FEDERAL ENVIRONMENTAL PROTECTION AUTHORITY (FEPA)

General Greenhouse Gas (GHG) Mitigation Policy Assessment Guideline

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Contents

List of Abbreviations

DOC	Degradable Organic Carbon
GDP	Gross Domestic Product
GHG	Greenhouse Gas
IMAGE	Integrated Model to Assess the Global Environment
IPCC	Intergovernmental Panel on Climate Change
LULUCF	Land Use, Land-Use Change and Forestry
OECD	Organization for Economic Co-operation and Development
REM	Register of Ecological Models
UNFCCC	United Nations Framework Convention on Climate Change

1. INTRODUCTION

Measures to mitigate climate change are defined as any human (anthropogenic) intervention that can either reduce the sources of Greenhouse Gas (GHG) emissions (abatement) or enhance their sinks (sequestration). The increase in CO_2 is primarily due to changes in fossil fuel use and land use, while the increases in CH4 and nitrous oxide (N_2O) are primarily due to agricultural activity. CO_2 is the most important anthropogenic GHG. The global atmospheric concentration of CO_2 has increased from a pre-industrial value of about 280 ppm (parts per million) to 379 ppm in 2005. The atmospheric concentration of CO_2 in 2005 far exceeded the natural range over the last 650,000 years (180 to 300 ppm), (IPCC 2007, Working Group I).

2. GHG MITIGATION ASSESSMENTS: CONCEPTS, STRUCTURE AND STEPS

In the context of the United Nations Framework Convention on Climate Change (UNFCCC), a mitigation assessment is a national-level analysis of the various technologies and practices that have the capacity to mitigate climate change. Typically, mitigation assessments include the development of one or more long-term mitigation scenarios. A mitigation scenario is a quantified projection of how future GHG emissions can be reduced relative to one or more baseline scenarios. A baseline scenario characterizes the likely evolution of GHG emissions in the absence of new, specific policies to reduce GHG emissions. A mitigation assessment, therefore, involves creating both baseline and mitigation scenarios.

It is important to note that, for many parties, mitigation does not necessarily imply an absolute reduction in emissions in relation to a given base year, rather it implies a reduction relative to what emissions would otherwise have been in the future in the absence of specific GHG mitigation action, that is, relative to a counterfactual baseline scenario. A mitigation assessment provides policy makers with an evaluation of technologies and practices that can mitigate climate change and also contribute to national development objectives. The assessment also identifies potential project and programme investments and provides an outline of the cost of avoiding climate disruption.

2.1 Scope of GHG Mitigation Assessment

The scope of a GHG mitigation assessment can include an analysis of policies:

- Energy demand and supply, forestry, agriculture, Industry rangelands and waste management,
- The macro-economic impacts of different options;
- The legislation, policies and programmes that facilitate the rapid implementation of mitigation technologies and practices.

2.2 Steps of GHG Mitigation Assessment

Any mitigation assessment should focus on clearly defined objectives and emphasize implementation. The basic steps will depend on the objectives and the scope of the assessment, but should include:

- Assembling base year or historical data on activities, technologies, practices and emission factors;
- Calibrating base year energy and emissions calculations with available standardized statistics such as national energy balances and/or national emissions inventories;
- Preparing baseline scenarios;
- Screening mitigation options;
- Preparing mitigation scenarios and sensitivity analyses;
- Assessing the social, economic or environmental impacts;
- Developing an overall mitigation strategy; and
- Preparing reports.

2.3 Key Participants for GHG Mitigation Policy Assessment

The development of mitigation assessments requires close cooperation among a wide range of stakeholders; energy, environment and finance ministries will all need to be involved while some tasks may be undertaken by outside consultants or the academic community. The expert skills of statisticians, energy policy experts, engineers, modellers and technical writers will be required. However, mitigation assessments are not simply technocratic exercises; they should also involve a much broader judgment on how mitigation activities can constitute part of national development priorities. It is therefore important to involve not only a diverse group of government agencies, but also non-governmental stakeholders. To maximize mitigation measures, any national mitigation strategy should also aim to increase public awareness of climate change.

