CGE SUPPLEMENTARY TRAINING MATERIAL FOR THE TEAM OF TECHNICAL EXPERTS

Module 2.1

Background material:

Mitigation actions and their effects

Version	Date	Changes
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ABBREVIATIONS

Btu	British thermal unit
BUR	biennial update report
CDM	Clean Development Mechanism
CER	certified emission reductions
CGE	Consultative Group of Experts on National Communications from Parties not included in Annex I to the Convention
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
COP	Conference of the Parties
CSD	United Nations Commission for Sustainable Development
DIA	Development Impact Assessment
ETS	emissions trading system
EU	European Union
EUA	European emission allowances
GDP	gross domestic product
GHG	greenhouse gas
GWP	global warming potential
ICA	international consultation and analysis
IPCC	Intergovernmental Panel on Climate Change
kg	kilogram
km	kilometre
kWh	kilowatt-hour
MAC	marginal abatement cost
MRV	measurement, reporting and verification

Mt	million tonnes
NMM	new market mechanism
PV	photovoltaic
QA/QC	quality assurance and quality control
SD	sustainable development
TTE	team of technical experts
UNFCCC	United Nations Framework Convention on Climate Change

1. INTRODUCTION

1.1. MAIN OBJECTIVES OF THE BACKGROUND MATERIAL

This material was developed within the context of the process for international consultation and analysis (ICA) to further support the training for the team of technical experts (TTE) and to provide additional background knowledge and context.

The material was developed to provide the TTE with:

- A solid understanding of the **context** in which reported mitigation actions are selected, designed and implemented;
- An understanding of **good practice** in mitigation design, analysis and reporting;
- Knowledge of the approaches to analysing **progress** in implementing mitigation actions and their effects;
- Identification of other key areas that potentially require **specific attention**;
- Background for the **technical analysis** of information on mitigation actions reported in accordance with provisions contained in decision 2/CP.17, annex III, paragraphs 11–13.

This is based on the understanding that the technical analysis under the ICA process is meant to:

a) Identify the extent to which the elements of information listed in paragraph 3(a) of the guidelines contained in annex IV to decision 2/CP.17, are included in the biennial update report (BUR) of the Party concerned;

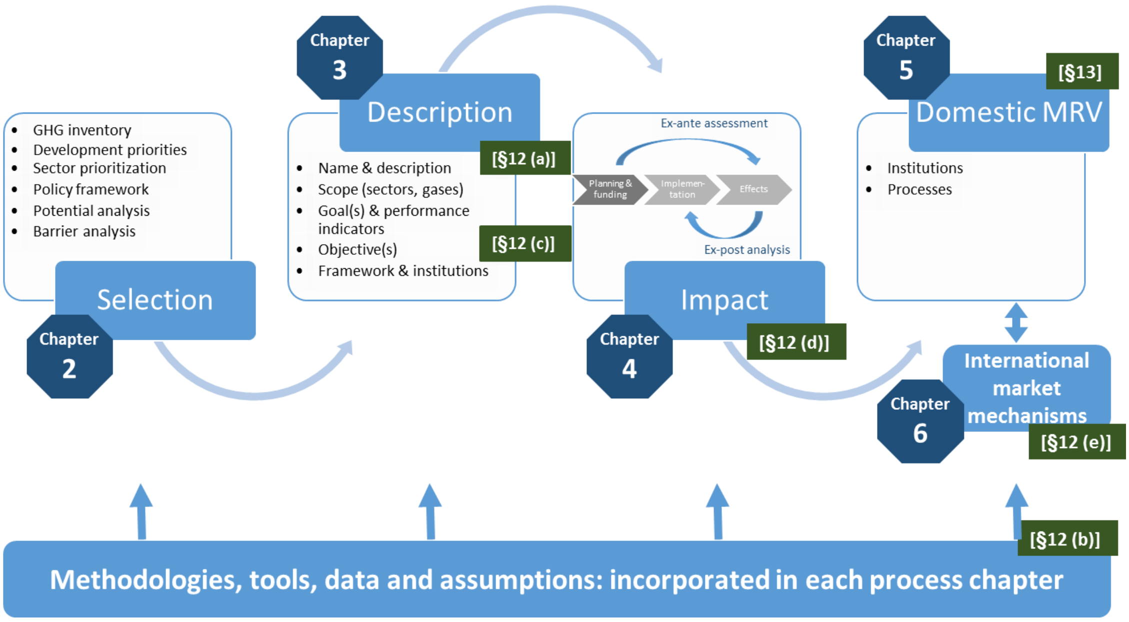
b) Undertake a technical analysis of information contained in the BUR as outlined in the “UNFCCC biennial update reporting guidelines for Parties not included in Annex I to the Convention” (hereinafter referred to as BUR guidelines) contained in annex III to decision 2/CP.17, and any additional technical information that may be provided by the Party concerned;

c) Identify, in consultation with the Party concerned, identify capacity-building needs in order to facilitate reporting in accordance with annex III to decision 2/CP.17, and participating in international consultation and analysis in accordance with annex IV to decision 2/CP.17, taking into account Article 4, paragraph 3, of the Convention.

1.2. STRUCTURE OF THE BACKGROUND MATERIAL

Figure 1 outlines the general understanding of mitigation actions for Parties not included in Annex I to the Convention (non-Annex I Parties), which forms the basis for the structure of this background document. It also highlights the relationship of different elements to the BUR guidelines (the relevant paragraphs are indicated in green boxes).

Figure 1
Structure of the background material



Note: Green boxes refer to relevant paragraphs in the "UNFCCC biennial update reporting guidelines for Parties not included in Annex I to the Convention".
Abbreviations: GHG = greenhouse gas, MRV = measurement, reporting and verification.

2. SELECTING MITIGATION ACTIONS

This chapter aims to provide experts with a background understanding on the process of developing mitigation actions, in the context of sustainable development. This includes understanding the national context, the emissions profile and possible mitigation potential. The chapter also provides concepts, methods and tools that allow countries to select and define their mitigation actions within their national development priorities.

2.1. STEPS FOR SUCCESSFUL SELECTION, DESIGN AND IMPLEMENTATION OF MITIGATION ACTIONS

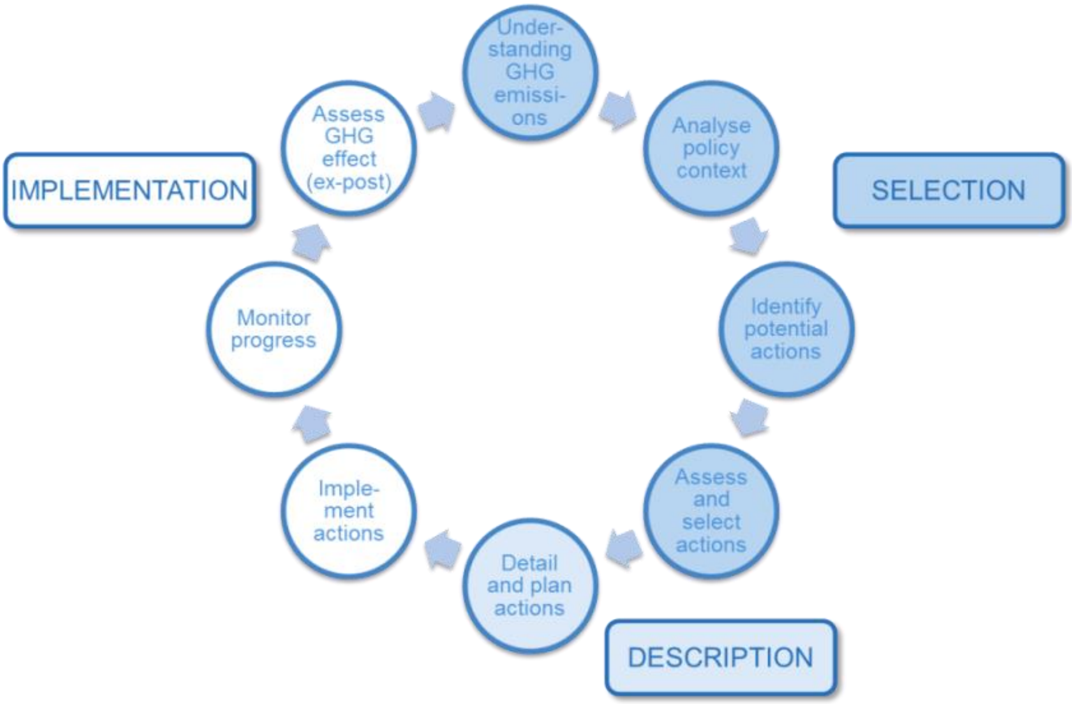
This section introduces the main steps and concepts that are normally part of mitigation analysis, planning and implementation. It provides the framework for the subsequent sections, which explain individual steps in more detail.

2.1.1. EMBEDDING MITIGATION ACTIONS IN ROBUST ANALYSIS

Ideally the implementation of mitigation actions is embedded in a robust analytical framework that supports decision-making and allows policymakers to evaluate success. Such a robust framework includes the analysis of the current greenhouse gas (GHG) emission profile, expected future developments and the identification of potential mitigation actions within the overall political context and the sustainable development priorities of the country. **Error! Reference source not found.** illustrates an example of such a process. Results and experiences from past activities inform future analyses and actions.

This cycle is also helpful to understand nationally appropriate mitigation actions that are framed around economy-wide, sectoral or technology goals. As required by the BUR guidelines, Parties need to report on envisaged steps to achieve envisaged reductions. This includes measures that may not yet be implemented. There should be a clear view as to how the goals are expected to be achieved. To arrive at this view, the steps related to ‘selection’ in this cycle or a similar approach should be used.

Figure 2
Illustrative example of a design and implementation cycle for mitigation actions



Source: Adapted from WRI (2014c).
Abbreviation: GHG = greenhouse gas.

Following a full mitigation analysis and implementation cycle has several advantages for Parties implementing mitigation actions. It provides policymakers with a solid basis of information for decision-making on which mitigation actions to select for implementation, given the wide range of choices and limited resources. It also provides an understanding of the robustness and sustainability of the enabling environment for mitigation actions, as well as of the effectiveness of mitigation actions regarding GHGs and sustainable development impacts. During implementation, it supports decision makers to identify the potential need to intervene to ensure effective outcomes.

At the same time, a robust analysis provides domestic and international funders with confidence that resources are well spent. Finance ministries need to be convinced to allocate domestic resources, international donors want to ensure maximum effectiveness, and private investors need to ensure effective returns on investment.

A robust analysis also supports Parties to meet the principles and objectives of the UNFCCC and provides a good basis for reporting in BURs. This should enable a solid understanding for the TTE of the mitigation actions reported.

Box 1
Key terminology in the design and implementation cycle

Ex-ante analysis: The process of estimating expected future greenhouse gas effects of a mitigation action.

Ex-post analysis: The process of estimating historical greenhouse gas effects of a mitigation action.

There are many reasons for following all steps in the design and implementation cycle. However, Parties may choose other processes or skip individual steps based on their national circumstances.

Error! Reference source not found. provides a more detailed description of each of the steps within the design and implementation cycle, which forms the basis for the subsequent sections.

Figure 3:
Illustrative steps of the selection, design and implementation cycle

Source: own illustration
Abbreviation: GHG = greenhouse gas.

The subsequent information in this section will address the first steps of the analysis around the selection of mitigation actions: understanding GHG emissions, the political context for mitigation action, and how to identify, assess and select possible mitigation actions. Section 3 will then focus further on how to detail and plan mitigation actions and the type of information that is required to understand mitigation actions reported in the BUR. Section 4 will focus on the last three elements and take a closer look at methodologies for how to track and evaluate progress and effects of mitigation actions.

2.1.2. EMBEDDING MITIGATION ACTIONS WITH STAKEHOLDERS

The successful implementation of mitigation actions often requires a wide range of stakeholders to participate in the process. This includes policymakers from different departments, such as energy, agriculture, environment, and finance. It often requires involvement at national, regional, and community levels. Other national agencies, like environment agencies, electricity boards, and national or international research institutions and universities can provide necessary data and analytical capacity. Civil society representatives from environmental groups, local women's groups, or other groups can significantly contribute to identifying options and barriers.

Stakeholder engagement is essential at all stages of policy development. This is especially true when the activities and policies planned affect fundamental sectors within society, such as energy supply, or sectors that large parts of the population depend on for their livelihoods, like agriculture.

Changes to existing patterns are often perceived as a threat for various reasons across all levels of society. Engaging all relevant stakeholders from early stages of planning can alleviate these fears, tap into existing knowledge, cultivate a sense of ownership and buy-in, and enable mutually beneficial solutions. It also prevents future barriers to effective implementation, which often results from inadequate stakeholder involvement earlier in the process. Government agencies that were not involved may create bureaucratic hurdles, private sector companies may refuse to invest, or civil society groups may interfere in implementation.

Ensuring ownership with the key stakeholders is therefore helpful for the effective implementation of activities. To enable this it is important to create an environment of mutual trust between stakeholders and common understanding of the underlying facts. Awareness of the engagement and trust established with stakeholders in the given national context can help the TTE to better understand the reported mitigation actions and their impacts.

2.2. DETERMINING THE CONTEXT FOR MITIGATION ACTIONS

This section provides an overview of the initial steps in mitigation analysis: understanding the GHG profile of a country, understanding its development priorities, and understanding the relevant policy framework for mitigation actions.

The section focuses on the following questions:

- Why is it important to understand these elements in the context of ICA?
- What are examples for the individual elements?

2.2.1. UNDERSTANDING THE GREENHOUSE GAS EMISSION PROFILE

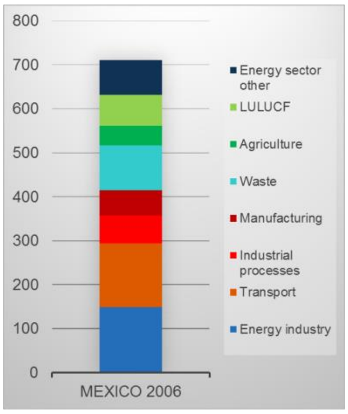
Understanding the GHG emission profile of a country is an important element for successful mitigation action.[1] For many developing countries, only limited GHG data is available. For all countries that have submitted a national communication to the secretariat, at least one GHG inventory is available. In many cases this may be a few years old and may contain only a small number of data points or years. The BUR guidelines encourage countries to provide a consistent time series back to the years reported in previous national communications. The most recent data available should be used. Where available, data from the national inventories can be supplemented with additional data that has been collected by the government, other national agencies or by international institutions and organizations, such as the International Energy Agency.

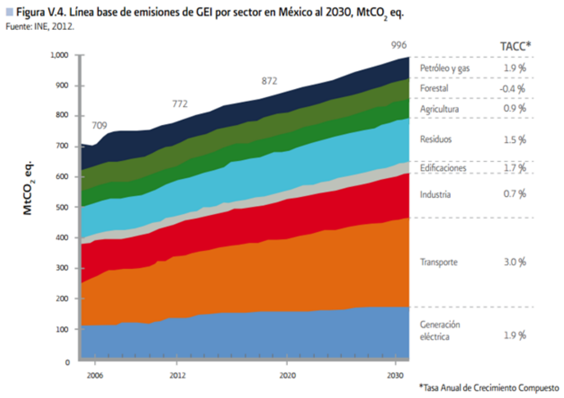
Understanding the national emissions profile and trends is important to be able to identify the highest mitigation potential. This can, in most cases, be represented either by the largest emitting sectors or by sectors with the largest expected growth. The analysis also enables the alignment of mitigation actions with national development priorities. Sectors with high potential that overlap with priority sectors of the national development strategy are especially suited for successful mitigation action. Mitigation potential is an important element in the design phase of activities, helping to screen sectors and measures for their suitability. It is usually determined on a sectoral or sub-sectoral level and in many cases represents technical or economic potential (see section 2.3 for more detail on mitigation potential).

[1] This section looks at why the GHG profile is important in the context of mitigation actions and does not go into detail about how to develop a GHG inventory. A separate training, in line with the BUR guidelines, section III, is available for this purpose and can be accessed here http://unfccc.int/349.php

Box 2
Understanding greenhouse gas profile and trends (Mexico)

The greenhouse gas (GHG) profile for Mexico provides a good example for the importance of looking at both the current emissions profile and future trends. In the left-hand figure, we see the GHG profile for 2006, where the energy industry and transport emissions are the main GHG emission sources. In the right-hand figure, the projections show that in the baseline scenario transport emissions are expected to grow much more than those from the energy industry sector. This analysis would indicate that the transport sector is a suitable sector for further mitigation activities.





Source: UNFCCC (Undated b).

Source: Comisión Intersecretarial de Cambio Climático (2012).

Abbreviations: LULUCF = Land Use, land-Use change and forestry, TACC = transparency, accountability, consistency and comparability.

2.2.2. UNDERSTANDING DEVELOPMENT PRIORITIES

Mitigation actions (implemented using domestic and international resources) that are in line with and support the development priorities of countries will likely be more successful and effective. Development priorities depend on the national context and can include a wide range of economy-wide or sector-specific goals and objectives, such as:

- Overall economic growth;
- Job creation;
- Poverty reduction;
- Rural development;
- Reduced pollution;
- Enhanced education;
- Improved health;
- Strengthening national identity;

- Sociopolitical stability;
- Reduced misplaced government spending (fuel subsidies).

Based on the understanding of the emissions and development priorities it is often useful to prioritize further analysis, especially when resources and capacity are limited. While a full analysis across all sectors can capture all possible mitigation measures, a detailed analysis of each possible mitigation action requires time and resources, which may not be available for the first step.

For many countries it will not be feasible to implement mitigation actions in all sectors and across all technologies available. Prioritizing specific sectors based on the understanding of GHG emissions and development priorities is therefore useful to deploy existing resources effectively and efficiently.

While this is an important step for Parties who conduct a mitigation assessment, it is not part of the mandate of the TTE to evaluate how far reported mitigation actions are in line with development priorities. It can, however, help to better understand choices made by Parties.

2.2.3. UNDERSTANDING THE POLICY CONTEXT

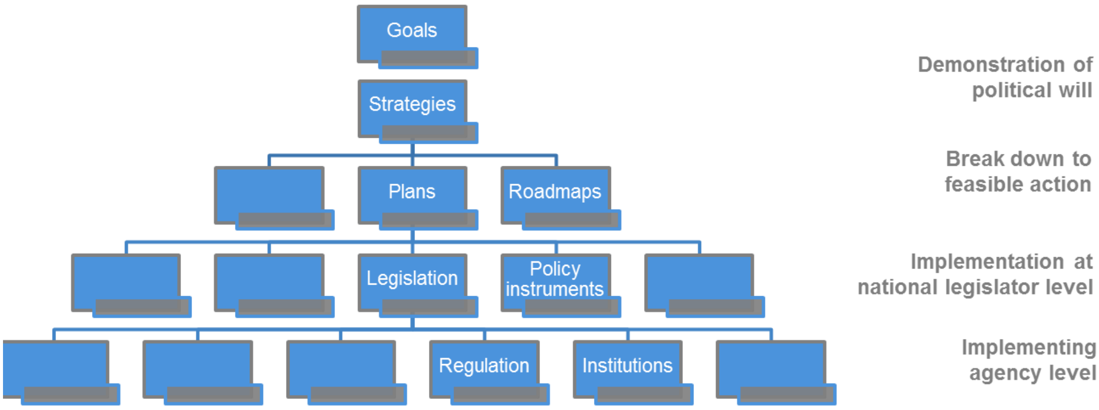
The existing policy framework will influence the effectiveness of mitigation measures. It represents the institutional and administrative framework for the implementation of measures as well as the existing landscape of goals, strategies, policies and regulations that affect a sector where mitigation actions are implemented. Underlying political regulation will affect the mitigation action and present barriers or enablers for effective mitigation action. To understand the effects of mitigation actions, the interaction of the measure with the existing policy framework must be taken into consideration.

The existing political framework influences the effectiveness of mitigation actions at different levels:

- **Purpose**: Strategies provide guidance, while detailed implementation regulations aim to achieve specific objectives and translate the strategies into practice;
- **Scope**: Strategies and policy instruments can be cross-cutting or multisectoral in nature or aim at sector or technology specific interventions. They can also overlap, reinforce or weaken each other.
- **Engagement**: Policies can be formulated around aspirational goals or constitute binding and enforceable legislation.

It is important to be aware of these different levels and dimensions of the policy framework. Strategies and related goals offer important guidance for the formulation of more concrete actions and implementation at the different levels of legislation. However, only the concrete implementation of instruments and actions will enable the achievement of expected results. **Error! Reference source not found.** illustrates the different levels of the political framework and their relationships.

Figure 4
Different levels of the political framework



Source: own illustration

Institutions and administrative processes linked to the policy framework are also important, as they can provide either the required enabling environment for the implementation of mitigation actions, or pose barriers, for example through lack of resources.

