specific models.

E3: Examples of Energy Sector Modelling Tools

This section includes a review of "off-the-shelf" software tools that are available for use in performing a GHG mitigation assessment within the energy sector. The criteria for including tools in this review were as follows:

- Widely applied in a variety of international settings;
- Thoroughly tested and generally found to be credible;
- Actively being developed and preferably professionally supported;
- Primarily designed for GHG mitigation assessment at the national level (not global models and not models for a specific country).

Note: Module E is NOT intended to provide in-depth training in the use of any of these tools. Separate, in-depth training will be likely required for any tools selected. The intention is only to provide sufficient information to help Parties choose an appropriate tool for their assessments.

3A: **Integrated Tools**

The tools discussed within the module for the energy sector can be integrated and include the following Integrated tools:

a. ClimateDesk (most recent update is 2010)
b. ENPEP-BALANCE
c. LEAP
d. MARKAL/TIMES
e. IAEA Tools (MAED, MESSAGE, SIMPACTS, FINPLAN)

3B: Sector Specific Tools

Additional tools discussed within the energy sector are sector specific and include the following:

a. HOMER Pro and HOMER Grid
b. RETScreen Expert
c. Transport Models
    a) ITDP
    b) ICCT (most recent update is 2017)
    c) GREET

Module E4: GHG Mitigation Assessment in Non-Energy Sectors

The objective of this Module is to provide an overview of the approach to undertake a mitigation assessment for sectors other than energy. These include Agriculture, LULUCF and Waste Management. The information provides guidance on the following:

a. The basic steps for mitigation assessment in non-energy sectors
b. Steps in assessing LULUCF
c. Steps in a comprehensive mitigation analysis process (COMAP)
d. Information to consider in mitigation for both agriculture and waste management

Module E5: Examples of Non-Energy Sector Modelling Tools

The information in this module explores examples of various models that can be used to conduct mitigation assessment in the non-energy sectors. These include the following:

LULUCF

a) CO2 Fix
b) GORCAM
c) WBE Model
d) GOTIL WA+
e) COMAP

Agriculture Models

a) CAMFor
b) EX-ACT
c) ROTH-C
d) BIOME BGE

Module E6

This concluding section provides further guidance on choosing a suitable approach and information on resources for modelling tools.

Important Disclosure: The author of these training materials, SEI, is also the developer of LEAP.

Module F: Reporting Mitigation in National Communications and Biennial Update Reports

The objective of this module is to improve the presentation of mitigation assessments in second and subsequent national communications in a consistent, transparent, comparable and flexible manner according to the "Guidelines for the preparation of national communications from Parties not included in Annex I to the Convention".

Mitigation assessments form an important part of Parties' national communications on climate change and are read by both the international scientific community and national and international policy makers. They therefore need to reflect scientific rigor, clarity and comprehensibility.

The slides for this module are contained in PowerPoint file: **ModuleF.ppt**

For more on this topic, please refer to:

- UNFCCC. 2004. *User Manual for Guidelines on NAI National Communications.* Available online in English, French and Spanish from: http://unfccc.int/national_reports/non-annex_i_natcom/guidelines_and_user_manual/items/2607.php;
- Sathaye J and Meyers S. 1995. *Greenhouse Gas Mitigation Assessment: A Guidebook.* Published in complete book form by Kluwer Academic Publishers, Netherlands or available online (minus tables and charts) from: http://ies.lbl.gov/iespubs/iesgpubs.html.

Reporting Commitments and Guidelines

Article 4, paragraph 1, and Article 12, paragraph 1, of the Convention provide for each Party to report to the COP:

- Information on its emissions by sources and removals by sinks of all GHGs not controlled by the Montreal Protocol (GHG inventories);
- National or, where appropriate, regional programmes containing measures to mitigate and to facilitate adequate adaptation to climate change (general description of steps taken or envisaged by the Party to implement the Convention);
- Any other information that the Party considers relevant to the achievement of the objective of the Convention.

This section includes:

- Reporting Commitments to the Convention;
- Objectives for national communications;
- Scope of national communications;

- Guidance on building on past national communications;
- Guidelines on national circumstances, mitigation measures and methodological approaches;
- Mitigation reporting within biennial update reports (BURs);
- Timing of submissions.

Suggestions for Reporting

This section includes:

- General reporting suggestions;
- How to report on scenario definitions, data and assumptions;
- Suggestions for reporting quantitative results;
- Options for displaying emissions results.

Module G: Building National Arrangements for Mitigation Assessment

The objective of this module is to present the documentation toolkit developed to assist Parties in developing and maintaining the mitigation component of a national development plan. The toolkit consists of five linked documents containing tables that can be filled out as needed and adapted to local circumstances. The toolkit is intended to reduce the effort required by future teams to develop the mitigation assessments and promote consistency within and among reports over time.

The slides for this module are contained in PowerPoint file: **ModuleG.ppt.**

The components of the toolkit are listed below:

A - Key Sectoral Emissions Analysis:
- Maps emissions inventory estimates to key sectors of the mitigation analysis and documents business-as-usual (BAU) emissions projections;

B - Institutional Arrangements for Mitigation Activities:
- Summarizes existing institutional arrangements for GHG mitigation analysis in your country, and helps mitigation teams assess and document the strengths and weaknesses of these existing arrangements;

C - Mitigation Assessment Methods and Data Sources:
- Documents methods and resources used for screening mitigation options, developing mitigation scenarios, and evaluating mitigation actions;

D - Mitigation Analysis Archiving System:
- Establishes procedures to retain and store data and documents for future use and reference;

E - National Plan for Further Mitigation Assessment:
- Identifies and prioritizes improvements to national mitigation assessments.

Part 2: Hands-On Exercises for Mitigation Assessment

A series of hands-on computer exercises has been developed that are designed to introduce participants to some of the basic techniques used in a GHG mitigation assessment.

1. **Group Exercise One** – Participants will be divided into groups and will work on a simple spreadsheet-based exercise in which they develop GHG mitigation cost curves for various GHG mitigation policies in a fictitious country;
2. **Group Exercise Two** – Building on the spreadsheets developed in Group Exercises One, participants will perform an overall screening of GHG mitigation options using multi-criteria attribute (MCA) analysis;
3. **Group Exercise Three** – Participants will again be divided into groups and will work on a third exercise in which they will construct a simple mitigation scenario in the Long-range Energy Alternatives Planning (LEAP) system (based on the options they previously identified in the first two screening exercises).

These exercises are described in detail in separate documents.

You can download these documents together with the spreadsheets and LEAP data sets needed to undertake the exercise here:

https://leap.sei.org/