2.4 Baseline Scenarios

As noted previously, a baseline scenario is a plausible and consistent description of how a system might evolve in the future in the absence of explicit new GHG mitigation policies. Baseline scenarios are the counterfactual situations against which mitigation policies and measures will be evaluated. A baseline should not be considered as a forecast of what will happen in the future, since the future is inherently unpredictable and depends, in part, on planning and policy adoption. Assessments will typically require one or more baseline scenarios as baselines are highly uncertain over the long term and may prove controversial, particularly in developing countries.

Ideally, multiple baseline scenarios should be constructed to reflect any uncertainties (i.e. a sensitivity analysis). Each baseline requires separate mitigation analyses although, in practice, a suitable balance will need to be struck between this ideal and maintaining a manageable assessment. Reasonable baselines are critical to a mitigation analysis since mitigation scenarios are largely judged on the basis of the incremental costs and benefits relative to the baseline scenario. Baselines should not be a simple extrapolation of current trends. They should consider the possible evolution of activities that affect GHG sources and sinks, including consideration of:

- Macroeconomic and demographic trends;
- Structural shifts in the economy;
- Projections of the main GHG emitting activities and sinks;
- The evolution of technologies and practices, including saturation effects and the likely adoption of efficient technologies that affect GHG emissions.

2.5 Screening of Mitigation Options

Screening enables a rough assessment of options to be made ahead of performing a more detailed mitigation scenario analysis. Screening is particularly important when using bottom-up methodologies in which a wide range of technologies and policies need to be considered. One approach to screening is to assign scores or rankings to mitigation options in order to identify those that need to be included later on in a more in-depth analysis. Screening reduces the level of effort required to conduct an in-depth mitigation analysis, while also reducing the likelihood of overlooking important options. Screening may include a quantitative assessment of the mitigation potential (tCO_2) and the cost of saved carbon ($/t C) of each option and it can also include qualitative factors. Screening criteria should be consistent with the overall framing of mitigation scenarios.

The Possible screening criteria include the following:

- The potential for a large impact on GHG emissions;
- Consistency with national development goals;
- Consistency with national environmental goals (e.g. reduction of local air pollutants, protection of biodiversity, and watershed management);
- Data availability;
- Political feasibility;

- Replicability (i.e., adaptability to different geographical, socio-economic-cultural, legal, and regulatory settings);
- Cost-effectiveness;
- Project-level considerations, such as capital and operating costs;
- Macro-economic considerations, such as: the impact on GDP; the number of jobs created or lost; effects on inflation or interest rates; the implications for long-term development; foreign exchange and trade, etc.

3. MODELING TOOLS FOR GHG MITIGATION POLICY ASSESSMENT

The modeling of mitigation options is a core component of a mitigation assessment.

3.1 Modeling Tools for the Energy Sector

A range of approaches are available for modeling the energy sector in a GHG mitigation assessment, and they can typically be divided into either top-down or bottom-up approaches. The UNFCCC guidelines do not specify which approach is most appropriate and both can yield useful insights on mitigation.

- Top-down models are most useful for studying broad macroeconomic and fiscal policies for mitigation, such as carbon or other environmental taxes.
- Bottom-up models are most useful for studying options that have specific sectoral and technological implications.

The lack of off-the-shelf top-down models and the focus in mitigation assessments on identifying potential projects (e.g., for future clean development mechanism (CDM) funding) has meant that, to date, most mitigation assessments have been conducted using bottom-up approaches. For this reason, the tools examined here are primarily bottom-up modeling approaches.

Types of bottom-up models

Bottom-up models comprise three basic types: optimization, simulation and accounting frameworks. There are various hybrid models that combine elements of these three approaches.