Table 1 presents general types of policies and actions that are usually applied at the national legislator level, thus forming the policy framework for mitigation actions. In many cases such policies will form the basis of mitigation actions (see section 2.3.1.2).

While the provision of information on the political framework is not required by BUR guidelines, countries that have conducted this analysis may choose to share this information and thus provide the TTE with additional material to enhance understanding of the reported mitigation actions.

Table 1
Examples for different types of policies

Type of policy or action	Description
Regulations and standards	Regulations that specify abatement technologies or minimum requirements for energy consumption, pollution output, or other activities. They may set obligations or mandates for specific sectors. They typically include penalties for non-compliance.
Taxes and charges	A levy imposed on each unit of activity by a source (e.g. fuel tax, carbon tax, traffic congestion charge, import or export tax).
Subsidies and incentives	Direct payments, tax reductions, price supports or the equivalent thereof from a government to an entity for implementing a practice or performing a specified action.

Type of policy or action	Description
Tradable permits	A programme that establishes a limit on aggregate emissions by specified sources, requires each source to hold permits, allowances, or other units equal to its actual emissions, and allows permits to be traded among sources. These are also known as emissions trading programmes, emissions trading systems, or cap-and-trade programmes.
Voluntary agreements or measures	An agreement, commitment, or measure undertaken voluntarily by public or private sector actors, either unilaterally or jointly in a negotiated agreement. Not all voluntary agreements are truly voluntary; some include rewards and/or penalties associated with participating in the agreement or achieving the commitments.
Information instruments	Required public disclosure of information, generally by industry to consumers. These include labelling programmes, rating and certification systems, and information or education campaigns aimed at increasing awareness and changing behaviour.
Research, development, and deployment policies	Policies aimed at supporting technological advancement, through direct government funding or investment, or facilitation of investment, in technology research, development, demonstration, and deployment activities.

Source: Gupta et al. (2007); WRI (2014c).

2.3. MITIGATION ANALYSIS: FROM POTENTIAL TO MITIGATION ACTIONS

This section provides an overview of the steps needed to identify possible mitigation actions in the national context, assess the GHG potential and sustainable development effects, and select mitigation actions for implementation.

2.3.1. IDENTIFYING MITIGATION ACTIONS

There are a number of steps involved in the selection of mitigation actions. It is useful to keep in mind that apart from the national context, the final selection will be influenced by the primary objective of the action:

- **Climate focused actions**: Mitigation actions can have GHG reduction as the primary objective and sustainable development effects as so-called co-benefits;
- **Development focused actions**: Mitigation actions can also have sustainable development objectives as the primary objective, but also deliver GHG emission reductions.

Box 3
Co-benefits

The term co-benefit implies that benefits occur additional to benefits or impacts that are the main intention of an action. As such, the term can relate to greenhouse gas emission (GHG) reductions as well as sustainable development impacts, depending on what the main objective of the action is.

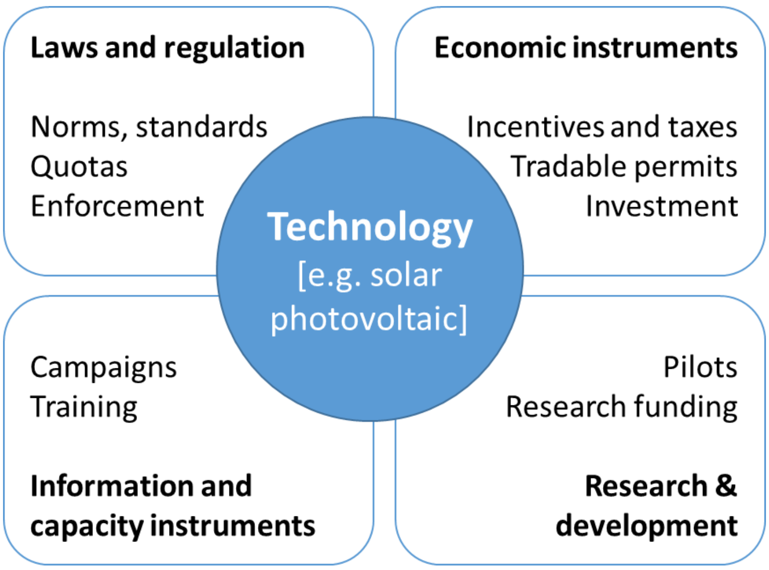
To avoid confusion and to stress that sustainable development can be the main objective of actions reported as mitigation actions, this material refrains from using the term co-benefits. Effects are discussed as GHG impacts and sustainable development impacts (or non-GHG impacts) irrespective of what is the main objective of the action.

2.3.1.1. Deployment of low carbon technologies and practices

Irrespective of the final objective of actions, the identification of mitigation actions usually starts with making choices on the low carbon technologies and practices appropriate for the national circumstances. The deployment of these technologies and practices can then be supported by a wide range of different mitigation actions.

Only the real use of low carbon technologies and practices on the ground will result in reduced GHG emissions. It is however important not to confuse technology with mitigation action. Mitigation actions aim to ensure that such technologies and practices are deployed at levels that would not be achieved in the absence of the mitigation action.

Figure 5**:**
Example of different mitigation actions to support a low carbon technology



Source: own illustration

Figure 6 illustrates that different mitigation actions can be used to influence the uptake of the same technology. It is important to provide a stable enabling environment, irrespective of the choice of instruments. If the goal is to achieve a certain capacity or share of solar photovoltaic (PV) power in a country, this could be achieved with a variety of different tools, including:

- PV could be made mandatory for new buildings (e.g. of certain type);
- Energy providers could be obliged to achieve a specific quota of PV within their energy mix;
- Taxes or charges on non-PV generation capacity could be applied;
- PV investments could be incentivized through subsidy, feed-in or loan schemes;
- Government could directly invest in PV capacity;
- Information campaigns could aim to inform the public and decision makers on advantages and opportunities for PV installation;
- Experts in PV installation and maintenance could be trained;
- Research and development capacity in the country could be supported to develop solutions specifically adapted to the national context.

2.3.1.2. Using the existing policy framework as the starting point

A good starting point for identifying possible mitigation options is the existing policy framework. While analysing the relevant policy context in the country, it is useful to identify areas where existing policies, regulations and instruments could be utilized to trigger mitigation action and where the existing framework provides barriers to effective deployment of low carbon technologies and practices.

Policies that target the same sector and/or the same policy area as mitigation actions are likely to interact with them. For the design of potential mitigation actions it is important to look at existing activities and identify:

- Activities or policies already in place that could be **adapted** for mitigation action, e.g. existing standards, taxes or incentive schemes that could be easily broadened for mitigation purposes;
- Existing activities that could be **scaled up** to enhance effects, e.g. existing project-based activities that could be enhanced through national support programmes;
- Existing activities that **prevent** effective mitigation actions (barriers) and that need to be removed as part of the future mitigation actions, e.g. overly bureaucratic procedures (see also section 2.4).

2.3.1.3. Making use of available resources

For many countries, material is already available that will support the analysis of mitigation options. This can provide a good starting point for the formulation of mitigation options and the subsequent selection. Material includes:

a) **Prior assessments for the country:** In many cases studies and assessments are already available, such as:

   i) National assessments, for example mitigation analysis conducted in the context of the preparation of national communications or low carbon development studies;

   ii) International assessments, by research institutions or intergovernmental agencies;

   iii) Sectoral assessments, for example conducted by industry associations.

b) **Assessments for other countries**: Existing studies for other countries can also be helpful to identify mitigation options. Even though each country has its own specific circumstances, there may be similarities in certain sectors, or measures that can be adjusted easily to fit the national context.

c) **Technical literature and experts**: A large number of technical studies is available that present available technical solutions, and policies and actions (including on best practice policies and measures) to enhance deployment of the technical solutions.

Consultation with relevant stakeholders can be used to tap experiences of government representatives, sectoral experts and other stakeholders that have the required experience with the concrete national circumstances and the relevant political frameworks.

In many cases, mitigation actions are framed as technology related goals, for example, to achieve a certain share of renewable electricity generation. Only if governments implement this goal within the sector strategy, and support implementation with concrete policies or projects, will it lead to real emission reductions. The choice of instruments or combination of instruments will depend on the national context as discussed in section 2.2.

2.3.2. ASSESSING MITIGATION POTENTIAL

The number of possible mitigation actions, or packages of mitigation actions,[2] can be large, depending on the national circumstances of the country and how far sectors or specific areas were already prioritized at an earlier stage in the process.

Before measures are in fact implemented, there are normally a number of steps to narrow down the list:

a) The assessment of the individual possible mitigation actions provides insights into:

   i) The possible mitigation potential and cost of actions;

   ii) Expected sustainable development benefits of actions;

b) The subsequent **selection of mitigation actions** then provides further clarity on:

[2] In some cases both the effective implementation as well as the evaluation of potential will be more appropriate for packages of actions that together aim to achieve an envisaged objective.

iii) Expected effects (GHG emissions, sustainable development benefits);
iv) Feasibility of implementation (capacity, funding, technology, politics).

2.3.2.1. Understanding the concept

Mitigation potential is an important element in the design phase of activities to screen sectors and measures for their suitability. It is usually determined on a sectoral or sub-sectoral level and in many cases represents technical or economic potential.

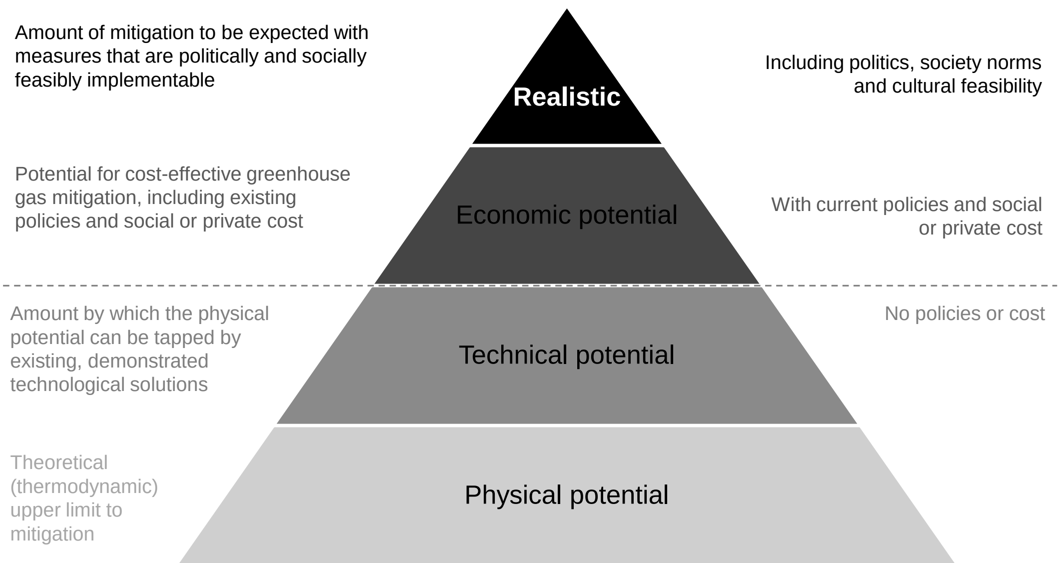
Understanding the methodologies and assumptions used to determine potential at an early stage is important, as it often influences the assessment of effects of mitigation actions. At the same time, underlying data for the potential analysis, as well as the assessment of effects, needs to be consistent.

Box 4:
Defining mitigation potential

To ensure a solid analysis and allow informed decision-making, it is essential to ensure a common understanding of terminology, to avoid comparing 'apples to oranges'.

> *"The term 'potential' is used to report the quantity of GHG mitigation compared with a baseline or reference case that can be achieved by a mitigation option over a given period" (Halsnaes et al., 2007)*

The term 'potential' can represent very different concepts, depending on which factors are taken into account in the analysis:



Source: own illustration based on Halsnaes et al. (2007).

Understanding the concepts illustrated in the pyramid is essential to be able to estimate mitigation potential. Otherwise potential can be substantially over- or underestimated.

Potential is usually expressed as megatonnes of carbon dioxide equivalent (Mt CO_2e) of avoided emissions per given time frame (e.g. year, 5-year period, etc.). There are, however, different elements of important information to enable full understanding of numbers provided:

Understanding the reference case

Reductions are normally compared to baseline emissions or the 'reference case' (see also section 4.2 for a more detailed discussion on baselines). Reductions could, however, also be stated compared to a historic reference year, where emissions are already known. While this is less frequent, it is important to be clear what the basis is.

Understanding the time frame

What is the relevant time frame for the analysis, i.e. from which year did/do emissions start to decline and what is the end year of the analysis?

Understanding the numbers

Potential can be presented in different ways:

a) Cumulative mitigation potential over the assessment period
⇨ **Mt CO_2e (2015 – 2030)**;

b) Average annual savings over the assessment period
⇨ **Mt CO_2e/a** or **Mt CO_2e/yr**;

c) Annual savings for a given year (usually the end year)
⇨ **Mt CO_2e/a (2030)**;

d) Net present values of reductions (discounted future savings)
⇨ **Mt CO_2e/a (2014)**;

Understanding how emission reductions are expected to develop over time

Expected potentials may not be realized at a constant rate over time (see section 4.3 for a more detailed discussion), but may be increasing, or declining over time. Understanding these effects is important to evaluate which numbers are most relevant for decision-making.

It is important to have clarity on these different aspects. Especially if assessments from different sources are used, it often happens that numbers are compared or even added up that are not really comparable. It is essential to obtain sufficient information on all of these elements with each assessment, to enable informed decision-making.

Understanding economic potential

The economic potential can differ significantly, depending on which type of mitigation cost is assessed. The differences between social cost and market cost are illustrated in Table 2. Each of the analysis types has its value. Together they provide a comprehensive picture. Both analyses arrive at a mitigation potential for particular levels of carbon prices in US$/t CO_2e.[3]

Table 2
Differences between social cost and market cost

Social cost	Market cost
Macroeconomic	**Microeconomic**
• Unit cost to society • Including externalities, i.e. non-market social costs and benefits • Social discount rates	• Unit cost to private actors • Current market price and projected market price development • Excluding non-market cost and benefits • Private discount rates
Assessment from a **government** perspective	Assessment from an **investor** perspective

Source: Based on Halsnaes et al. (2007).

2.3.2.2. Available methods and tools to assess mitigation potential

A variety of equations, algorithms and models may be used to estimate emissions and mitigation potential, including (WRI, 2014c):

- **Top-down** methods (e.g. econometric models, regression analysis, computable general equilibrium models);
- **Bottom-up** methods (e.g. engineering models, marginal abatement cost (MAC) curves);
- **Simple equations** (e.g. simple extrapolation);
- **Complex models** (e.g. simulation models, integrated assessment models);
- A combination of methods.

It is important to understand the purpose and limitations of the different methods to be able to understand results and the information provided within the BUR. The different types of models will be discussed in more detail below after providing some general guidance on which elements differentiate models.

It is important to note that mitigation potential in this context is not necessarily the same as envisaged mitigation effects of a specific mitigation action. The mitigation potential derived at this stage often represents the full available technical or economic potential. The final design of selected mitigation actions may not tap this fully. The full assessment of envisaged mitigation effects is detailed in section 4.

[3] Or another currency.

Differences between methods

Modelling approaches can be very different. These differences can have important implications for the variation among scenarios. Understanding these differences is therefore important to correctly understand and interpret results of such models. Differences identified by the Intergovernmental Panel on Climate Change (IPCC) for top-down models also apply to most other approaches and include:

- **Scope:** Full-economy models vs. partial-economy models (often sectoral);
- **Foresight:** Perfect-foresight models vs. recursive-dynamic models;
- **Trade:** Homogeneous goods (global uniform price) vs. preference for domestic products vs. no trade;
- **Flexibility:** Degree to which models can change course, e.g. regarding capital allocation across sectors, resource availability, substitution across technologies, etc.;
- **Detail:** Sectoral, regional, technological and GHG gases covered;
- **Technological change:** Exogenous technological change vs. endogenous (induced) technological change;
- **Actor behaviour:** rational or preferential.

Top-down methods.

These methods use economics as the basis for decision-making and typically assume fully functioning markets and competitive market behaviour. Top-down models generally rely on aggregated data and various types of macroeconomic and/or econometric modelling methods. Consumption trends are forecast into the future using historical trends or aggregate econometric relationships (gross domestic product (GDP), fuel prices, price elasticity, etc.). Most top-down models are global in scope or specific to a particular country. Important input assumptions for top-down methods include population growth, economic growth, resources, and technological change (Clarke et al., 2014; UNFCCC, 2013c). Some of the basic differentiators of different models are provided by the IPCC and summarized in **Error! Reference source not found.**.

There are different types of top-down models:

- **Computational general equilibrium** models use economic data to estimate how an economy will respond to changes in policies, technologies and prices;
- **Input/output** models focus on interdependencies between different sectors of an economy;
- **Other macroeconomic models**.

The **advantages** of top-down models are that they provide insights into non-GHG effects at the macroeconomic level and capture macroeconomic feedback effects.

The **disadvantages** include the fact that few are easily adaptable for use by developing countries. They rely heavily on having good historical time series data, which is often not readily available in developing countries. They also assume a stable macroeconomic evolution as relationships are based on historic observations and trends. For long-term assessments, they may not be well suited, since the exogenous variables (e.g. prices) are themselves poorly known in the long run. Their highly abstract structure does not capture technology trends in detail. This does not allow the examination of technology-specific issues, like for example the choice of appropriate technologies and subsequent mitigation actions.

Box 5

The Intergovernmental Panel on Climate Change on differences in top-down models

Economic coverage and interactions. Models differ in terms of the degree of detail with which they represent the economic system and the degree of interaction they represent across economic sectors. Full-economy models (e.g. general equilibrium models) represent interactions across all sectors of the economy, allowing them to explore and understand ripple effects from, for example, the imposition of a mitigation policy, including impacts on overall economic growth. Partial-economy models, on the other hand, take economic activity as an input that is unresponsive to policies or other changes such as those associated with improvements in technology. These models tend to focus more on detailed representations of key systems such as the energy system. All else being equal, aggregate economic costs would tend to be higher in full-economy models than in partial-economy models because full-economy models include feedbacks to the entire economy. On the other hand, full-economy models may include more possibilities for substitution in sectors outside of those represented in partial-economy models, and this would tend to reduce aggregate economic costs.

Foresight. Perfect-foresight models (e.g. inter-temporal optimization models) optimize over time, so that all future decisions are taken into account in today's decisions. In contrast, recursive-dynamic models make decisions at each point in time based only on the information in that time period. In general, perfect-foresight models would be likely to allocate emissions reductions more efficiently over time than recursive-dynamic models, which should lead to lower aggregate costs.

Representation of trade. Models differ in terms of how easy it is for goods to flow across regions. On one end of the spectrum are models assuming goods are homogeneous and traded easily at one world price (Heckscher-Ohlin) or that there is one global producer (quasi-trade). On the other end of the spectrum are models assuming a preference for domestic goods over imported goods (Armington) or models without explicit trade across regions (e.g. models with import supply functions). In general, greater flexibility to trade will result in lower-aggregate mitigation costs because the global economy is more flexible to undertake mitigation where it is least expensive. More generally, many partial-equilibrium models include trade only in carbon permits and basic energy commodities. These models are not capable of exploring the full nature of carbon leakage that might emerge from mitigation policies, and particularly those associated with fragmented international action.

Model flexibility. The flexibility of models describes the degree to which they can change course. Model flexibility is not a single, explicit choice for model structure. Instead, it is the result of a range of choices that influence, for example, how easily capital can be reallocated across sectors including the allowance for premature retirement of capital stock, how easily the economy is able to substitute across energy technologies, whether fossil fuel and renewable resource constraints exist and how easily the economy can extract resources. The complexity of the different factors influencing model flexibility makes clear delineations of which models are more or less flexible difficult. Evaluation and characterization of model flexibility is an area of current research (see Kriegler et al., 2015). Greater flexibility will tend to lower mitigation costs.

Sectoral, regional, technology and greenhouse gas detail. Models differ dramatically in terms of the detail at which they represent key sectors and systems. These differences influence not only the way that the models operate, but also the information they can provide about transformation pathways. Key choices include the number of regions, the degree of technological detail in each sector, which greenhouse gases are represented and how, whether land use is explicitly represented, and the sophistication of the model of earth system process, such as the carbon cycle. Some models include only carbon dioxide (CO_2) emissions, many do not treat land-use change and associated emissions, and many do not have sub-models of the carbon cycle necessary to calculate CO_2 concentrations. In addition, although the scenarios in this section were generated from global models that allow for the implications of mitigation for international markets to be measured, regional models can provide finer detail on the implications for a specific region's economy and distributional effects. The effects of detail on aggregate mitigation costs are ambiguous.