Optimization models

- Use mathematical programming to identify configurations of energy systems that minimize the total cost of providing energy services;

3.1.1 Simulation Models

- Simulate the behavior of energy consumers and producers under various signals (e.g., price, income levels) and constraints (e.g., limits on the rate of stock replacement);
- Can include non-price factors in an analysis compared with optimizing models;
- Balance demand and supply by calculating market-clearing prices;
- Adjust prices and quantities endogenously, using iterative calculations to seek equilibrium prices;

3.1.2 Accounting Frameworks

- Account for flows of energy in a system based on simple engineering relationships (e.g. conservation of energy);
- Account explicitly for the outcomes of decisions made by energy consumers and producers, rather than simulate their decisions;
- Tend to be simple, transparent, intuitive and easy to parameterize;
- Serve primarily as a sophisticated calculator, database and reporting tool (the evaluation and comparison of policies are largely performed externally by the analyst);

3.2 Modeling Tools for the Non-energy Sectors

A wide variety of modeling methods can be used to examine mitigation in non-energy sectors. The majority of these models focus on issues of land use, land-use change and forestry (LULUCF). Many alternative models and modeling approaches have been developed for examining LULUCF mitigation, including:

- Individual tree growth models;
- Forest gap models;
- Bio-geographical models;
- Ecosystem process models;
- Terrestrial carbon-circulation models;
- Land-use change models;
- Spreadsheet models

Notable models that have been applied in these areas include:

IMAGE (Integrated Model to Assess the Global Environment), developed at the National Institute for Public Health and the Environment (RIVM) in the Netherlands. For more information on IMAGE, visit the website

COMAP (Comprehensive Mitigation Assessment Process), a spreadsheet-based model developed by the Lawrence Berkeley Laboratory in the USA.

A wide array of additional models is available for modeling mitigation in the LULUCF sector. Unfortunately, unlike the tools listed for the energy sector, these tools are not normally professionally developed, distributed and supported, and it is therefore more difficult to get access to them and support when using them. The University of Kassel maintains a web-based Register of Ecological Models (REM), which is a useful resource for reviewing many of these tools.

3.2.1 Key Steps in a LULUCF GHG Mitigation Assessment

- Identification and categorization of mitigation options;
- Assessment of current and future land area available for mitigation options;
- Assessment of current and future demand for products and land;
- Determination of the land area and product scenarios by mitigation option;
- Estimation of the carbon sequestration per hectare for major available land classes, by mitigation option;
- Estimation of unit costs and benefits;
- Evaluation of cost-effectiveness indicators;
- Development of future carbon sequestration and cost scenarios;
- Exploration of policies, institutional arrangements and incentives necessary for the implementation of mitigation options;
- Estimation of the national macro-economic effects of these scenarios.

4. MITIGATION GOAL STANDARD

How to assess and report overall progress toward national, subnational, or sectoral GHG reduction goals. Types of mitigation goals include GHG reductions from a base year, reductions to a fixed-level of emissions (zero in the case of carbon neutrality), reductions in emissions intensity, and GHG reductions from a baseline scenario.

Policy and Action Standard: How to estimate the greenhouse gas effects of policies and actions. Types of policies and actions include regulations and standards; taxes and charges; subsidies and incentives; information instruments; voluntary agreements; implementation of new technologies, processes, or practices.