Representation of technological change. Models can be categorized into two groups with respect to technological change. On one end of the spectrum, models with exogenous technological change take technology as an input that evolves independently of policy measures or investment decisions. These models provide no insight on how policies may induce advancements in technology. On the other end of the spectrum, models with endogenous technological change (also known as induced technological change) allow for some portion of technological change to be influenced by deployment rates or investments in research and development. Models featuring endogenous technological change are valuable for understanding how the pace of technological change might be influenced by mitigation policies.

Source: Clarke et al. (2014).

Bottom-up methods

These methods are based on a detailed physical accounting of systems. They provide a more fundamental understanding of how systems behave and may evolve into the future, so are well suited for examining potential long-term transitions. At a general level bottom-up models can be distinguished by their sectoral scope:

- **Integrated models**: Cover an entire country and thus allow for modelling of interactions between sectors. This comes at the expense of detail within sectors;
- **Sector-specific models**: Provide informed inputs into integrated models and can be used on their own to evaluate high-emitting and key sectors with a higher level of detail.

Different types of models based on the methodologies used are:

- **Optimization models**: Use mathematical programming to identify configurations of energy systems that minimize the total cost of providing services.
- **Accounting frameworks**: Account for physical stocks and flows in systems based primarily on engineering relationships and explicit assumptions about the future (e.g. technology improvements, market penetration rates).
- **Technology screening**: Focuses on how a particular technology (or set of technologies) will perform under certain constraints and can track associated costs and emissions. MAC curves represent a specific type of technology screening method (see **Error! Reference source not found.**).

The **advantages** of bottom-up models are that complexities of individual sectors are better captured and individual technologies are better represented through the high level of technological detail.

The **disadvantages** include the lack of macroeconomic feedback effects. There is no reflection of indirect rebound effects and limited representation of cost-independent market distortions. While bottom-up models, unlike top-down methods, are able to provide technology-specific evaluation, they can also not provide measure-specific evaluation of individual mitigation actions.

Figure 6 provides a summary of strengths and weaknesses of bottom-up, top-down and hybrid approaches.

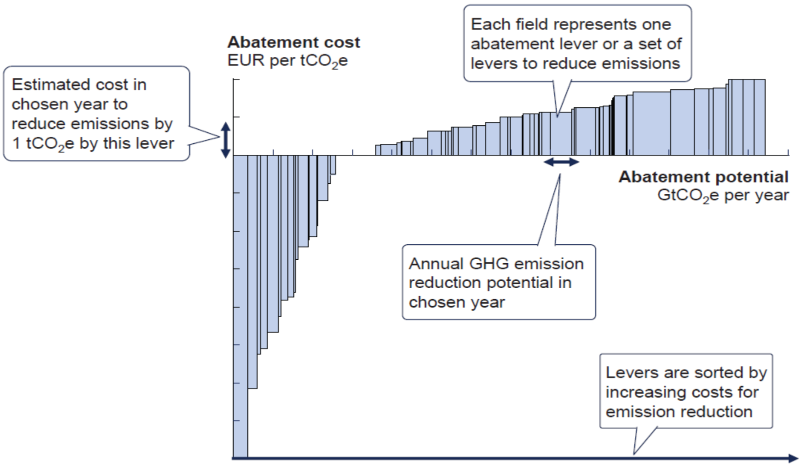
Figure 6
Summary of strengths and weaknesses of different types of models

	Bottom-up		Top-down		Hybrid
	Accounting	**Optimisation**	**Simple extrapolation**	**Computable general equilibrium**	
Strengths	Ease-of-use and potentially small data needs	Technological detail and least-cost projections	Ease-of-use and potentially small data needs	Feed-back effects on macroeconomic variables	Technological detail and consistency with economic projections
Weaknesses	Linkages with broader macroeconomic developments missing		Lack of technological detail		Can be very resource-intensive
Examples[12]	LEAP[13], MEDEE and MAED	MARKAL/ TIMES, POLES, RESGEN and EFOM	Spreadsheet models	ENV-Linkages (OECD), SGM and CETA	WEM (IEA), NEMS, MARKAL-MACRO and IPAC

Source: DEA, OECD & URC (2013).

Box 6
Marginal abatement cost curves

Marginal abatement cost (MAC) curves represent a methodology to present and rank mitigation options based on their cost-effectiveness. Abatement potential is always displayed for a single dedicated year. Options are sorted with the lower cost alternatives to the left and increasing cost to the right. The width of each column indicates the annual greenhouse gas emission reduction potential of the option for the year chosen.



Source: McKinsey & Company (2009).
Abbreviations: GHG = greenhouse gas, t CO2e = tonnes of carbon dioxide equivalent, Gt CO2e = gigatonnes of carbon dioxide equivalent.

There are different approaches to constructing marginal abatement cost curves. They can be developed expert-based using bottom-up methods, or model-based using computable general equilibrium models (CGE) or partial equilibrium models (Senatla et al., 2013).

Limitations to MAC curves include (Kesicki, 2011; Senatla et al., 2013):

- Real cost: Cost or time required for the implementation of policies and for barrier removal is not included. Costs are exclusively based on direct investment cost and operational cost;
- Based on market cost: External costs and benefits, and impact on macroeconomic variables are not always included in the calculations;
- Interdependence: Interaction between measures is not always reflected. Measures may influence each other and either add to or reduce the potential of other measures if implemented jointly;
- Transparency: Information on assumptions used for baseline and technology options is often limited;
- Non-dynamic: MAC curves represent abatement cost for a single point in time and cannot capture inter-temporal dynamics;
- Uncertainty: Limited representation of uncertainty and sensitivity.

Simple equations

Simple equation-based calculations can easily be implemented in standard software, such as Microsoft Excel. They cover basic relationships between activity data, fuel use and emissions.

The **advantages** are that they are easy to use, also in developing countries, and provide highly transparent calculations.

The **disadvantages** include the limited coverage of interactions between sectors and the limited possibilities to represent dynamic development over time.

Complex models

The equations which form the basis of complex systems are generally derived from statistical physics, information theory and non-linear dynamics. They represent organized but unpredictable behaviours of systems that are considered fundamentally complex. Examples include:

- **Integrated assessment models**: Tend to be based on physical or technological descriptions of systems and their interconnections. They combine natural earth systems (physical climate science) with human systems (economy, infrastructure, security, etc.).
- **Simulation models**: Simulate behaviour of consumers and producers under various signals (e.g. price, income levels) and constraints (e.g. limits on rate of stock replacement).

The advantages and disadvantages for top-down methods apply also to complex models.

Limits to mitigation potential analysis

Mitigation potential is only one aspect relevant for decision-making and should not be the only criterion for the selection of mitigation actions. Assumptions made for the potential analysis need to be logical and realistic in the given context. A number of factors are usually not adequately reflected, which can potentially lead to an **overestimation** of effects, such as:

- If the time needed to implement mitigation actions is not adequately reflected, effects are calculated to start earlier than is realistic;
- If the cost of implementing the required political frameworks is not taken into account, total cost per tonne of reduction is underestimated, which can lead to a higher mitigation potential at a given price.
- Barriers, or the lack of an enabling environment, are often not explicitly included in the analysis.

The interaction of different mitigation actions can lead to over- or underestimation of effects (see section 4.3 for details). At the early stage of evaluating multiple options the level of detail of the analysis of potential effects of measures will often be limited to the assessment of technical potential rather than a full evaluation of a defined measure, which would need to include an assessment of the political framework.

2.3.3. SELECTING MITIGATION ACTIONS

Some Parties may choose not to prioritize and select actions, but instead to assess and report the full set of mitigation actions that have been identified in order to maximize opportunities for support and to demonstrate the full spectrum of activities that are possible within the country. If Parties choose to prioritize and select actions, they may follow different approaches to prioritization and selection of actions. Most will be variations of the multi-criteria analysis illustrated in this section. The same principles presented below apply to all possible methods.

Multi-criteria analysis was developed out of the realization that most prioritization problems have a number of factors in common:

- There are typically **multiple criteria** that are relevant for decision-making;
- These are often **conflicting** to a certain degree, for example cost criteria with quality criteria;
- The question then becomes how to **weigh** these different elements against each other.

Multi-criteria analysis (MCA) is a method to structure the evaluation of such multiple criteria and make the weighting explicit and transparent. Table 3 provides an example from a tool developed by the Stockholm Environment Institute that can be used to support the process.

Table 3
Example of a tool for multi-criteria analysis

Examples of Criteria	Criteria Weight (Sum to 100 across all criteria)	Mitigation Option 1	Option 2	Option 3
Criteria Taken from Cost Curve				
Mitigation Potential (Million Tons CO_2e)				
- Mitigation Potential Score (0=lowest, 10=highest)				
Direct Unit Costs ($/Ton CO_2e)				
Direct Total Costs (Million $)				
- Direct Total Cost Score (0=highest, 10=lowest)				
Other Criteria (add your own)				
- Reliance on Local Technologies (0=bad-10=good)				
- Reliance on Domestic Energy Sources (0=bad-10=good)				

Source: Greenhouse Gas Mitigation Screening Tool, developed by the Stockholm Environment Institute as part of the Long range Energy Alternatives Planning System (LEAP) (Stockholm Environment Institute, undated).

Individual criteria, especially for sustainable development effects, will vary between countries and the selection should be aligned with the country's development priorities.

Selection criteria and weighting factors for an MCA are ideally determined together with the involved stakeholders to ensure that they reflect the priorities of the different groups. Important in this process is to document the rationale for determining criteria weights and individual ratings for qualitative criteria. Examples of possible criteria for mitigation actions, based on their primary objective, include:

Greenhouse gas effects

- Significance of emissions impact (t CO_2e);
- Cost-effectiveness (e.g. marginal abatement cost);

Sustainable development effects

- Consistency with national development plans and goals;
- Social and macroeconomic impact (employment, trade);
- Equity (differential impacts on income groups);
- Environmental impact (e.g. local air quality, biodiversity, etc.);

Other considerations

- Feasibility, including institutional capacity (data collection, monitoring, enforcement, permitting, etc.) and political acceptability;
- Replicability (adaptability to different settings);
- Technology transfer.

It is not within the mandate of the TTE to evaluate the prioritization and selection of mitigation actions by countries. Information on the process and criteria used can, however, promote understanding of the mitigation actions reported and enhance transparency.

2.4. BARRIERS AND MEANS OF IMPLEMENTATION

This section discusses barriers and means of implementation. Both aspects are crucial to successful mitigation actions. A lack of means of implementation often presents a barrier in itself. Barrier assessment will in most cases not be part of the BUR. However, understanding whether barriers have been assessed and taken into consideration in the selection, design and implementation of mitigation actions, is important. It helps to understand whether reported effects may fall short of the envisaged impact and to identify support needs to overcome such barriers.

A barrier to mitigation potential is any obstacle to reaching a potential that can be overcome by policies and measures (Halsnaes et al., 2007). Market barriers are conditions that prevent or impede the diffusion of cost-effective technologies or practices that would mitigate GHG emissions (Allwood et al., 2014).

The removal of barriers can in itself be a mitigation action, as part of a portfolio of actions or as an individual action to support already existing measures.

Barrier analysis forms an important element of the assessment of mitigation actions. If different types of barriers are not taken into account the mitigation action could be less effective than envisaged. For example:

a) **Institutional or political barriers** can actively prevent effective implementation or reduce effectiveness through:

  i) Lack of enforcement;

  ii) Implementation of counteracting policies and regulations;

b) **Technological barriers** can limit the exploitation of potentials;

c) **Capacity** constraints can hinder effective implementation at various levels, including:

  i) Institutional and administrative capacity to plan and implement measures;

  ii) Skills available in the private sector to implement technology solutions, for example for installation and maintenance of equipment;

d) Availability of **financial resources** to effectively implement the mitigation action.

Table 4 provides examples of barriers and options and suggestions to overcome them.

Table 4
Illustrative examples of barriers and options to overcome them

Barriers	Options to overcome barriers
Institutional and political	
• Conflicting goals • Uncertainty of long-term policy framework • Inadequate enforcement • Unclear responsibilities and lack of coordination • Counter-acting subsidies or taxes • Missing or counterproductive regulation • Undefined property rights • Principal-agent issues • Inadequate information • Highly bureaucratic processes	• Creating an integrated, long-term strategy, involving all stakeholders • Implementation of coordinating bodies or institutions • Put in place missing legislation or adapt existing legislation • Establish institutional and legislative systems to gather required data at the required level of detail, frequency and quality
Technology barriers	
• Lack of storage systems and technologies to manage intermittency • Low quality of local technology products • Limited availability of monitoring technology (e.g. satellite monitoring) • Lack of standardization	• Strengthen national research and development (R&D) activities • Incentivize national technology production • Strengthen education and training • Support standardization, e.g. through industry round tables

Barriers	Options to overcome barriers
Capacity constraints	
• Limited number of experts in-country • Limited local R&D • Limited awareness about technical solutions • Limited knowledge on related benefits of mitigation technologies • Lack of technical personnel for installation and maintenance • Lack of personnel for monitoring and enforcement • Unavailability of detailed information on wind potentials and solar irradiation • Lack of training and education capacity	• Strengthen education and training system, e.g. introduction of formal training programmes for selected technologies • Increase R&D investment • Awareness campaigns • Pilot/demonstration projects • Develop strategic partnerships with international funders
Financial constraints	
• High up-front investment cost • Access to loans at competitive interest rates • Short-term perspective of investors • Continuity of finance • Unclear risk assessment and management	• Governmental incentive schemes with low interest rates • Information and awareness campaigns • Develop consistent, clear and long-term strategies to reduce investor risk perception

Source: Based on Fekete, Vieweg & Mersmann (2013).

While discussions around support often centre on financial resources, limitations regarding the availability of technology and capacity constraints can limit the successful use of available financial resources. On the other hand, financial resources can help to overcome capacity and technology constraints.

Box 7
Examples for reporting on barriers

The following two examples from national communications show different ways to report on barriers to implementation.

Potentials and existing barriers for solar photovoltaic power in Peru

POTENCIALIDADES	BARRERAS EXISTENTES
El Perú es un país con altos niveles de radiación solar, especialmente en zonas de sierra y en algunos departamentos de la costa.	La energía solar fotovoltaica es sumamente costosa ($ 7,000 dólares americanos - 10,000/ Kw), por lo que requiere subsidios y exoneración de impuestos y aranceles de parte del estado.
Existen tecnologías maduras que se emplean para el calentamiento de agua (termas solares).	La mayoría de los componentes de la energía fotovoltaica son importados, lo que encarece los precios.
Se han desarrollado muchos proyectos en el país que emplean sistemas fotovoltaicos como fuente de energía.	Muchos proyectos se han implementado sin tener en cuenta la sostenibilidad en el tiempo de la instalación.
Existen zonas, especialmente en la selva, donde no hay otras opciones de abastecimiento de energía.	Alto nivel de informalidad, en especial en zonas rurales del país para las licitaciones y preparación de estos proyectos.

Source: Ministerio del Ambiente (2010).

Objectives, measures and barriers for improved production systems in Benin

Policy	Objectives	Principle measures/actions	Status of implementati on	Barriers
Development of improved crop production systems	• Reduce GHG emissions by C-fixation in the soil • Improve agricultural productivity	Promotion of soil fertilizing techniques (composting, agro-forestry) Promotion of improved varieties Installation of a mechanism to improve access to agricultural inputs and credits	Ongoing Planned Starting	High price of compost Reluctance by farmers due to competition of trees and crops in agro-forestry systems Difficulty to find the financial resources to start implementation Difficult access to inputs (grains and fertilizers)

Source: Ministère de l'Environnement de l'Habitat et de l'Urbanisme (2011).

3. DESCRIBING MITIGATION ACTIONS

This chapter aims to enhance the understanding of information needs related to the description of the mitigation action. The objective is to enhance the understanding of experts of the interaction between mitigation actions and the wider political and institutional framework of the country and its overall development objectives and strategies. This should form the basis of a better understanding of the mitigation action and the overall portfolio of mitigation actions reported in the BUR in their context and the intended effects on emissions and sustainable development.

3.1. DESCRIBING THE MITIGATION ACTION

This section provides an overview of the information required to describe a mitigation action in a way that is in line with BUR guidelines and allows experts to understand the nature of the action.

3.1.1. ADVANTAGES OF DESCRIBING MITIGATION ACTIONS IN DETAIL

Describing mitigation actions in detail has advantages beyond complying with BUR reporting guidelines. A certain minimum level of detail is necessary to be able to understand the achieved or expected effects of mitigation actions, but more detail allows a more robust understanding of these effects for the Party implementing the mitigation action. In particular:

- A clear definition and description of the mitigation action is necessary to **accurately understand** the action and its intended or achieved effects for national and external stakeholders;
- A high level of detail supports a robust design and can **facilitate the successful implementation** of mitigation actions;
- Having a clear definition of the mitigation action is also useful when **communicating** the action and expected impacts to policymakers and other interested parties;
- Detailed information will enhance **opportunities for support** for planned mitigation actions.

3.1.2. SETTING THE SCENE

The basic information for setting the scene comprises the title, description and objectives. These provide the context and basic understanding of the mitigation action. While the title provides an easy reference point to differentiate actions, the description should elaborate on this and provide sufficient insight to understand the mitigation action and its objectives. The separate formulation of objectives is particularly relevant if the mitigation action is framed as a goal or where GHG emission reduction is not the main objective of the action.

The description

The type of information provided in the description will depend on the type of mitigation action. It should be concise and provide a basic understanding of the mitigation action. Additionally it should enable the identification of what type of mitigation action is reported in line with the discussion of types of mitigation actions in chapter 2, contained within this background training material.

Additionally the description should be clear about the way in which the mitigation will lead to actions that deliver GHG emission reductions.

In general, the description should provide a short summary of the more detailed information provided later in the BUR, related to the coverage and steps of the mitigation action as appropriate (see sections 3.1.3 and 3.2.1).

Objectives

Developing countries face the challenge of combining a low-carbon development pathway and sustainable development. On the one hand, climate change influences key natural and human living conditions and thereby also the basis for social and economic development, while on the other hand, society's priorities on sustainable development influence both the GHG emissions that are causing climate change and the vulnerability (UNFCCC, 2013c).

Most stakeholders currently regard mitigation actions mainly from the climate change perspective: the main objective is mitigating climate change through GHG reductions, i.e. sustainable development aspects are seen as 'co-benefits'. However, sustainable development may also be seen as the main objective, of which mitigation of climate change impacts is only one element. The focus of mitigation actions could also be to shift activities that mainly aim to support progress towards more climate-friendly development.

The latter perspectives may lead to different views about the sustainability of mitigation activities, hence influencing the selection and prioritization of actions. The challenge lies in combining these two complementary approaches according to given priorities.

A clear statement of the objectives will help improve understanding of the steps taken to achieve the action and progress in implementation.

3.1.3. UNDERSTANDING THE SCOPE

A number of factors relating to the scope of the action further refine the understanding of the mitigation action, including the sectoral and geographic coverage of the action, which indicate how much of national emissions could be impacted. To this end, it is also important to understand which sources and/or sinks are targeted by the action. Finally, the choice of gases covered will influence the expected and/or achieved impact of the action.

Sectors

The *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* groups GHG emissions and removals into six main sectors:

- Energy;
- Industrial processes;
- Solvent and other product use;
- Agriculture;
- Land-use change and forestry;
- Waste.

The *2006 IPCC Guidelines for National Greenhouse Gas Inventories* have a different sector classification. Non-Annex I countries are encouraged to use the latest IPCC guidelines, if capacity and resources allow or the country finds elements from the 2006 IPCC Guidelines useful for its national context. These sector classifications are:

- Energy;
- Industrial processes and product use (IPPU);
- Agriculture, forestry and other land use (AFOLU);
- Waste;
- Other.

To ensure that experts understand the reported mitigation actions and their effects it is important to be clear about the sector definitions used.

Sources and sinks

Apart from the sectoral approach, mitigation actions can also be framed around a specific set of sources and/or sinks. Sources and sinks are also the main guiding categories for the development of GHG inventories. However, in the context of mitigation actions, they can reflect a specific target group within or across sectors.

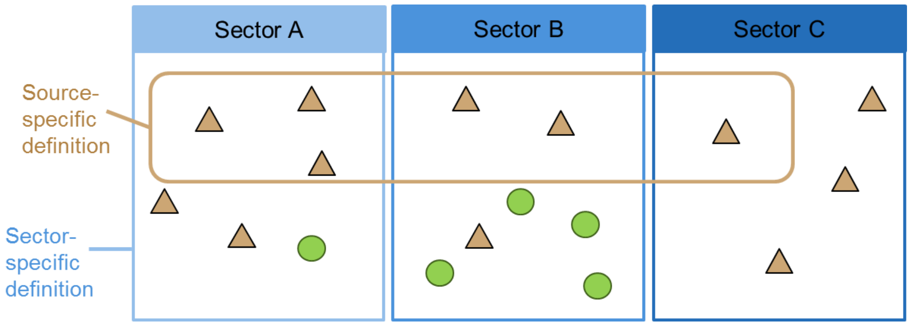
Box 8
Understanding the relationship between sectors, sources and sinks

Sources and sinks are the elements of sectors responsible for emitting or uptake of greenhouse gases. They are defined as (UNFCCC, undated a):

Sources: Any process or activity that releases a greenhouse gas, an aerosol, or a precursor of a greenhouse gas into the atmosphere, for example a power plant or a landfill.

Sinks: A reservoir that absorbs a pollutant from another part of its cycle. Soil and trees tend to act as natural sinks for carbon.

Mitigation actions can target individual sources and sinks, for example fossil fuel combustion in specific power plants. They can also target aggregated categories of sources and sinks, like for example all fossil fuel combustion in all power plants connected to an electric grid.



Mitigation actions that target specific types of sources can also cross different sectors, depending on the sector definitions. If for example buildings in general are targeted as a source, they could be covered by the residential, commercial and industry sector.

Geographic coverage

Normally it is the case that the larger the geographic coverage the larger the share of national emissions that is potentially covered by the mitigation action. There may be exceptions to this rule, where specific sources or sinks, for example industrial installations or forest areas, are strongly clustered in selected regions. In such cases, concentrating on specific regions may cover most of the relevant sectoral emissions and be an efficient way to achieve expected results. An example of this is from Brazil, where the mitigation actions regarding deforestation concentrate on the two provinces where the majority of deforestation occurs.

Implementation of mitigation actions may in some cases be easier at a smaller geographic scale. This can for example be the case with transport related measures or related to the conservation of forests. Other cases will require action at a national level to be effective. In many cases the policy framework at the national level needs to supports more local actions.

Irrespective of the rationale for selecting the appropriate geographic boundary for a mitigation action, the reporting should clearly define in which geographic area the mitigation measure is applied or planned to be applied, for example:

a) At the national level;
b) At a regional level;
c) Within one or more communities;
d) For one or more cities.

Gases

The GHG data reported by non-Annex I Parties contains estimates for direct greenhouse gases, such as (FCCC/CP/2002/7/Add.2):

- Carbon dioxide (CO_2);
- Methane (CH_4);
- Nitrous oxide (N_2O);
- Hydrofluorocarbons (HFCs);
- Perfluorocarbons (PFCs);
- Sulphur hexafluoride (SF_6).

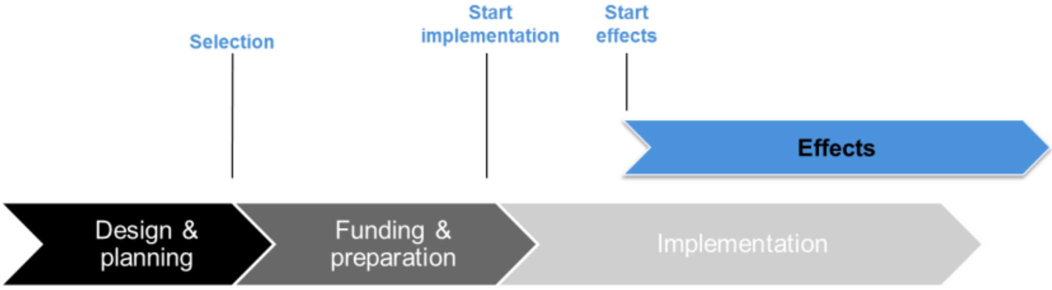
They could also cover nitrogen trifluoride (NF_3) and the indirect greenhouse gases such as sulphur dioxide (SO_2), nitrogen oxides (NO_x), carbon monoxide (CO) and non-methane volatile organic compounds.

It is important to be clear which of these gases are targeted by the mitigation measure and if other gases are expected to be impacted by the mitigation action. Given the large differences in global warming potential (GWP) of different gases, the impacts of other gases can easily outweigh CO_2 effects.

3.1.4. UNDERSTANDING THE TIMELINE

To understand the effects of mitigation actions, it is important to understand what the status of the mitigation action is within the mitigation implementation cycle. This will provide an indication of how long it will take until effects can be expected, or how long effects can have been effective. There can be a substantial time lag between different steps of the process to implement mitigation actions. Additionally effects can take some time after implementation to take off. Figure **7** illustrates the different timing of elements of mitigation actions.

Figure 7
Timeline of a mitigation action



Source: Based on WRI (2014c).

It is important to keep in mind that:

- **Design and planning processes can take a substantial amount of time**, especially for larger scale actions and policies and where there are intensive stakeholder engagement processes deployed. Ideally this process is completed when the mitigation actions are reported, but this may not always be the case, especially if the mitigation actions are formulated as goals.
- **Securing funding and preparing for the actual implementation can also take a long time**. This is especially the case for policy-based mitigation actions where the national legislative process and the political situation will strongly influence the time it takes to adopt and enact new legislation or to implement new institutions.
- **It is important to be clear on the duration of the implementation phase**. While projects normally can be clearly defined with a start and end date, this is less easy for policy-based or goal-type mitigation actions. Some policy instruments are, at least at the time of implementation, not intended to end at a certain point, like for example regulations or taxes, which remain in place until the government revises or revokes the legislation. Others are time-bound, which is usually the case for incentive schemes that have an impact on public budgets.
- **Effects often do not start directly after implementation has started**. Depending on the type of action, different factors need to be considered: for investment projects, the time required for procurement, building and installation can take anything from a few months to a number of years for large-scale installations. Policies need to filter down to all relevant levels of administration and often show slow pick-up rates at the start with increasing impact over time, depending on the policy instrument.
- **How long effects will be sustained depends strongly on the type of action**. For all actions that aim to impact infrastructure, the long time horizons for different types of infrastructure need to be considered (more detail on the time dimension of effects can be found in chapter 4).

3.2. IDENTIFICATION OF STEPS TO ACHIEVE THE ACTION

This section discusses different aspects related to the steps towards achieving the mitigation action. This includes a discussion on what constitutes a 'step towards achieving the action', examples and the relationship to barrier analysis.

3.2.1. STEPS TO ACHIEVE THE MITIGATION ACTION

A statement of intended effects (or goals) alone is not in line with BUR guidelines and does not support the understanding of mitigation actions. Mitigation goals should be underpinned with concrete measures (policies, instruments or projects) to effectively reduce emissions. The steps to achieve the mitigation action depend on the type of mitigation action. This will determine which steps of the overall process (as illustrated in **Error! Reference source not found.**) have already been completed. This will influence which steps still need to be taken. Depending on the type of mitigation action there are different starting points within the overall process. Countries may require:

- **Steps to select the policy or instrument of choice to achieve objectives**: If the mitigation action is framed as a goal and the process of determining the measures to support the goal is not yet completed, steps include the analysis and selection of mitigation options to be implemented;
- **Steps to implement the chosen policy or instrument**: If the mitigation action is framed as a concrete measure or the policy or instrument for implementation are already selected, the individual steps for implementation need to be outlined.

There should be a clear cause and effect relationship between steps taken or envisaged and reported or expected results. For more details on how to demonstrate the cause and effect relationship between steps and results, refer to section 4.3.

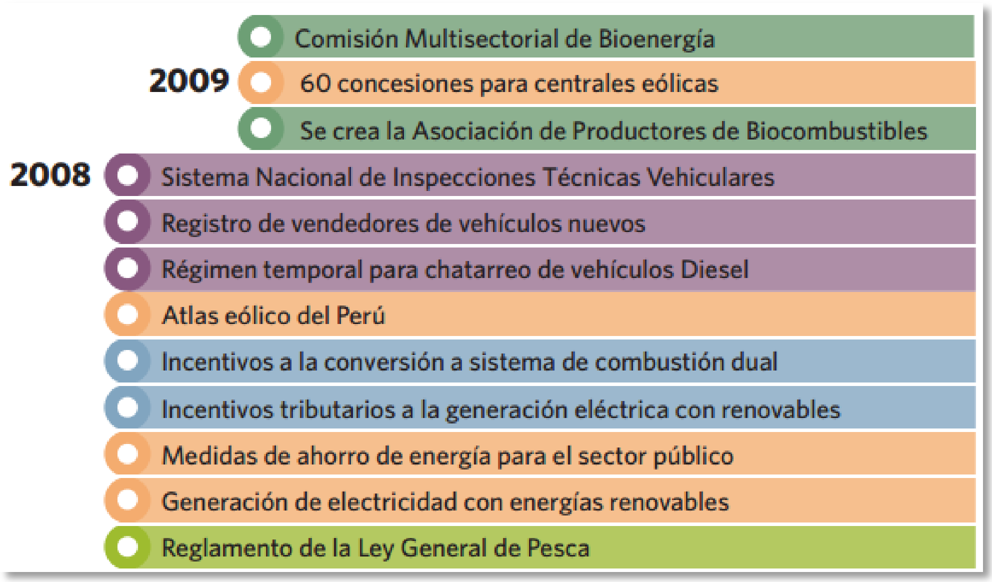
Box 9

Examples of reporting on steps taken

There are different ways to report on steps taken, two examples of which are presented below. The first example shows a tabular format, from the second national communication of the Democratic People's Republic of Korea. The second example shows a more graphic approach, which was used by Peru in its second national communication.

Sector	Strategy	Policies and measures
Energy supply	Technical modernization, and development and utilization of renewable and new energy resources	• Enactment and enforcement of laws and regulations related to energy. • Energy strategy. • Modernization of existing thermal power plants. • Creation of hydropower generation capacity. • Development of new energy resources including atomic energy. • Introduction of clean coal combustion technology. • Improvement of the network for transmission and distribution of electricity. • Promotion of development and implementation of CDM projects.
Transport	Modernization and improvement of transport management	• Introduction of heavy rails and modernization of railway. • Introduction of modernized, heavy-duty and high-speed road. • Car service by date of the week and control of loadless trucks. • Encouragement of public transport facilities. • Encouragement of walking and bicycle use. • Improvement of transport organization and control, and vehicles.

Source: National Coordinating Committee for Environment (2012).



Source: Ministerio del Ambiente (2010).

3.2.2. ELEMENTS TO CONSIDER IN ANALYZING INSTITUTIONAL ARRANGEMENTS

Mitigation actions are implemented by institutions. It is therefore important to ensure that the following are clear:

- Which institution has the overall responsibility?
- Which institutions are or should be involved, for example to provide information, data or resources?
- What are the communication and reporting processes?
- Is the capacity available at all the institutions involved to implement the mitigation action?

Not all of this information will necessarily be reported within the BUR, but as a minimum the responsible institution should be reported. More information will support enhanced understanding.

Unclear responsibilities and lines of communication can represent a barrier to effective implementation. Deficits in capacity in institutions can also lead to measures being less effective than planned. It is therefore important in the design of mitigation actions to not only ensure funding for actual expenses from activities, but also to ensure sufficient additional capacity in the institutions involved.[4]

3.2.3. UNDERSTANDING THE POLITICAL FRAMEWORK

If possible, the policy framework should also identify relevant linkage and synergies with other mitigation actions, although these may not necessarily be at a policy level. They form part of the framework and can enhance or limit the effectiveness of the reported mitigation action.

Information on the policy framework for the mitigation action is important to enable an understanding of whether a policy framework exists that will allow direct implementation of the mitigation action or whether additional policies and legislation will be required to allow the action to be effective.

For example, measures to promote the efficiency of the building envelope often require additional legislation. For such measures, it would be good to know whether buildings need a permit; whether building codes for new and old buildings exist (if yes, since when and at what level); and whether there are enforcement mechanisms in place. Having a functioning permit system with existing building codes in place would likely speed up implementation of additional measures in this area.

Existing strategies, policies and regulations can constitute barriers to implementation (for a more detailed discussion of barriers see section 2.4). It is

[4] Reporting on these constraints follows the BUR guidelines, section V “Finance, technology and capacity-building needs and support received.” Here we concentrate only on the information required to understand the institutional setup of the mitigation action.

important to identify these, as barriers can severely limit the effectiveness of mitigation actions.

3.3. IDENTIFICATION OF GOALS AND PROGRESS INDICATORS

This section gives an overview of different types of goals, explores how the goal type influences the information needs, and provides a discussion of progress indicators.

3.3.1. GOALS OF MITIGATION ACTIONS

There are different types of mitigation actions. One type of mitigation action is an action framed as a goal. The term ‘goal’ can, however, also be used in the context of other types of mitigation actions. Goals and objectives are often used interchangeably, as both refer to the desired result of an action, although they represent different concepts.

Goals tend to be long term and provide a vision of where to arrive, while **objectives** define more manageable steps in how to get there. Objectives in turn can be qualitative or have their own quantitative targets that break down the larger goal into more manageable pieces. In the context of mitigation actions, the term ‘target’ is usually avoided and replaced with ‘goal’. This can create confusion between the different concepts. While one represents a more overarching aspiration, the other constitutes a concrete quantitative indicator.[5]

Table **5** illustrates the different meanings of ‘goal’ in the context of mitigation actions and identifies the implications of the different uses of the term. In principle, similar information needs exist in both cases, but the political focus and the significance of the goal varies.

[5] It is important to note that overarching goals and concrete indicators in this context do not necessarily need to be framed in terms of GHG reductions. They can also be framed around other outcomes.

Table 5
Implications of different uses of the term 'goal'

	Goal-type mitigation actions	Policy- or project-type actions
Nature of the goal	Goal represents the mitigation action	Goal serves to guide implementation (quantitative objectives)
Information requirements	Clarity on all parameters is required	Information on all parameters useful but not mandatory
Implications for definition of steps	Policies and/or projects to achieve the goal need to be defined	Steps at a more detailed level of implementation of measures required

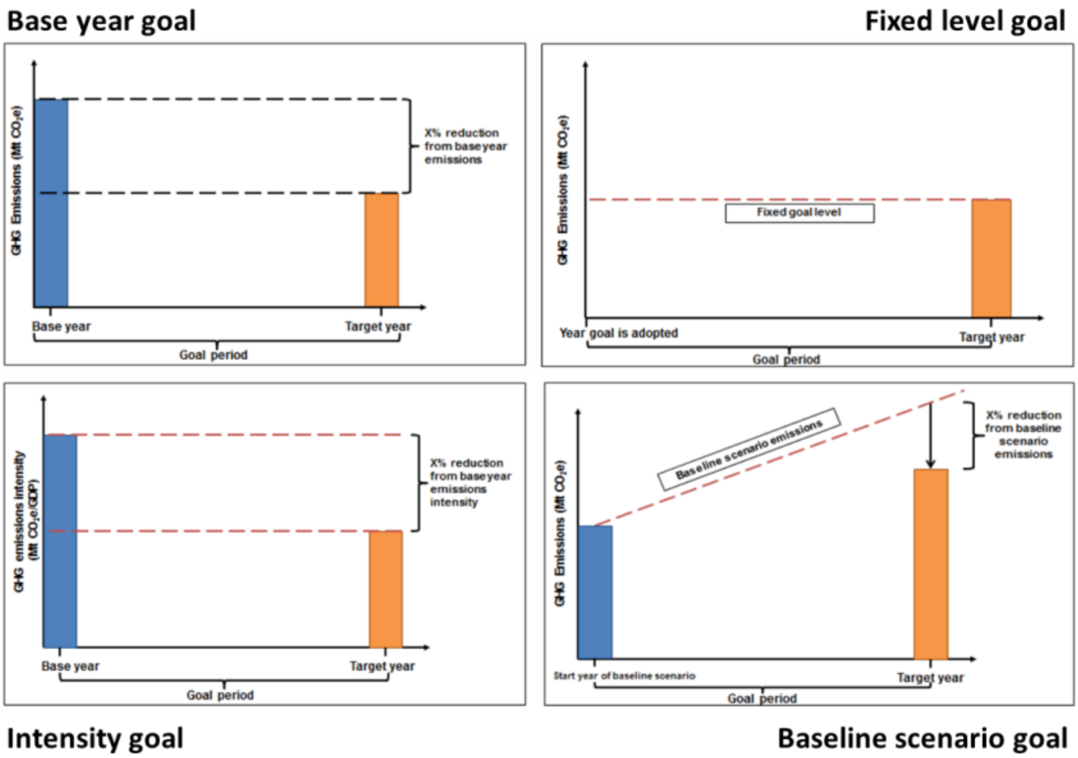
The reference case for goals

Goals for individual mitigation actions or for mitigation actions that are framed as sectoral or economy-wide GHG targets can be differentiated depending on their reference case (see Figure 8 for an illustration) (WRI, 2014a):

- **Base year goal**: Change in emissions relative to a historical base year. This is also often referred to as 'absolute goals'. Base year goals are usually framed in terms of a percentage reduction below base year emissions.
- **Fixed level goal**: Commitment to reduce, or control the increase of, emissions to a defined emissions level.
- **Intensity goal**: Change in emissions intensity relative to a historic base year. Emissions intensity is emissions per unit of another variable, typically output, such as gross domestic product GDP, but could also be population or energy use.
- **Baseline scenario goal**: Emission reductions relative to a projected emissions baseline scenario. These goals are sometimes referred to as a 'business as usual' goals.

This list is not exhaustive, but includes the large majority of different goals that Parties have adopted. While these types of goals are mostly discussed in relation to economy-wide goals, they nevertheless also apply to all different types of mitigation actions. While they were developed mainly for GHG emissions-related goals, they can also apply to goals that are framed around other outcomes, such as energy efficiency goals or renewable goals.

Figure 8
Illustration of different goal types



Source: WRI (2014a).
Abbreviations: GHG = greenhouse gas, CO_2 = carbon dioxide equivalent.

Information requirements

Independent of the goal type the following information is required for reporting mitigation actions that are framed as a goal (WRI, 2014a):

- Goal type;
- Target year or target period;
- All information on the scope of the mitigation action as discussed in section 3.1.3, including information on the treatment of emissions from land use where applicable.

Depending on the type of goal, different information is required:

- **Base year goal**: Base year and relevant base year emissions;
- **Intensity goal**: Unit of output for the intensity goal, value of the output and value of intensity in base year;
- **Baseline scenario goal**: Type of baseline (dynamic or static), values of the baseline scenario, cut off year for inclusion of policies in the baseline, current and planned policies included in the baseline.

For goals that are formulated to support the implementation of policies and/or projects, ideally all information should be provided to ensure that the intended impact of goals can be fully understood.

Outcome goals

Mitigation actions can also include goals that are not framed around emissions reductions, but around intermediate results, including sustainable development impacts, for example:

e) **Renewable energy goals**: Could be set either for all renewable energy sources in the country or for one or more specific technologies:

   iii) Capacity goals: Target to install a specified amount of capacity (installed megawatts);

   iv) Share of electricity production: Goal to achieve a defined share of renewables within the electricity production of the country (percentage of kilowatt hours);

f) **Energy efficiency goals**: Goal to increase energy efficiency (energy use per unit of GDP or other unit of output);

g) **Energy access goals**: Increase the number of households with access to clean energy;

h) **Geographic coverage goals**: Goal to apply the mitigation measure to a specified land area. This is mainly relevant for agriculture and forestry measures.

This list only provides a few examples. Goals for individual mitigation actions can be as varied as the mitigation actions themselves. Often outcome-based goals are more meaningful for policymakers and stakeholders than emission reductions, especially if the objective of the mitigation action is mainly to contribute to sustainable development.

Understanding goals in the context of the national greenhouse gas profile

Bringing stated goals into the context of the GHG profile helps those involved in preparing and prioritizing mitigation actions, but also facilitates understanding of mitigation actions by national stakeholders and international experts. It will help to understand the importance of different actions and to some extent influence the level of detail that will be required to understand the action. Mitigation actions with almost no visible effect on the overall GHG emissions of the country may be strategically important to implement, but may require less detailed information at the international level.

Where goals are not economy-wide, it is useful to compare individual goals to the broader context of the GHG profile of the country:

- Compare goals to emissions of the relevant sector(s);
- Compare goals to total national emissions.

Understanding how the goals for mitigation actions relate to the national GHG profile will help to show how difficult it could be to effectively implement the action, especially if connected to information on the economic cost of the mitigation actions. This will enhance understanding of how realistic the goals are and how the reported mitigation actions will influence the overall national emissions once effectively implemented. This should help to prioritize the understanding of effects of individual mitigation actions.