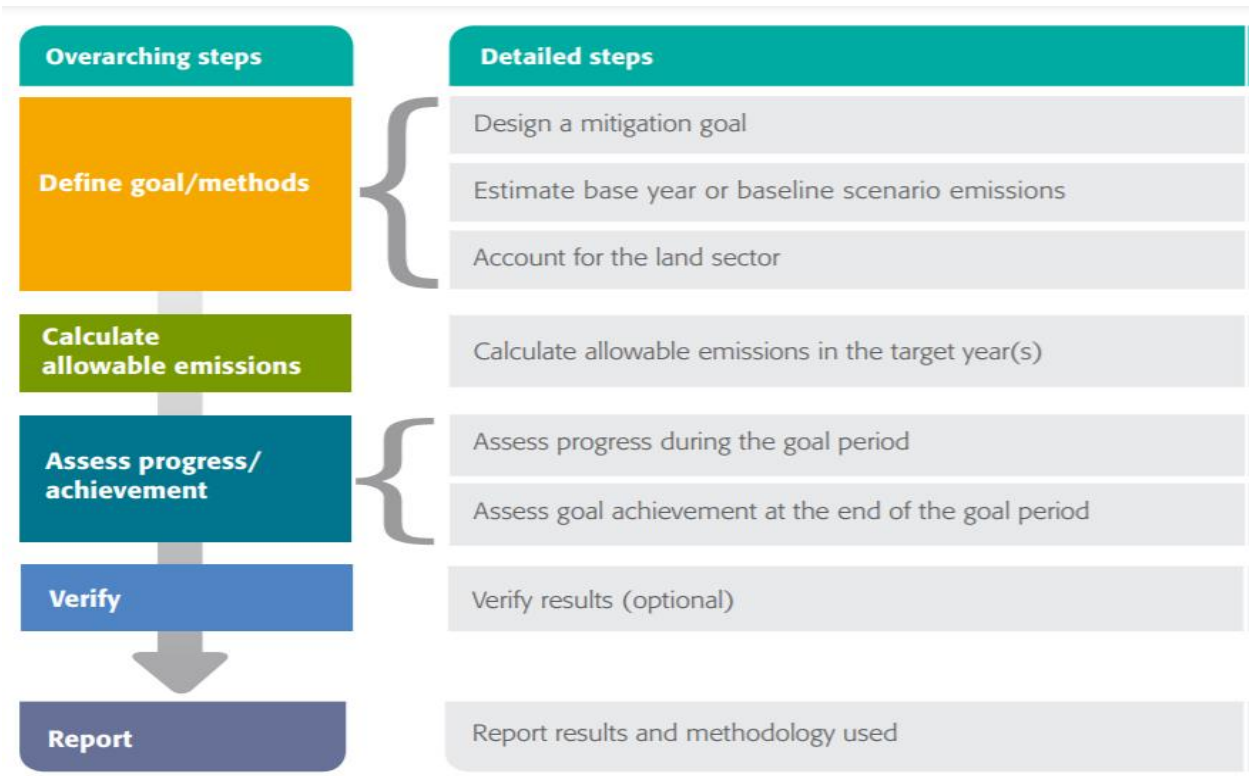

Figure 1: That show overview of steps for mitigation goal accounting; Source: WRI, 2009

5. OVERVIEW OF THE MITIGATION ASSESSMENT PROCESS IN WASTE SECTOR

The following four steps are recommended for performing a mitigation option analysis.

Step 1: Develop Scenario Inputs. The purpose of this step is to prepare inputs, such as the number of landfills and the volume of waste stream targeted for diversion away from landfills. These will serve as inputs for the preparation of both baseline and mitigation scenarios.

Step 2: Identify Target Sub-Groups to be the Focus of the Emissions-Reduction Effort and Refine the Emissions Estimates for the Sub-Group. The purpose of this step is to focus the analysis on those portions of the GHG source that are amenable to control. The target sub-groups are selected based on the applicability of the mitigation options for the source. A more detailed baseline emissions estimate is then developed for the target subgroups. This detailed baseline will be used to estimate the emissions reduction that can be achieved.

Step 3: Evaluate the Mitigation Options for the Sub-Group. The purpose of this step is evaluating the impacts that the mitigation options have on the emissions and other characteristics of the target sub-group.

Step 4: Develop Baseline and Mitigation-Emissions Scenarios. Using the information generated in Steps 1, 2 and 3, baseline and mitigation emissions scenarios may be developed for landfills and wastewater treatment.