3.3.2. PROGRESS INDICATORS AND MONITORING

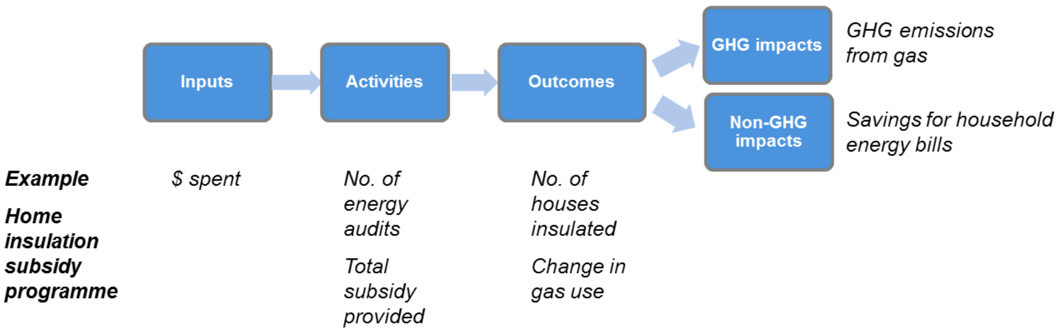
Progress indicators are an essential element of monitoring. This is distinct from estimating the effects of the policy or action ex-post. Monitoring key performance indicators is generally less onerous than estimating GHG effects and is useful as a relatively low-cost way of understanding policy effectiveness by tracking trends in key indicators. This indicates policy effectiveness, but is not sufficient to prove or estimate policy effectiveness. Where progress is not on track, monitoring can inform any necessary corrective action (WRI, 2014c).

Monitoring performance during the policy implementation period serves two related functions:

- **Monitoring policy or action implementation**: Monitoring trends in key performance indicators to understand whether the policy or action is on track and being implemented as planned, and to inform necessary changes to ensure success;
- **Monitoring to estimate policy or action effects**: Collecting data on the parameters needed to estimate ex-post policy scenario emissions, estimate GHG effects ex-post, and understand whether the policy or action is delivering the expected results.

Progress indicators can be easily developed based on the simple relationship illustrated in Figure 9.

Figure 9
Identifying progress indicators



Source: based on WRI (2014c)
Abbreviation: GHG = greenhouse gas, No. = number.

Table 6
Defining types of indicators

Indicator type	Definition	Example for a home insulation programme
Inputs	Resources that go into implementing a mitigation action	Money spent to implement the subsidy programme
Activities	Activities that are involved in implementing the mitigation action	Number of energy audits carried out; total subsidies provided
Outcomes	Changes in behaviour, technology, processes or practices that result from the mitigation action, often also referred to as intermediate effects	Amount of insulation purchased and installed by consumers; fraction of homes that have insulation; amount of natural gas and electricity consumed in homes
GHG impacts	Changes in GHG emissions caused by the mitigation action	GHG reductions from decreased gas use
Non-GHG impacts	Changes in relevant environmental, social or economic conditions other than GHG emissions that result from the mitigation action	Household disposable income from energy savings

Source: Adapted from WRI (2014c).
Abbreviation: GHG = greenhouse gas.

Performance indicators can be quantitative or qualitative in nature. Both types can provide useful information for policymakers. Table 6 provides information on defining types of indicators.

Quantitative indicators often relate to inputs for the action, the activities carried out or intermediate effects. They can also correspond to outcome goals. From the intermediate effects a first rough estimate of GHG effects can often be derived.

Qualitative indicators can be used to track progress of elements that are difficult to quantify. This is often the case for non-GHG effects. However, it is also useful to try and identify quantifiable progress indicators for non-GHG effects, which could for example be more on the input or activity level, if quantification of intermediate and final effects is not possible.

Many useful progress indicators are already included in national statistics or are easily collected during implementation of the action. Table **7** provides some examples of such information.

Table 7
Examples of progress indicators for various policies

Examples of policies	Examples of outcomes used as progress indicators
Renewable portfolio standard	Total electricity generation by source (e.g. wind power, solar power, coal, natural gas)
Public transit policies	Vehicle-kilometres travelled by mode (e.g. subway, bus, train, private car, taxi, bicycle)

Examples of policies	Examples of outcomes used as progress indicators
Waste management regulation	Tonnes of waste sent to landfills; tonnes of waste sent to recycling facilities; tonnes of waste sent to incineration facilities
Landfill gas management incentive	Tonnes of methane captured and flared or used
Sustainable agriculture policies	Soil carbon content; tonnes of synthetic fertilizers applied; crop yields
Afforestation/reforestation policies	Area of forest by type
Grants for replacing kerosene lamps with renewable lamps	Number of renewable lamps sold; market share of renewable lamps; volume of kerosene used for domestic lighting
Subsidy for building retrofits	Number of buildings retrofitted; energy use per building
Information campaign to encourage home energy conservation	Household energy use (sample of households or average use)

Source: WRI (2014c).

The accuracy of measurement or data collection approaches depends on the instruments used, the quality of data collected and the rigor of the quality control measures. It is therefore important to identify data sources and report calculation assumptions and uncertainties related to the data. To support this process it is useful to develop a monitoring plan. A monitoring plan details (WRI, 2014c):

- The progress indicators used;
- Measurement or data collection methods and procedures;
- Sources of data (either existing data sources or additional data collected specifically to monitor the indicators);
- Monitoring frequency;
- Units of measure;
- Sampling procedures (if applicable);
- Whether the data is verified, and if so, verification procedures used;
- Any other relevant information.

It may also be useful to add information on the process for data collection, such as:

- Entity(ies) or person(s) responsible for monitoring activities and roles and responsibilities of relevant personnel;
- Competencies required and any training needed to ensure personnel have the necessary skills;
- Methods for generating, storing, collating and reporting data on monitored parameters;

- Databases and tools (e.g. software systems) to be used for collecting and managing data;
- Procedures for internal auditing, quality assurance and quality control (QA/QC);
- Record keeping and internal documentation procedures needed for QA/QC, including length of time the data will be archived.

4. ANALYZING THE IMPACTS OF MITIGATION ACTIONS

This chapter aims to provide additional background to understanding the assessment of achieved and expected outcomes, GHG impacts, and impacts on sustainable development. This also includes guidance on understanding the progress of implementation, i.e. impacts of activities to date and expected future impacts of activities.

The chapter includes information on analysing methodologies and assumptions to provide experts with a solid understanding of the methodological choices available. As there is no one agreed tool or methodology, countries will make choices depending on a number of criteria. Independent of choice of tools and methodologies, there are good practice procedures, as outlined in this chapter that will help experts to analyse whether choices are adequate for the purpose and suggest improvements where necessary. At the same time, the chapter will familiarize experts with good practices in how to report on methodologies and assumptions, which allow an analysis of the robustness of results.

The following sections outline different elements within the analysis of impacts. Each will provide guidance on key concepts, methodologies and methods available and good practice reporting elements.

4.1. METHODOLOGIES FOR DATA COLLECTION AND PROCESSING

This section provides guidance on the fundamental element of any analysis data. Any analysis can only be as good as the data providing its foundation. It is therefore important to be familiar with some basic concepts of data collection and processing.

Data types

The quality of the monitoring depends on the quality of the data used to develop it, as well as on the methodologies applied to process it. The relevant data to be collected depends on the objective to be monitored and on the methods chosen for assessment ex-post, and if applicable ex-ante. We differentiate the different types of data based on the level where it is collected:

- **Bottom-up data** is measured, monitored, or collected (e.g. using a measuring device such as a fuel meter) at the source, facility, entity or project level. Examples include energy used at a facility (by fuel type) and output of production;

- **Top-down data** are macro-level statistics collected at the jurisdiction or sector level. Examples include national energy use, population, GDP and fuel prices. In some cases, top-down data are aggregated from bottom-up data sources.

Data can also be differentiated by whether it is measured, modelled, calculated or estimated. **Measured data** refers to direct measurement, such as directly measuring emissions from a smokestack. **Modelled data** refers to data derived from quantitative models, such as models representing emissions processes from landfills or livestock. **Calculated data** refers more specifically to data calculated by multiplying activity data by an emission factor, such as multiplying natural gas consumption data by a natural gas emission factor. **Estimated data** (in the context of monitoring) refers to proxy data or other data sources used in the absence of more accurate or representative data sources (WRI, 2014c).

Additionally, data is divided by level of detail. **Primary data** is collected from specific sources or sinks, for example installations affected by the mitigation measure, and usually collected for the specific purpose of the analysis. **Secondary data** is not source or sink specific and is normally available in aggregated form, for example from public databases, government statistics or sectoral associations. Secondary data was often collected for other purposes.

Data collection process

The process of data collection is illustrated in Figure 10. It is an iterative process, which will ideally improve data quality over time through a learning process. Given resource restrictions, not all useful data can normally be collected. Depending on methods chosen, and previous analysis of relevant sectors, data can be prioritized. Then the type of data as described above is chosen, based on the desired level of accuracy and availability of resources. The collection of data includes the compilation of data, processing and QA/QC procedures. An important step in the process is to fill data gaps that will automatically arise.

Figure 10
Iterative process of data collection

Source: WRI (2014c).

Data gaps

If data of sufficient quality is not available, proxy data is often used to fill data gaps. Proxy data is data from a similar activity that is used as a stand-in for the given activity, such as similar data from other geographic regions. Proxy data used in the assessment should be strongly correlated with the relevant parameter. Use of proxy data should be reported and justified as part of the description of data sources used.[6]

Tools

Data management systems are classical tools to support measurement, reporting and verification (MRV) systems. They serve as a repository for data, including:

a) Collected data based on progress indicators and parameters required for estimations;
b) Calculated emissions estimates;
c) Emissions factors and GWP used.

Data management systems also support the documentation of the inventory process, including quality insurance procedures, and of methodologies and data sources used. They help in archiving historical data and information and sharing data and information between staff and institutions. This creates an institutional memory that relies less on individuals and thus is more sustainable in the long-term. They often also support the analysis of data (MAPT, 2014).

4.2. GUIDANCE ON BASELINE SETTING

This section provides an overview of a good practice methodology to determine baselines. It provides definitions for key concepts related to baseline setting and highlights crucial areas for reporting baselines in the context of mitigation actions.

4.2.1. UNDERSTANDING BASELINES

The baseline is a reference case that represents the events or conditions most likely to occur in the absence of specific implemented or planned mitigation action(s). Baselines are used to understand effects of most likely developments. This can serve as a basis for setting emission goals, but also to assess financial, economic or other impacts of mitigation actions against a situation without these actions (WRI, 2014c).

Technology choices

Choices on technology development within the baseline can have a significant effect on the results. For instance, the special report on emissions scenarios concluded that technology is of similar importance for future GHG emissions as population and economic growth combined (IPCC, 2000). It is therefore essential to understand which type of baseline is represented. We distinguish two types of technology development in baselines (Halsnaes et al., 2007):

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6 For additional guidance on filling data gaps, see *2006 IPCC Guidelines for National Greenhouse Gas Inventories*, Volume 1, Section 2, Approaches to Data Collection.

- **Frozen technology**: No technological change is assumed to occur over the assessment period;
- **Autonomous improvement**: Technological change is assumed to happen, based on different assumptions regarding availability, efficiency improvements and development of prices of different technologies.

Box 10
Baseline terminology

A **scenario** represents a coherent, internally consistent and plausible description of a possible future state of the world given a pre-established set of assumptions. Several scenarios can be adopted to reflect, as well as possible, the range of uncertainty in those assumptions (DEA, OECD & URC, 2013).

A **baseline** is a scenario that aims to represent likely developments under a given policy framework as accurately as possible. There are other terms that are used as synonyms:

- **Counterfactual**: Normally used in the context of an ex-post assessment;
- **Business-as-usual**: Normally used for an ex-ante baseline, although the term can also be used ex-post;
- **Reference scenario**: Especially used where the scenario serves as the reference for determining other values, for example goals.

The term baseline should not be confused with:

- **Trend**: Determination of tendencies of a time series of past data. Historic trends that have been statistically determined can also be used as a tool to extrapolate developments to the future. The trend is a statistical method. It is often used to understand past developments. Under the assumption that certain parameters are most likely to develop in the same way as in the past, the trend is often extrapolated to the future. As such it does not necessarily constitute the ‘most likely scenario’ for all relevant variables for the determination of a baseline;

Projection: A more general term for estimating future values, based on formal statistical methods. The term should mainly be applied to individual parameters, but is often also used as synonymous to ‘scenario’, i.e. to a full set of assumptions on future developments.

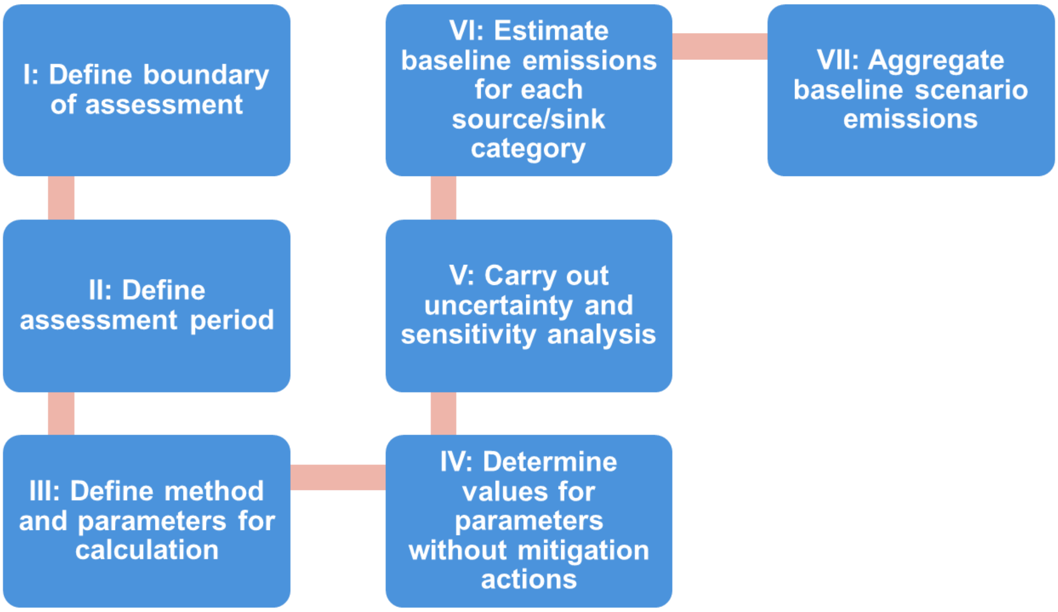
4.2.2. THE PROCESS TO DETERMINE BASELINE EMISSIONS

There are many valid ways to arrive at estimates for baseline emissions. A series of logical steps need to be carried out, many of which include choices on methods and assumptions.

Figure 11 illustrates a best practice process for determining baseline emissions. Steps may not necessarily be carried out in this exact order. Depending on the situation individual steps may be more or less important and may require different levels of detail. In principle, however, most standard tools and methods will follow these steps, although sometimes individual steps may not be made explicit. The steps can be applied to a wide variety of situations and types of mitigation measures. Robust analysis and transparent reporting is about making all elements and assumptions explicit.

The process is independent of different analysis methods and tools, which will be discussed in later sections.

Figure 11
Best practice process to determine baseline emissions



Source: Based on WRI (2014a, 2014c).

Box 11
Calculating greenhouse gas impacts without baseline

Deemed estimates method

In certain cases this simplified method can be used to calculate effects directly. This method can be used for ex-ante and ex-post analysis. Caution needs to be exercised when using this approach, since it involves establishing implicit baseline and policy scenario assumptions (for ex-ante analysis), which are not normally made explicit and thus make understanding results difficult. For details on the method see WRI (2014c).

The following sections discuss the different steps and related methodological questions. The numbers in parenthesis refer to the steps in Figure 11 for easy reference.

4.2.3. THE ASSESSMENT BOUNDARY (I)

Baselines can be developed for all types of actions, geographic scopes and sectoral coverage. For baselines with an economy-wide boundary, it needs to be specified whether land use, land-use change and forestry is included.

If a baseline is developed to formulate a goal for, or in general to assess effects of, mitigation actions, the boundary should be set in line with the mitigation action(s) as defined (compare with section 3.1.3).

4.2.4. THE ASSESSMENT PERIOD (II)

The timeframe for the baseline scenario refers to the period over which emissions are projected. The start year, often referred to as 'base year', can depend on:

- Availability of data;
- Objective of the assessment;
- Starting point of implemented or planned mitigation activities.

The end year can depend on:

- The time frame set for a goal;
- The time frame set for mitigation actions;
- Political cycles;
- Internationally relevant points in time;
- Availability of reliable data projections for key assumptions.

4.2.5. SELECTING THE METHOD (III)

The most 'appropriate' method depends on the available resources, modelling experience, country circumstances and key sectors. Most mitigation modelling has so far focused on bottom-up approaches due to the lack of off-the-shelf econometric models. Sophisticated models can be useful where expertise and data are relatively plentiful, otherwise, simpler, more user-friendly tools may be more suitable. Sector-specific tools can complement integrated models and provide a more detailed view on key sectors and technologies (UNFCCC, 2013c).[7]

Depending on the type of mitigation action, established methodologies for the Clean Development Mechanism (CDM) can also provide useful tools. They provide methods for specific types of project activities, and in the absence of tailored sector- or economy-wide models can also provide useful information for larger-scale mitigation actions.

Methods will vary for individual source or sink categories. Even if integrated within sector- or economy-wide models, equations will be distinct for source and sink categories and will have their individual parameters. Some parameters will be input to a range of these methods, such as, for example, population.

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[7] The World Resource Institute provides an overview of available methods for various sectors and purposes (WRI, 2014b)

Box 12
Definitions for emission estimation

Methodology: The process applied to determine baseline emissions (see Figure 11).

Method: Equations, algorithms and models used to estimate baseline emissions. These include top-down, bottom-up and complex methods as well as simple equations (see section 2.3).

Examples for general algorithms for baseline scenarios include (WRI, 2014a):

<u>Based on activity data</u>:

$$Baseline\ emissions = Projected\ activity\ data \times Projected\ emission\ factor$$

<u>Based on energy consumption data</u>:

$$Baseline\ emissions = Projected\ energy\ consumption \times Projected\ energy\ efficiency^{*} \times Projected\ greenhouse\ gas\ intensity\ of\ energy\ generation\ +\ Projected\ non-energy\ emissions$$

<u>Based on the Kaya identity:</u>[a]

$$Baseline\ emissions = Projected\ population \times \frac{Projected\ GDP}{Projected\ population} \times \frac{Projected\ gross\ energy\ consumption}{Projected\ GDP} \times \frac{Projected\ emissions}{Projected\ gross\ energy\ consumption} + Projected\ non-energy\ emissions$$

These algorithms are not sufficient on their own to develop baseline scenarios, but illustrate the underlying logic of how emissions projections may be created. Different methods may be required for different types of sources and/or sinks.

Model: A schematic (mathematical, computer-based) description of a system that accounts for its known or inferred properties (DEA , OECD & URC, 2013).

Parameter: A variable (e.g. activity data, emission factor) that is part of an emissions estimation equation or algorithm or other calculation.

> <u>Example</u>: ‘emissions per kWh of electricity’ and ‘quantity of electricity supplied’ are both parameters in the equation
>
> 0.5 kg CO_2e/kWh of electricity x 100 kWh of electricity supplied = 50 kg CO_2e.

Data: Historic values of individual parameters, ideally in the form of a time series. The term is normally used for measurable, i.e. historic values. Expected future values for parameters are called trends or projections. To avoid confusion the terms ‘historic data’ and ‘future trend data’ or ‘projected data’ could be used.

Tool: Instruments to support calculations, using specific or standard software. Tools usually at least implicitly follow a certain methodology and are based on a defined set of methods. To the extent possible, tools can also provide standardized data, such as emission factors or global warming potential values. Tools range from complex modelling to simple spreadsheet solutions.

[a] *The Kaya identity (Kaya, 1990) is a decomposition that expresses the level of energy related CO_2 emissions as the product of four indicators: (i) carbon intensity (CO_2 emissions per unit of total primary energy supply (TPES)), (ii) energy intensity (TPES per unit of gross domestic product), (iii) gross domestic product per capita (GDP/cap) and (iv) population (Zhou et al., 2007)*

4.2.6. DEFINING PARAMETERS FOR CALCULATION (III)

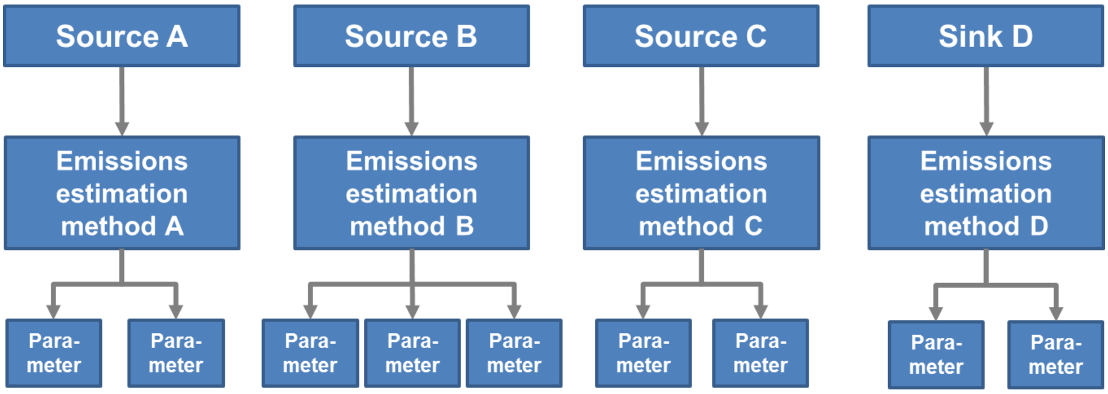
In the absence of secure knowledge about future developments, assumptions need to be made regarding the different elements impacting the model calculations:

- What are the relevant **drivers** within the assessment period?
- Which **parameters** in the calculation method are changing over time and how?