Scenario inputs

Scenarios of future emissions, with and without the implementation of mitigation options, may be developed by forecasting the key variables that drive the emissions. Methane emissions from landfills are driven principally by the amount of degradable organic material disposed in landfills. Future emissions depend both on the amount of waste already placed in landfills and the amount placed in landfills in the future. Therefore, future waste disposal rates must be estimated to forecast future emissions. Future disposal rates will depend on the amount of waste generated and the portion of the waste placed in landfills. Per capita waste generation rates have been found to be dependent on consumer preferences and industrial activity. Because per capita income has been found to be one predictor of waste-generation rates, the data presented in the IPCC/OECD emissions inventory method can be used to estimate future per capita waste-generation rates as per capita incomes increase. The implications of changes in landfilling practices should be considered in the baseline scenario if such changes are expected.

Like emissions from landfills, methane emissions from wastewater treatment are driven principally by the amount of organic material that is treated anaerobically. The IPCC/OECD emissions inventory method recommends that the emissions be estimated separately for municipal and industrial wastewater. The amount of organic material in municipal wastewater nationally may be estimated as the population times a per capita waste-generation rate in units of BOD (i.e., kg BOD per capita-day). Regional rates of BOD generation per capita are given in the IPCC/OECD method, which are adequate for assessing the rough magnitude of GHG emissions reduction.

5.1 Analysis of GHG Mitigation

The analysis of options for reducing methane emissions from landfills can proceed in two directions: gas recovery and waste diversion from landfills. The following approach is recommended for evaluating gas recovery.

5.2 Identification of Landfills at which Gas Recovery is Attractive

The purpose of this step is to identify the population of landfills at which gas recovery and use is feasible and economically attractive. Experts in landfill gas recovery and use should be consulted to define those landfill characteristics that make landfills attractive for gas recovery. Generally, landfills should be relatively large (e.g., have at least 1 million metric tons of waste in place) and should be able to support the drilling of wells into the refuse (i.e., the refuse and the soil should be stable and not saturated with water). The actual landfill-gas recovery plant size will depend on the gas production rate, costs of gas collection and utilization, and the value of the energy derived from the gas in the specific circumstance. To the extent possible, data on the individual landfills should be obtained, e.g., from landfill operators. For this set of landfills, detailed information on waste characteristics should be obtained for purposes of developing more detailed estimates of methane emissions. Test wells at selected landfills would be useful for verifying the emissions estimates for this set of landfills.

5.3 Evaluate Gas Recovery Projects

For the targeted set of landfills, the costs and benefits of landfill gas recovery projects should be assessed. The costs of recovering the gas may be estimated using engineering cost estimates, such as those in USEPA (1993c), or similar country-specific cost factors. The amount of gas expected to be recovered may be estimated as a portion of the estimated emissions (e.g., 75% of emissions). The revenue from using the collected gas should be estimated based on the quantity of gas collected and the local value of the gas. A discounted cash flow analysis can then be done to identify the cost or benefit per unit of landfill gas emissions avoided.

5.4 Estimate Emissions Reductions

Based on the evaluations of the gas recovery projects, the extent to which landfill methane emissions can be reduced from the targeted landfills can be estimated. The cost of reducing emissions by various amounts can be estimated as well using the results of the discounted cash flow analysis.

In addition to evaluating opportunities for recovering landfill gas, options for diverting waste away from landfills can also be considered. The major alternatives of recycling, source reduction, composting, and incineration may be examined. The impact on future methane emissions would be estimated based on the amount of degradable organic carbon (DOC) diverted away from landfills over time. The general approach to this assessment would include the following:

- Identify the component of the waste stream targeted for diversion away from landfills (e.g., paper).
- Identify options for managing the targeted portion of the waste stream (e.g., recycling).
- Estimate costs and benefits of diverting the waste.
- Estimate the amount of waste diverted over time and the avoided methane emissions from the avoided landfilling of the waste.

5.5 Constructing Baseline and Mitigation Scenarios

The purpose of this step is to estimate emissions with and without the implementation of selected mitigation options. It is recommended that these scenarios be developed in detail for the target sub-groups for specific years, such as 2000, 2010, and 2025. The same models or techniques should be used to estimate both the baseline and the mitigation scenarios for each of the sources. The IPCC/OECD emissions inventory methods are recommended.

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