The number and level of detail of assumptions depend on the calculation method and model chosen. Assumptions represent expected developments over time. In certain cases, multiple options may seem equally likely. In such cases, reporting of a range of results based on multiple alternative baseline scenarios is good practice. Understanding assumptions for baseline development is essential in understanding baseline emission results in their national context.

As described in section **Error! Reference source not found.**, methods will vary between source and sink categories. **Error! Reference source not found.** illustrates how this relates to the definition of individual parameters.

Figure 12
Relationship between sources/sinks, methods and parameters



Source: Based on WRI (2014c).

Drivers

Policies and socioeconomic or other conditions, so called drivers, affect the parameters, i.e. variables, in the calculation. We distinguish two types of drivers: **policies** and **non-policy drivers** (e.g. socioeconomic conditions).

For the baseline, all policy and non-policy drivers should be considered that are significant and to the extent that they are not related to the mitigation actions proposed.

In the baseline scenario, **policies** should be reflected that have a significant effect on GHG emissions (increasing or decreasing) from the sources or sinks included in the GHG assessment boundary; and are implemented or adopted at the time the assessment is carried out (for ex-ante assessment) or are implemented at the time the action is carried out (for ex-post assessment). Table 8 provides a definition for the potential status of a policy or action.

Table 8
Status of policies or actions

Policy or action status	Definition
Implemented[a]	Policies and actions that are currently in effect, as evidenced by one or more of the following: (a) relevant legislation or regulation is in force, (b) one or more voluntary agreements have been established, (c) financial resources have been allocated, (d) human resources have been mobilized.
Adopted	Policies and actions for which an official government decision has been made and there is a clear commitment to proceed with implementation, but that have not yet been implemented (e.g. a law has been passed, but regulations to implement the law have not yet been established).
Planned	Policy or action options that are under discussion and have a realistic chance of being adopted and implemented in the future, but that have not yet been adopted.

Source: FCCC/CP/1999/7.
[a] *Policies that were stopped or withdrawn before the base year do not need to be considered, as they are reflected in historic developments. Policies that were stopped or withdrawn within the assessment period should be treated like implemented policies with a determined end date (compare with section '3.1.4: Understanding the timeline').*

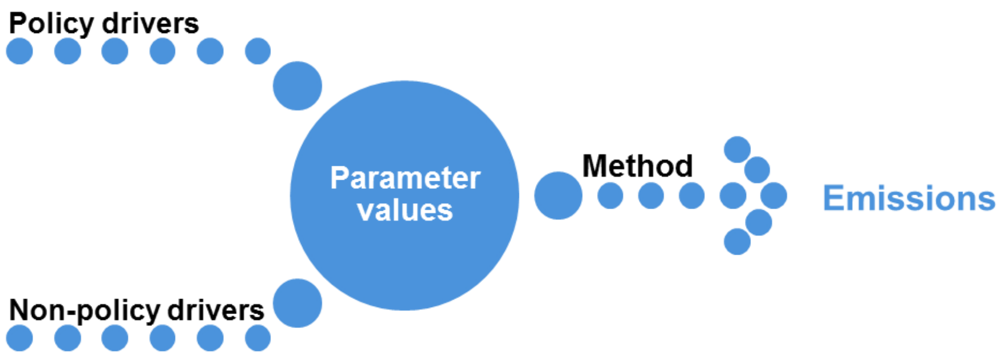
A wide range of **non-policy drivers** influence calculations. These include socioeconomic factors as well as physical and technical elements. Examples of non-policy drivers include:

- Economic activity (e.g. GDP, household disposable income);
- Population;
- Energy prices (e.g. prices of natural gas, petroleum products, coal, biofuels, electricity) and other relevant prices (e.g. commodity prices);
- Costs (e.g. of various technologies);
- Weather (e.g. differences in energy use based on colder than average winters as expressed in heating degree days, or hotter than average summers as expressed in cooling degree days);
- Structural effects (e.g. structural changes in economic sectors, shifts from industry to service sector jobs, shifts of industrial production between countries);
- Changes in consumer preferences (e.g. preferences for types of vehicles, household size, commuting practices);
- Autonomous technological improvement over time (e.g. decarbonization of economic sectors, energy efficiency improvements, long-term trends in carbon- or energy-intensity of the economy), if applicable.

Parameters

The elements described above all impact on the individual variables of the chosen equations and models for calculating baseline emissions as illustrated in Figure 13. Depending on the length of the assessment period, the value of parameters can change significantly over time, influenced by the various drivers. Specifics of determining parameter values for the baseline are discussed in section 4.2.7.

Figure 13
Relationship between drivers, parameters and methods



4.2.7. DETERMINING PARAMETER VALUES WITHOUT MITIGATION ACTIONS (IV)

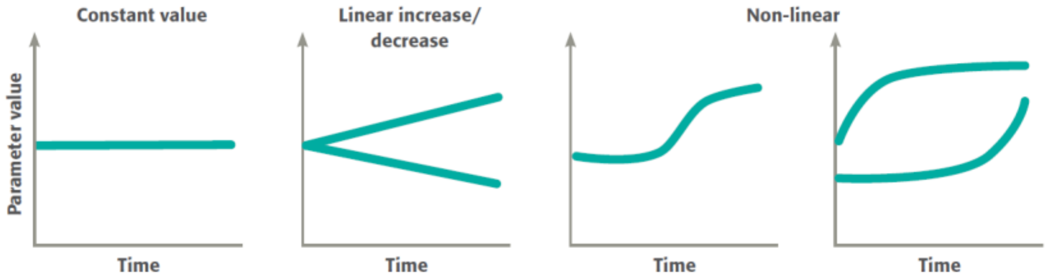
After it has been defined which parameters are needed, the actual values of the parameters over the assessment period need to be established. Determining the influence of drivers on the parameters used in the equations is the most challenging task of baseline development and requires a large number of assumptions on future developments. The magnitude and shape of the change over time can substantially influence results.

We categorize parameters as:

- **Static**: Parameters have constant values over the entire assessment period ;
- **Dynamic**: Parameter values change over the course of the assessment period.

Dynamic parameters can have different types of developments over time as illustrated in Figure 14. Static parameters present a constant value over time, while dynamic parameters can increase or decrease with a constant factor over time or have a non-linear development.

Figure 14
Parameter development over time



Source: WRI (2014c).

Box 13
Examples of reporting on baseline methods and parameter assumptions

The two examples from Kenya and Jordan show detailed reporting on methods used, with Kenya providing equations for the different sources. They also provide time series information on assumptions about parameters. This level of information can be provided as an annex within the document (as in the case of Jordan) or in a separate document (as in the case of Kenya).

Kenya's climate change action plan

New Additions to Capacity Between 2012 and 2017		
New power plants and generating capacity that will come online in the next five years	2012	HYDRO 21MW – Sang Geothermal 2.3 MW – Eburru Geothermal 75 MW - Olkaria
	2013	Wind 60MW - Aeolus MSD 81MW - Triumph MSD 84MW - Gulf MSD 87MW - Melec
	2014	Geothermal 36 MW - Olk3 Wind 50 MW - Osiwo Hydro 32 MW- Kindaruma Geothermal 140 MW - Olk 1 – 4&5
	2015	Geothermal 280MW Hydro 6 MW – small hydro
	2016	IMPORT 400MW Coal 600MW - Mombasa
	2017	Geothermal 140MW Geothermal 45MW

Equation 2.5: GHG Emissions from the Electricity Sector

$$Emissions_{GHG,fuel} = \sum_{tech} Fuel\ Consumption_{fuel} \times Emission\ Factor_{GHG,fuel,tech}$$

Source: Stiebert (2012).

Jordan's second national communication

Energy Type	Sector	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
LPG	Industry	5	5.2	5.4	5.6	5.8	6						
	H.Hold	382.2	398.2	414.4	431.3	448.8	466.8						
	Agr.	17.2	17.7	18.3	18.8	19.4	20.1						
	Comm.	31	32.2	33.4	34.7	36	37.4						
	Total	435.4	453.3	471.5	490.4	510	530.3						
Kerosene	Industry	2.6	2.7	2.8	2.9	3.1	3.2						
	H.Hold	180.2	187.6	195.1	202.9	211	219.3						
	Agr.	1.2	1.2	1.2	1.3	1.3	1.4						
	Comm.	9.7	10.1	10.4	10.8	11.2	11.6						
	Total	193.7	201.6	209.5	217.9	226.6	235.5						

Year	Population *	Solid Waste (000) Tonnes
2001	4940000	1,623
2002	5070000	1,665
2003	5200000	1,708
2004	5350000	1,757
2005	5473000	1,798
2006	5600000	1,840
2007	5723000	1,880
2008	5840000	1,918
2009	5960000	1,958
2010	6080000	1,997
2011	6200000	2,037
2012	6310000	2,073
2013	6430000	2,112
2014	6540000	2,148
2015	6640000	2,181
2016	6750000	2,217
2017	6850000	2,250

Source: The Hashemite Kingdom of Jordan (2009).

The following examples further illustrate the practical implications of different forms of parameter development.

Constant values: Some parameters are usually assumed to remain constant because they represent the current understanding of physical processes, this includes:

- Emission factors for individual fuels;
- GWP values.

Another reason to choose constant values can be because no information is available on future developments and current values represent a best estimate.

Linear: Extrapolation of historic developments (trend) to the future often results in a linear increase or decrease of parameters. Examples, where this technique is often used include:

- Linear extrapolation of historic efficiency development in industry;
- Floor area (m^2) of housing space per person.

Non-linear: Non-linear developments are usually captured by more complex models, but can also be found in simplified calculations. Typical non-linear effects include:

- Learning curves, with a slow effect at the beginning, then more rapid take-up and saturation after a certain period;
- Exponential growth functions;
- Developments based on bottom-up data, such as detailed electricity generation capacity planning.

Box 14
Global warming potential

The index used to translate the level of emissions of various gases into a common measure in order to compare the relative radiative forcing of different gases without directly calculating the changes in atmospheric concentrations. GWPs are calculated as the ratio of the radiative forcing that would result from the emissions of one kilogram of a greenhouse gas to that from the emission of one kilogram of carbon dioxide over a period of time (usually 100 years) (UNFCCC, undated a).

The global warming potential (GWP) presents a specific parameter with a constant value over time, based on the best available current scientific knowledge. The Intergovernmental Panel on Climate Change provides GWP values for 20-year, 100-year, and 500-year time horizons. GWP values published in 1995 were revised in 2006.[a]

[a] *For GWPs under the UNFCCC see <https://unfccc.int/ghg_data/items/3825.php>.*
For the full list of the revised direct GWPs see <http://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-10-2.html >.

Policy interaction

In many cases, an individual policy or action will overlap or interact with other policies and actions to produce total effects that differ from the sum of the individual effects of each individual policy. The best approach to assessing interacting policies – individually or as packages of policies – depends on the objectives of the analysis, the type and magnitude of interaction, as well as data availability and technical feasibility. A good way to report on such interaction is the policy interaction matrix. An example is provided in **Error! Reference source not found.**.

Table 9
Example of a policy interaction matrix for natural gas use in space heating

	Insulation subsidy	**Natural gas tax**	**Energy labelling**	**Energy efficiency standards**
Insulation subsidy	**NA**			
Natural gas tax	- -	NA		
Energy labelling	++	-	NA	
Energy efficiency standards	- - -	-	- -	NA

Key: Independent: 0;
Overlapping: - - - major/- - moderate/ - minor interaction
Reinforcing: +++ major/++ moderate/+ minor interaction
Uncertain: U
Not applicable: NA
Source: WRI (2014c).

Levels of accuracy

Table 10 provides an overview of the different elements related to methodology and the impact of choices on the level of accuracy of the results. Parties should select a desired level of accuracy based on the objectives of the assessment, the level of accuracy needed to meet stated objectives, data availability, and capacity and resources. In general, countries should follow the most accurate approach that is feasible for each of the methodological choices outlined in Table 10.

For different choices, different levels of accuracy may be available. For example, the estimation method could be using simplified equations, while data could be used that is jurisdiction specific. Given this, there is no overall assessment of the level of accuracy possible in most cases. However, the level of accuracy for different methodology choices should be reflected in the uncertainty assessment. Information provided in the BUR on methodologies and assumptions should ideally allow the TTE to gain an understanding of the impact of choices on the level of accuracy. This will then allow comparison of this with the information, if provided, on the uncertainty of impacts reported.

Table 10
Range of methodological options for estimating baseline emissions

Level of accuracy	Emissions estimation method	Other policies included	Non-policy drivers included	Assumptions about drivers and parameters	Source of data for drivers and parameters
Lower	Lower accuracy methods (e.g. Tier 1 methods in the IPCC Guidelines for National Greenhouse Gas Inventories)	Few significant policies	Few significant drivers	Most assumed to be static or linear extrapolations of historical trends	International default values
	Intermediate accuracy methods	Most significant policies	Most significant drivers	Combination	National average values
Higher	Higher accuracy methods (e.g. Tier 3 methods in the IPCC guidelines)	All significant policies	All significant drivers	Most assumed to be dynamic and estimated based on complex modelling or equations	Jurisdiction- or source-specific data

Source: WRI (2014c).
Abbreviation: IPCC = Intergovernmental Panel on Climate Change.

4.2.8. DEALING WITH UNCERTAINTY (V)

Uncertainty assessment refers to a systematic procedure to quantify and/or qualify the sources of uncertainty in a GHG assessment. Identifying and documenting sources of uncertainty can assist users in improving assessment quality and increasing the level of confidence users have in the results. There are different types of uncertainty (WRI, 2014c):

- Parameter uncertainty: Activity data, emission factors, GWPs;
- Scenario uncertainty: Methodological choices (see Table 10);
- Model uncertainty: Model limitations.

Parameter uncertainty describes the uncertainty regarding whether a parameter value used in the assessment accurately represents the actual activity. If parameter uncertainty can be determined, it typically takes the form of a probability distribution of possible values that include the chosen value used in the assessment. When evaluating the uncertainty of a result, parameter uncertainties can be propagated to provide a quantitative measure (also as a probability distribution) of uncertainty in the final assessment. There are two different forms of parameter uncertainty:

- **Single parameter uncertainty** refers to incomplete knowledge about the true value of a parameter. Single parameter uncertainty can arise with activity data and emission factors. Measurement errors, inaccurate approximation and how the data was modelled to fit the conditions of the activity influence parameter uncertainty;
- **Propagated parameter uncertainty** is the combined effect of each parameter's uncertainty on the total result. Methods are available to propagate

parameter uncertainty from single data points. Two methods are random sampling (such as in Monte Carlo simulation) and analytical formulas (such as in the Taylor Series expansion method and other error propagation equations).

Box 15
Data quality

Data quality is closely linked to parameter uncertainty, which arises from poor data quality for historic data as well as from uncertainty around future developments.

Historic data as well as projections for future development of different parameters should be taken from high-quality, peer-reviewed datasets from recognized, credible sources. Where these are not available, historic data and projections can also be specifically collected and/or generated by the assessment team preparing the baseline. In all cases, it is essential to accurately state the sources for data and information transparently. Information should allow the tracing back of calculation results to the original data sources.

There are a number of indicators that can guide data collection:

- **Technological representativeness**: The degree to which the data set reflects the relevant technology(ies).
- **Temporal representativeness**: The degree to which the data set reflects the relevant time period.
- **Geographical representativeness**: The degree to which the data set reflects the relevant geographic location (e.g. country, city or site).
- **Completeness**: The degree to which the data is statistically representative of the relevant activity. Completeness includes the percentage of locations for which data is available and used out of the total number that relate to a specific activity. Completeness also addresses seasonal and other normal fluctuations in data.
- **Reliability**: The degree to which the sources, data collection methods and verification procedures used to obtain the data are dependable. Data should represent the most likely value of the parameter over the GHG assessment period.

Scenario uncertainty refers to variation in calculated emissions due to methodological choices. Multiple methodological choices create scenario uncertainty. The use of standards results in a reduction in scenario uncertainty by constraining choices the user may make in their methodology. To identify the influence of these choices on the results, users should undertake a sensitivity analysis.

Model uncertainty arises from limitations in the ability of the modelling approaches to reflect the real world. Simplifying the real world into a numeric model always introduces some inaccuracies. In many cases, model uncertainties can be represented, at least in part, through the parameter or scenario approaches described above. However, some aspects of model uncertainty might not be captured by those classifications and are otherwise very difficult to quantify.

There are a number of ways in which model uncertainties can be expressed. Model uncertainties should be acknowledged and the limitations stated qualitatively. If feasible, quantitative assessments may be carried out. There are three key approaches for estimating model uncertainty. These approaches can also be used in combination:

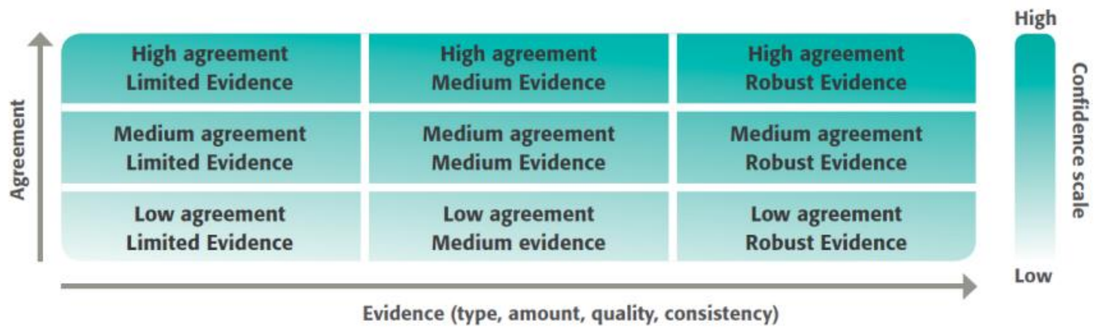
- Comparison of model results with independent data for purposes of verification;
- Comparison of the predictions of alternative models;
- Expert judgment regarding the magnitude of model uncertainty.

Sensitivity analysis assesses the extent to which the outputs of an emissions modelling approach (e.g. projected activity data, projected emissions factors and projected emissions) vary according to model inputs (e.g. assumptions, projected values for key parameters and methodological choices). It can be used to explore model sensitivity to inputs and the uncertainty associated with model outputs. For the sensitivity analysis the values for key parameters in the model are adjusted methodologically to test how end results are affected. As a general rule, variations of parameter values in the sensitivity analysis should at least cover a range of +10% and –10%.

Qualitative uncertainty analysis is a way to express the confidence of the team developing the calculation in a qualitative way. Usually two variables are used, as illustrated in

Figure 15.

Figure 15
Matrix for qualitative uncertainty analysis



Source: WRI (2014c) based on Mastrandrea et al. (2010).

Quantitative methods aim to provide a numerical assessment of the uncertainty. A wide range of tools exists for quantitative uncertainty analysis.

For **single parameter** uncertainty tools include:

- Measured uncertainty (represented by standard deviations);
- The pedigree matrix approach, based on data quality indicators;
- Default uncertainties for specific activities or sector data (reported in literature);
- Probability distributions from commercial databases;
- Uncertainty factors for parameters reported in literature;
- Expert judgement (based on as much data as available);
- Survey of experts to generate upper and lower bound in estimates;
- Other published approaches.

Propagated parameter uncertainty tools include:

- Taylor series expansion;
- Monte Carlo simulation;
- Error propagation equations.

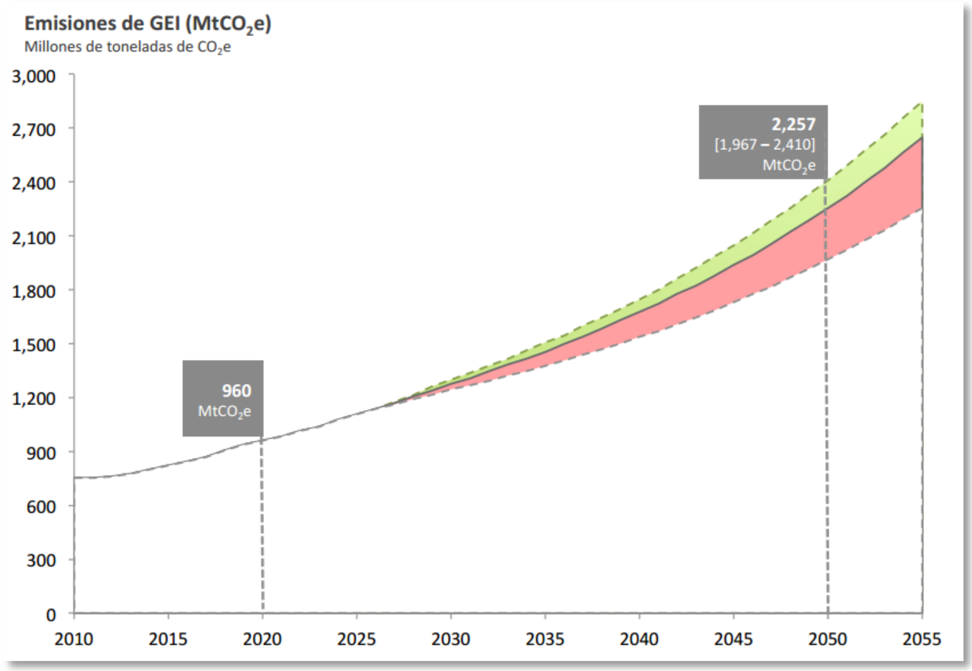
Reporting uncertainty requires a description of the uncertainty, either quantitative or qualitative. Methods or approaches used to assess uncertainty need to be specified and the range of results from the sensitivity analysis should be included.

Box 16
Example of reporting uncertainty

The methodological background document for Mexico's climate strategy provides a range for the emissions baseline based on:

- A range of assumptions for potential gross domestic product growth from 2020;
- Different scenarios for future fuel mix in electricity production.

The dotted lines represent the upper and lower boundary of this range, the solid line the chosen baseline.

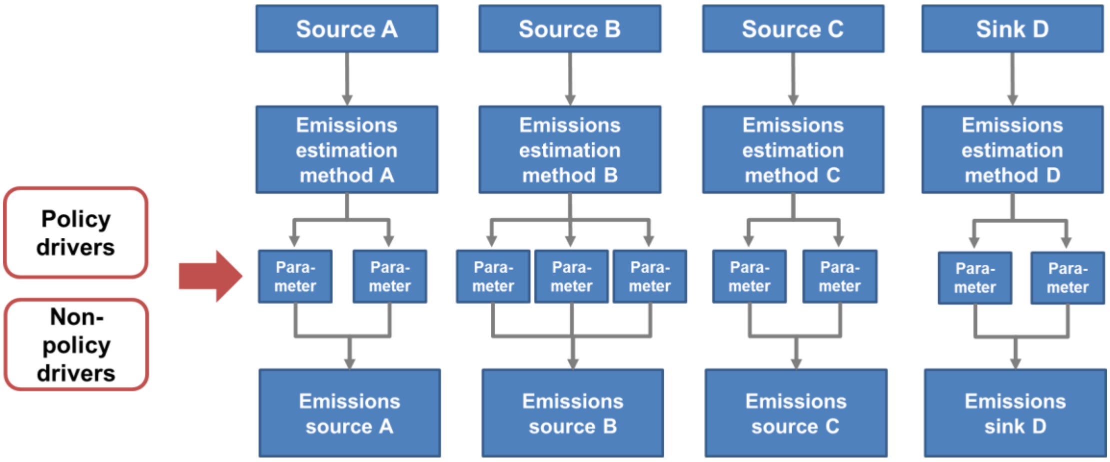


Source: Gobierno de la República (2013).

4.2.9. CALCULATING BASELINE EMISSIONS FOR EACH SOURCE OR SINK CATEGORY (VI)

Once all elements of the calculation have been identified, using best available data sources and the most appropriate methods, baseline emissions are calculated. In a first step, baseline emissions for each source or sink category are estimated using the selected calculation method and appropriate tools. Figure 16 illustrates the relationship between the different elements of the calculation.

Figure 16
Impact of drivers on parameters for calculation



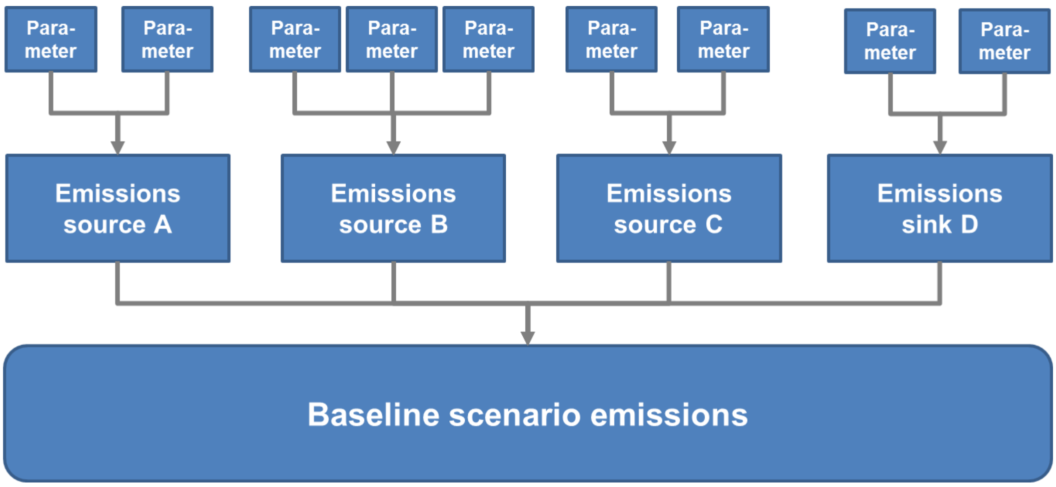
Source: Based on WRI (2014c).

Different source and sink categories can have different methods for calculating emissions. Classically the land-use sector and non-energy related emissions vary from other sectors.

4.2.10. AGGREGATING BASELINE SCENARIO EMISSIONS (VII)

Starting with the emissions per source or sink category (see Figure 17), total baseline scenario emissions can be calculated. For the aggregation across sources and sinks, it is important to address any possible overlaps or interactions between sources and sinks to avoid over- or underestimation of total baseline emissions. Addressing these overlaps or interactions, the individual results for sources and sinks are added up to derive the total baseline scenario emissions.

Figure 17
Aggregation of baseline scenario emissions



Source: Based on WRI (2014c).

Box 17
Important elements for reporting on baselines in the biennial update report

a) **Method** chosen;

b) Assessment **period;**

c) Assessment **boundary**, including:

   i) Sectors;

   ii) Gases;

   iii) Treatment of land use, land-use change and forestry;

   iv) Geographic coverage;

   v) Policies included or excluded in the baseline (alternatively cut-off year for policies);

d) **Assumptions** on key parameters:

   vi) Type of development expected;

   vii) Source of historic data and projections;

   viii) Non-policy drivers included in the baseline;

   ix) Sources and values for global warming potential used;

e) Results and methods used for **uncertainty** and **sensitivity** analysis.

4.3. ANALYZING THE EXPECTED RESULTS OF MITIGATION ACTIONS

This section provides guidance on good practice for the analysis of expected results of mitigation actions, i.e. ex-ante analysis of effects. The section provides an overview of steps that are usually conducted in ex-ante assessments. Not every assessment will necessarily follow all steps and for each step various methods and tools are available.

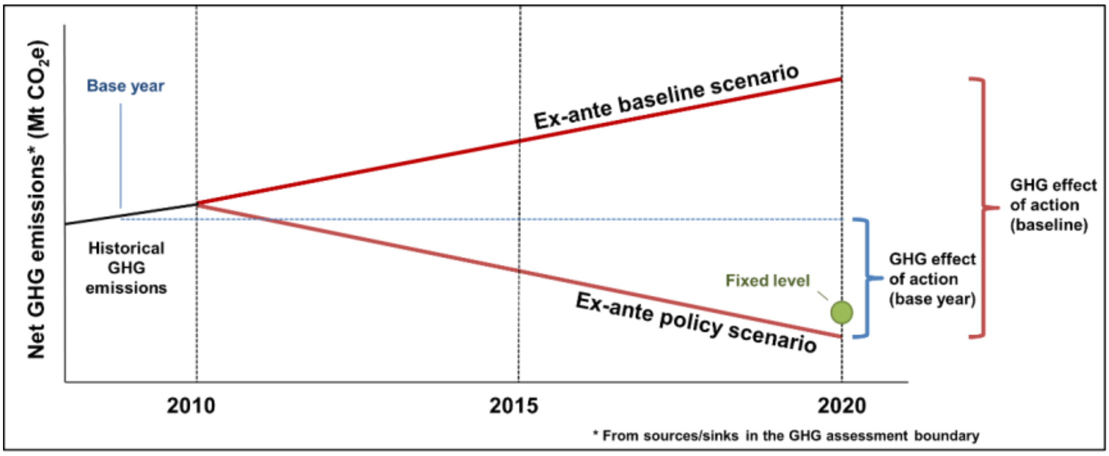
This type of analysis is usually carried out during the selection process of mitigation actions to support the identification of the most effective actions. Most ways of conducting mitigation potential analysis during the screening of options follow some steps of the ex-ante analysis process. The analysis in the context of screening is often less detailed than a full ex-ante determination of effects. It does not necessarily reflect all aspects of the mitigation actions selected. Figure 20 provides an illustration of the principle of ex-ante determination of expected effects.

It could also be conducted:

- Once actions have already been selected, before or just after the start of implementation to determine expected effects;

- During implementation to re-assess expected effects based on changed circumstances.

Figure 18
The principle of ex-ante determination of expected effects



Source: Based on WRI (2014c).
Abbreviations: GHG = greenhouse gas, Mt CO_2e = megatonnes of carbon dioxide equivalent.

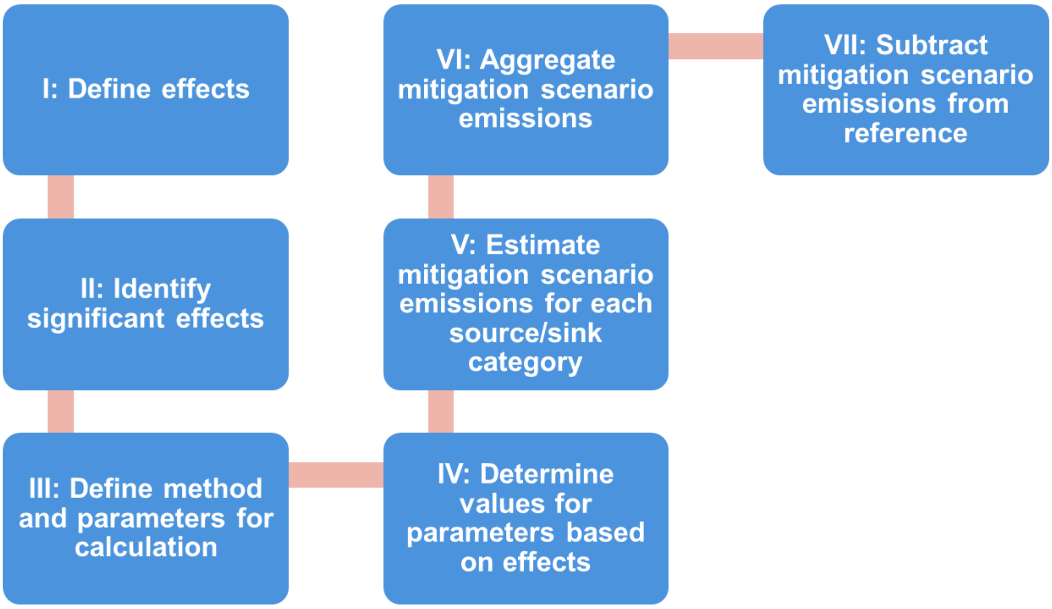
Achieved results can be provided in a variety of ways, depending on the nature of the mitigation action, the objectives and goals formulated and availability of data. The metrics are closely linked to the progress indicators (see section 3.3), including:

- GHG emissions in tonnes of carbon dioxide equivalent;
- Installed capacity in megawatts;
- Produced renewable energy in kilowatt-hours;
- Area covered by the action in square kilometres of hectares;
- Number of households reached;
- Share of population reached in a percentage of total population or relevant sub-sections of population.

4.3.1. THE PROCESS TO DETERMINE MITIGATION IMPACTS

The structure of this section follows the process illustrated below and identifies key requirements for each process step. The numbers in parenthesis in section headings refer to the steps in figure 21 for easy reference.

Figure 19
Best practice process to determine mitigation scenario emissions



Source: Based on WRI (2014c).

Box 18
Effects vs. impact

The terms ‘effect’ and ‘impact’ are mostly used interchangeably and in principle refer to the same idea – to represent changes that result from specific actions. For clarity we use a more specific definition, distinguishing for most of the document:

- **Effects**: Changes resulting from an action that is qualitative in nature;
- **Impacts**: The result of the quantitative assessment of changes.

Changes in both cases can relate to GHG emissions, sustainable development and economic or social consequences of the implementation of response measures. The use of terminology may not follow this definition 100 per cent, but the definition serves to differentiate individual steps within the analysis process with their distinct outputs.

4.3.2. EFFECTS OF MITIGATION ACTIONS (I)

4.3.2.1. Types of effects

Many effects of the policy or action may not be immediately apparent, and many GHG effects (whether increases or decreases) may be far removed from the direct or immediate effects of the policy or action (WRI, 2014c). For a given objective not all effects will need to be quantified nor will this be possible given available data and resources. It is however important to be aware of these potential effects and their impact on the overall results from mitigation actions, which is detailed by the following.

Intended and unintended effects

Unintended effects may include a variety of effects. These include **rebound effects**, like for example increases in energy-using activities resulting from energy efficiency improvements. Unintended effects often occur in sectors other than the targeted sector or on members of society not targeted by the mitigation action. They also include effects on behaviour once a policy is announced but before it is implemented, for example increased sales of inefficient appliances before higher efficiency standards come into effect. Unintended effects can be either GHG increasing or decreasing.

Short-term and long-term effects

Effects that are both nearer and more distant in time, based on the amount of time between implementation of the policy and the effect. Depending on the nature of the mitigation action, it may be useful to assess both time horizons, defining them based on the individual circumstances.

Likely, possible and unlikely effects

Different effects will be more or less likely to occur. This depends on how directly the mitigation action causes the effect and which other drivers have an impact on the decisions leading to the effect. Where possible, all potential effects should initially be identified, regardless of their likelihood of occurring. The final estimation of effects will then only address effects that are deemed significant.

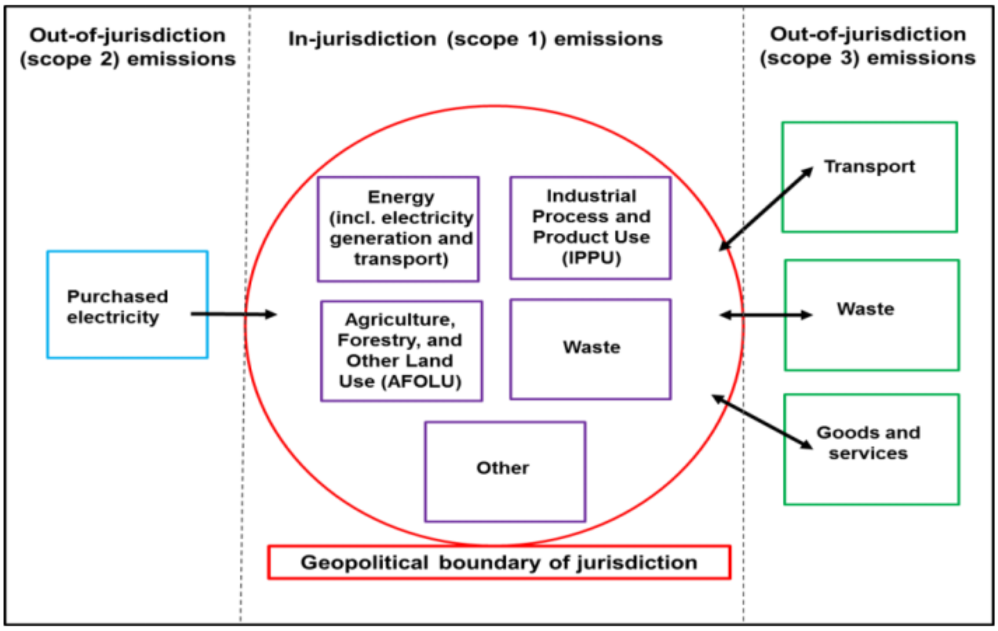
Greenhouse gas emissions or removals increasing and decreasing effects

Effects can increase and decrease emissions released from sources and sinks. Even though the final goal of any mitigation action is to decrease emissions or increase removals, a number of unintended effects can potentially be counteractive. It is important to explore these effects, as they can render mitigation actions ineffective, if they are found to be substantial.

In-jurisdiction and out-of-jurisdiction effects

Effects that occur both inside and outside of the geopolitical boundary over which the implementing entity has authority, such as a city boundary or national boundary. To identify such effects, we first need to define the relevant jurisdictional boundary. Out-of-jurisdiction effects are called **spillover effects** if they reduce emissions outside the jurisdictional boundary and **leakage** if they increase emissions outside the jurisdictional boundary.

Figure 20
Scopes framework for jurisdictions

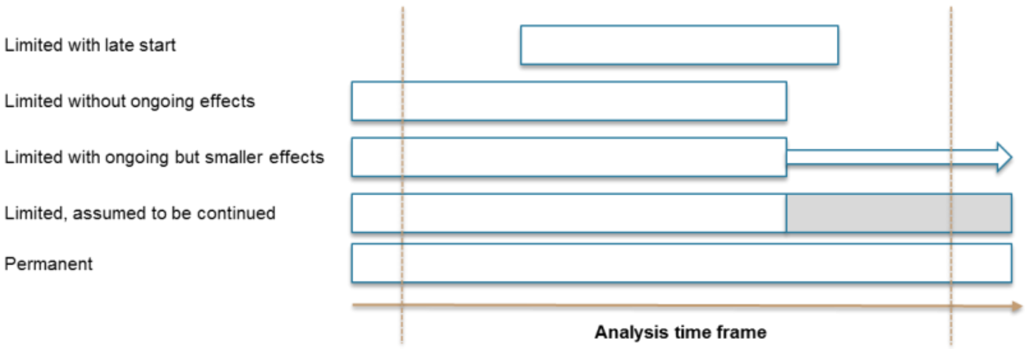


Source: WRI (2014a).

Duration of effects

As discussed in section 4.2, effects can change over time in a linear or non-linear way. Additionally, effects can have different duration. Together this creates a complex set of possible developments of effects over time. Figure 21 highlights some of the most common patterns.

Figure 21
Types of effects over time



Note: Each of the effects illustrated could be static or dynamic (linear or non-linear).

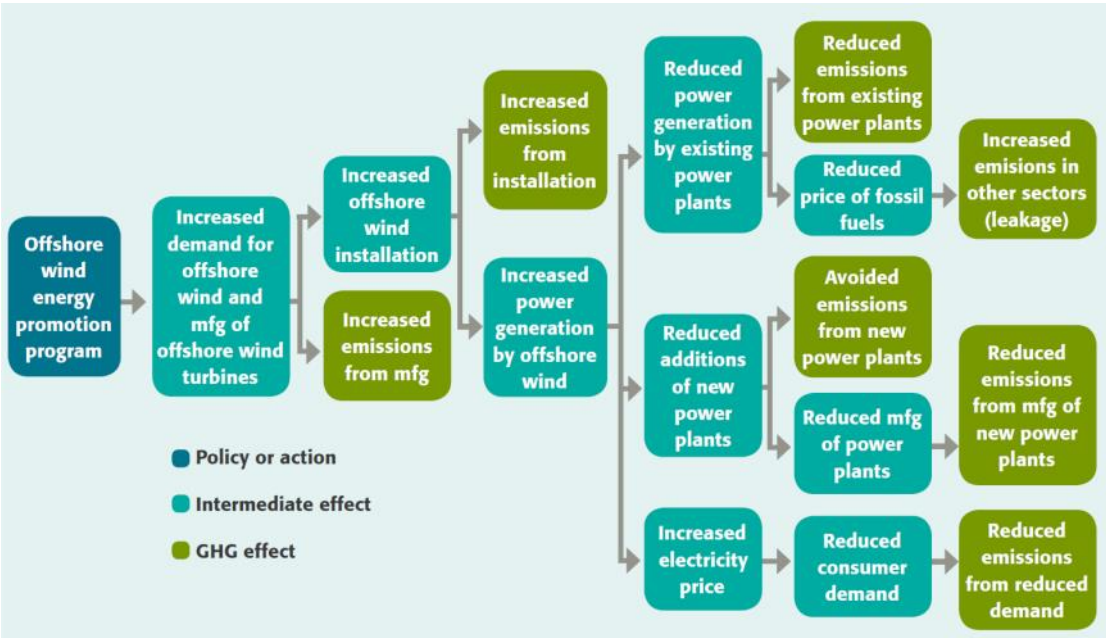
4.3.2.2. Reporting on effects of mitigation actions

Understanding and communicating the cause and effect relationships of a mitigation action is one of the key challenges of evaluating the impacts of such actions. There are multiple ways to do this, although often the cause and effect relationships remain implicit or hidden in highly technical annexes to model calculations. This section introduces the causal chain, a tool developed for the GHG Protocol Policy and Action Standard (WRI, 2014c).

The **causal chain** is a tool to make cause and effect relationships explicit that are often included implicitly in the analysis of mitigation effects, and thus not communicated. It is a conceptual diagram, tracing the process by which a mitigation action leads to effects through a series of interlinked logical and sequential stages.

Especially for policy-based mitigation actions this can help understand how the inputs and activities are expected to lead to GHG and non-GHG effects. The visualization of relationships also facilitates discussion and enhances understanding during the analysis within the team conducting the analysis and supports the identification of additional effects that otherwise would not have been identified. The resulting causal chain graphs also serve as a useful communication tool.

Figure 22
Example causal chain: Belgium's offshore wind energy promotion programme



Source: Results from pilot testing illustrated in WRI (2014c).
Abbreviations: GHG = greenhouse gas, mfg = manufacturing.

4.3.3. IDENTIFYING SIGNIFICANT EFFECTS (II)

Some of the effects will be outside the boundary set by the mitigation action, for example effects occurring outside the geographic or sectoral boundary as defined in the mitigation action. However, governments may wish to include some of these effects in their analysis. For all effects that are within the defined boundary it should be determined whether they are significant, based on the likelihood and magnitude of the effect as illustrated in Figure 23.

Figure 23
Recommended approach for determining significance

Definition of likelihood:

- ***Very likely:*** *Reason to believe the effect will happen (or did happen) as a result of the policy. (For example, a probability in the range of 90–100 per cent).*
- ***Likely:*** *Reason to believe the effect will probably happen (or probably happened) as a result of the policy. (For example, a probability in the range of 66–90 per cent).*
- ***Possible:*** *Reason to believe the effect may or may not happen (or may or may not have happened) as a result of the policy. About as likely as not. (For example, a probability in the range of 33–66 per cent). Cases where the likelihood is unknown or cannot be determined should be considered possible.*
- ***Unlikely:*** *Reason to believe the effect probably will not happen (or probably did not happen) as a result of the policy. (For example, a probability in the range of 10–33 per cent).*
- ***Very unlikely:*** *Reason to believe the effect will not happen (or did not happen) as a result of the policy. (For example, a probability in the range of 0–10 per cent).*

Definition of magnitude:

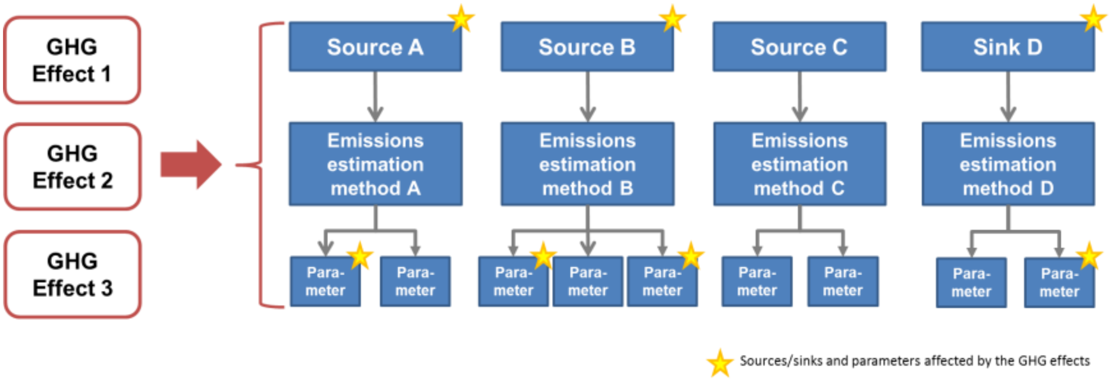
- ***Major:*** *The effect significantly influences the effectiveness of the policy or action. The change in greenhouse gas emissions or removals is likely to be significant in size (> 10 per cent).*
- ***Moderate:*** *The effect influences the effectiveness of the policy or action. The change in greenhouse gas emissions or removals could be significant in size (1–10 per cent).*
- ***Minor:*** *The effect is inconsequential to the effectiveness of the policy or action. The change in greenhouse gas emissions or removals is insignificant in size (< 1 per cent).*

Source: WRI (2014c).

4.3.4. IDENTIFYING AFFECTED PARAMETERS (III)

For mitigation actions that are assessed against a baseline, all methods, parameters and values should be identical to the baseline, apart from those that have been determined to be affected by the GHG effects identified, for example through a causal chain process. Figure **24** illustrates this concept. Only marked parameters are affected and values would differ compared to the baseline scenario. These differences in parameters, for example regarding energy use or fuel mix, determine the mitigation effect of the mitigation action.[8]

Figure 24
Relationship between effects and parameter values



Source: Based on WRI (2014c).
Abbreviation: GHG = greenhouse gas.

4.3.5. DETERMINING MITIGATION SCENARIO VALUES FOR PARAMETERS (IV)

The change in individual parameters over time should be based on what is considered the most likely scenario, based on evidence, such as peer-reviewed literature, modelling or simulation exercises, government statistics, or expert judgement. A variety of factors need to be considered in determining the parameter values for the mitigation scenario, some of which are similar to those considered for the baseline scenario, others are additional:

- **Policy interaction**: The mitigation action assessed may interact with policies included in the baseline scenario, i.e. those that are implemented or adopted, either in overlapping or reinforcing ways. Policies or actions that interact produce total effects that differ from the sum of the individual effects of each individual mitigation action.
- **Implementation changes over the assessment period**: The implementation of the mitigation action may include changes over the assessment period. Examples for such changes are increasing standards in a number of steps, or the phase out of subsidies according to a defined timeline. This also includes cases where a fixed budget is provided for an incentive scheme, which will lead to changes in parameters over the assessment period. Other policies are designed to operate permanently at a given level.
- **Barriers**: Barriers can limit the effectiveness of mitigation measures, as discussed in section 2.4. Such barriers should be taken into consideration in

[8] The same methodology can be used to quantify non-GHG effects, where methods and parameters would differ, but in principle, the same methodology could be applied.

the assessment as far as possible. One option is to discount the maximum effects under full implementation, based on expected limitations in policy implementation, enforcement or effectiveness.

- **Timing of effects**: As described in section 3.1.4, effects of mitigation actions do not necessarily occur directly after implementation. They may also increase continuously with broader uptake over time. These effects should be captured in the assumed development of parameters over time.

Table 11 provides an example for the reporting of parameter values, methods and assumptions used and data sources.

Table 11
Example: reporting parameter values (ex-ante) for a home insulation subsidy

Parameters	Policy scenario value(s)	Method and assumptions to estimate value	Data source(s)
Natural gas used for space heating	1,000,000 MMBtu/year from 2010–2014; 910,000 MMBtu/year from 2015–2025	Values calculated based on 30 per cent anticipated uptake of the insulation subsidy starting in 2015 and remaining constant through 2025; and 30 per cent energy use reduction per home with insulation (based on previous studies of similar policies)	Peer-reviewed literature: Author (Year). Title. Publication.[9]
Natural gas used for water heating	500,000 MMBtu/year (constant)	Same value as in baseline scenario since the policy does not affect this parameter	National energy statistical agency
Natural gas used for cooking	300,000 MMBtu/year (constant)	Same value as in baseline scenario since the policy does not affect this parameter	National energy statistical agency
Natural gas emission factor	55 kg CO_2e/MMBtu (constant)	Same value as in baseline scenario since the policy does not affect this parameter	National energy statistical agency

Source: WRI (2014c).
Abbreviations: CO_2e = carbon dioxide equivalent, MMBtu = million British thermal units.

[9] This is an example of a style which could be used to cite the source, if peer-reviewed or grey literature is used.

Box 19
Example of reporting differences of assumptions between scenarios

In its second national communication Botswana directly compares baseline values for different parameters to policy scenario values.

Sector	Baseline	Policy and measures
Residential	Growth at 0.8% from 2000, 8.4% from 2005, 7.9% from 2010, 5.2% from 2015 3.0% Note: Percentages of households (HH) with cooking, lighting, from the CSO Environment report 2006	Growth 2%
Cooking	LPG from 40.59% of HH in 2001; 86.7% in 2009 to 91% in 2015; electricity: from 5% of HH in 2001,15.6% in 2009 to 10% in 2015 Firewood: from 45.72% in 2001, 15.4% in 2010 to 5% in 2015	LPG from 40.59% of HH in 2001; 91% in 2015 to 95% in 2025; electricity: from 5% of HH in 2001, 15.6% in 2009 to 10% in 2015 Firewood: from 45.72% in 2001, 15.4% in 2010 to 5% in 2015
Lighting	CFLs in use about 5% penetration	CFLs in use (distributed to some residences during 2010 so assume penetration of 50% in 2010 and 90% as of 2015)
Industry	Electrical energy and diesel fuel used Growth rate (customers) 3% to 2015; 1% to 2030 No change in energy intensity	Growth rate same as reference 10% Reduction in overall energy by 2015 and 15% by 2030 due to energy conservation measures (education)

Abbreviations: CFL = compact fluorescent lamp, HH = household
Source: Government of Botswana (2011).

4.3.6. CALCULATING MITIGATION SCENARIO EMISSIONS FOR EACH SOURCE OR SINK CATEGORY (V)

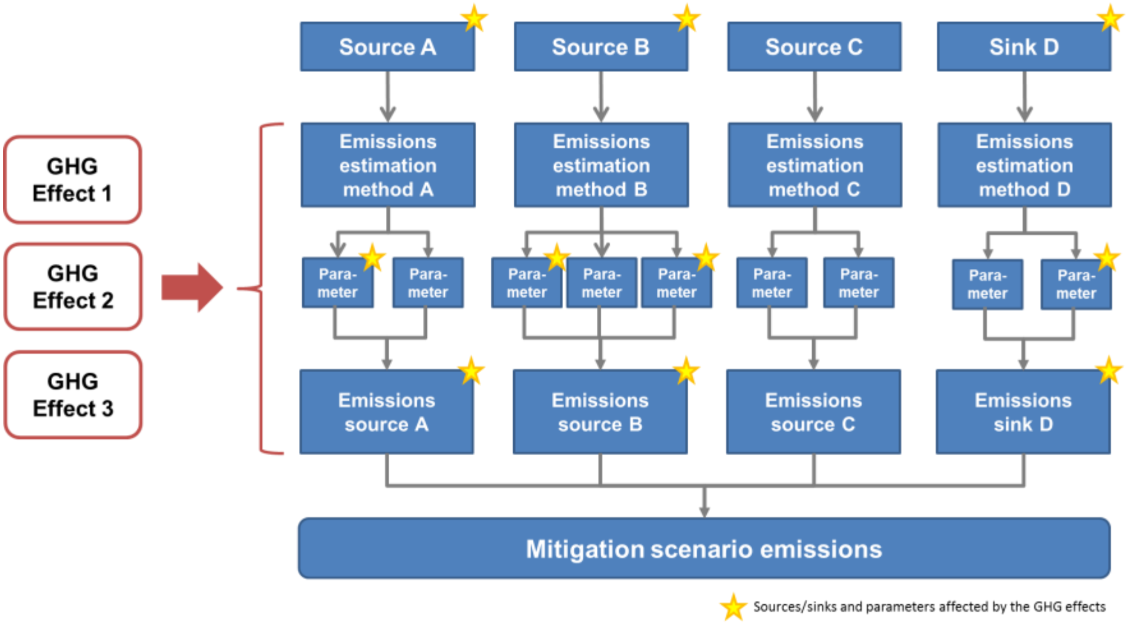
The methods used for calculating emissions for each source and sink category should be the same as for determining baseline scenario emissions. The only difference is in parameter values that have been identified in the previous steps.

Depending on which sources, sinks and parameters are affected by the mitigation action, emissions for individual source and sink categories may or may not differ from baseline scenario emissions.

4.3.7. AGGREGATING MITIGATION SCENARIO EMISSIONS (VI)

The aggregation of mitigation scenario emissions follows the same logic as for baseline scenario emissions. Also here potential overlaps and interactions between source and sink categories need to be taken into account. Figure 25 shows the principle. All sources and sinks are added up, irrespective of whether they are affected by the mitigation action or not.

Figure 25
Aggregation of mitigation scenario emissions



Source: Based on WRI (2014c).
Abbreviation: GHG = greenhouse gas.

4.3.8. CALCULATING THE GREENHOUSE GAS IMPACT OF MITIGATION ACTIONS (VII)

Once the differences in parameters are identified, the mitigation scenario emissions can be calculated using the same methods applied to the baseline. The impact of the mitigation action is then determined as the difference between mitigation scenario emissions and baseline emissions. There are two different ways to express the impact:

- **Total net change:**[10] Represents the net change from the baseline and is expressed as a negative number if the mitigation scenario reduces emissions below baseline and a positive number if emissions are increased above the baseline scenario.

  > *Total net change in GHG emissions and removals resulting from the mitigation action (t CO_2e) = Total net mitigation scenario emissions (t CO_2e) – Total net baseline scenario emissions (t CO_2e)*

- **Total net reduction**: Here the calculation is tailored to represent reductions, which means that positive numbers indicate a reduction in emissions below baseline, a negative number indicates an increase.

[10] 'Net' refers to the aggregation of GHG emissions and removals. 'Total' refers to the aggregation of emissions and removals across all sources and sinks included in the GHG assessment boundary.

> *Total net reduction in GHG emissions and removals resulting from the mitigation action (t CO2e) = Total net baseline scenario emissions (t CO2e) – Total net mitigation scenario emissions (t CO2e)*

It is important to be clear which of these ways is used, to allow an accurate understanding of the results.

Box 20

Important elements for reporting on expected impacts in biennial update reports

- Method chosen;
- Assessment period;
- Assessment boundary;
- Reference for reporting mitigation effects (baseline values, base year values);
- Potential greenhouse gas effects of the action that were considered in the assessment;
- Source/sink categories and greenhouse gases affected by the policy or action;
- Assumptions on key parameters:
    i. Potential interaction of the mitigation action with policies included in the baseline;
    ii. Sources for parameter changes based on the mitigation action;
    iii. Expected development of parameters over the assessment period;
    iv. Information on barriers analysed and the impact on results;
- Results and methods used of **uncertainty** and **sensitivity** analysis.

4.4. PROGRESS OF IMPLEMENTATION ACTIONS

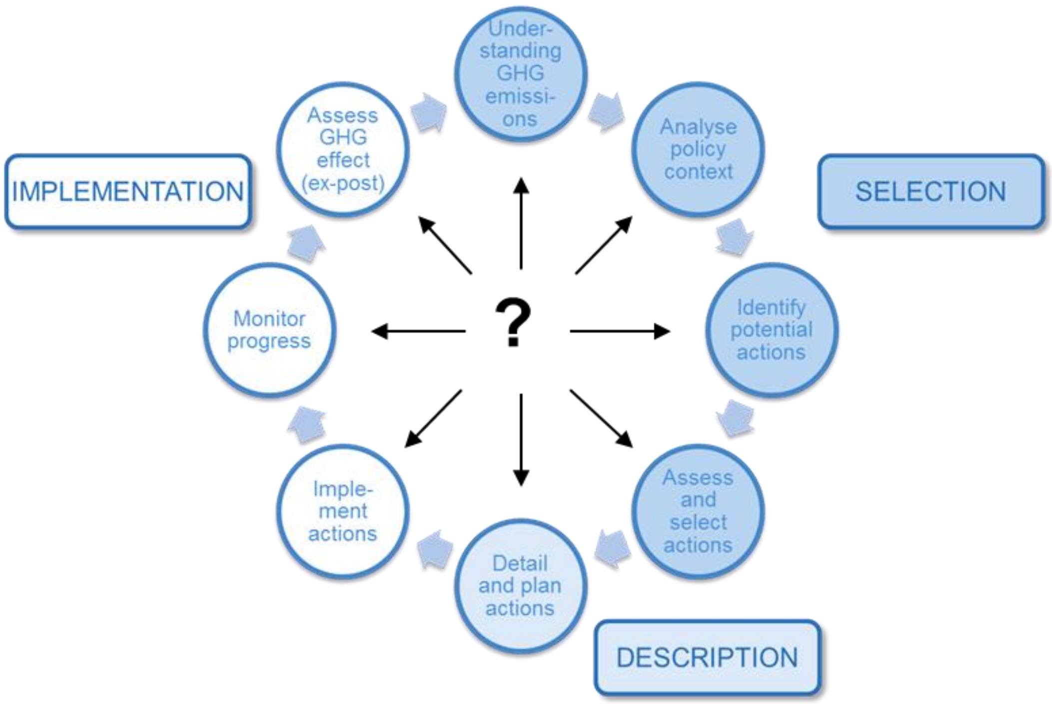
This section reviews different dimensions of progress on implementation. It discusses two dimensions of progress, understanding the status of implementation and understanding results achieved to date.

4.4.1. UNDERSTANDING THE STATUS OF THE MITIGATION ACTION

To understand the exact status in the process cycle of selecting, designing and implementing mitigation actions, the reported action is an important element in the analysis. **Error! Reference source not found.** illustrates that mitigation actions that are reported can be at any stage within the design and implementation cycle.

Mitigation actions that are framed as a goal may be based on the full analysis and selection process, with policies and actions already defined for implementation or already under way. They may also be aspirational and still require additional analysis to identify the mitigation actions for implementation.

Figure 26
Determining the status of mitigation actions



Abbreviation: GHG = greenhouse gas.
Source: own illustration

Policy- and project-based mitigation actions may still need to be developed in further detail or be already well under way in implementation. In particular, the more general steps of detailing, planning and implementing actions involve a number of distinct activities (see **Error! Reference source not found.** and **Error! Reference source not found.**). These activities will differ depending on the type of mitigation action.

Planning and implementing policies

Concrete steps and the order of steps will vary depending on differences in legislative processes in the country. Legislative processes will differ depending on the specific national circumstances. The time required for legislation to pass through the process will also differ from country to country. It is important to be aware of these processes and the time involved to conduct the different steps, in order to understand where in the process a mitigation action that involves the adoption of legislation is. Each individual activity could be defined as a progress indicator or milestone within the monitoring plan (compare section 3.3).

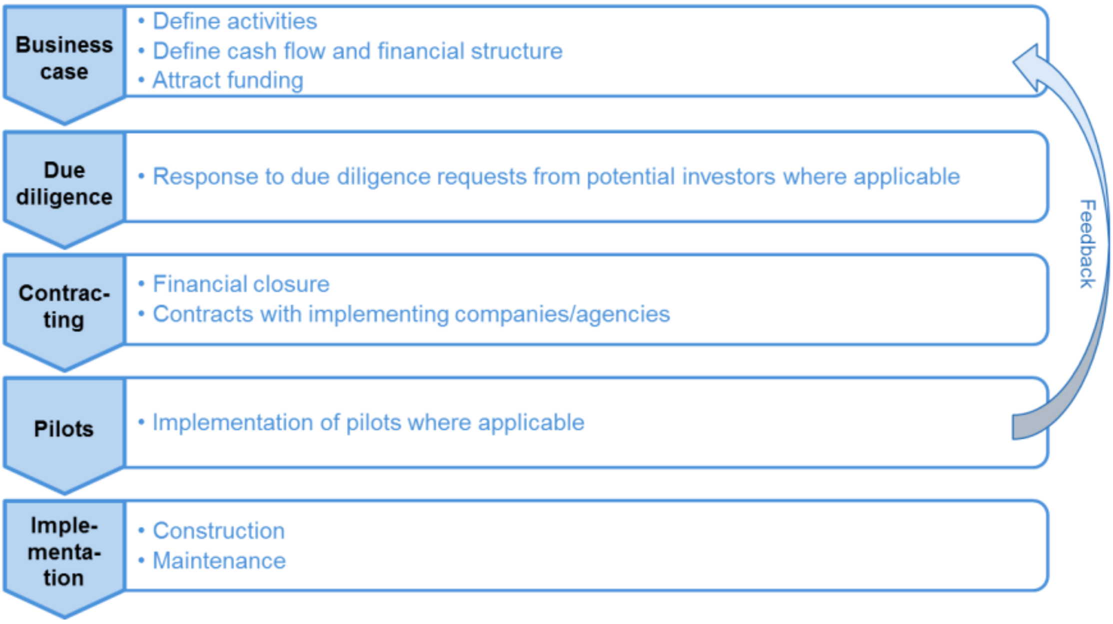
Figure 27
Example of implementation steps for policy-based mitigation actions

Source: own illustration

Planning and implementing projects

Steps for project-based activities will vary depending on the type of project. The example in **Error! Reference source not found.** provides common steps for investment oriented projects, for example for the construction of renewable energy capacity. Other project types, for example capacity building or information activities will have slightly different steps. It is important to capture key steps in the form of progress indicators or milestones and report on achievements.

Figure 28
Example of implementation steps for investment oriented projects



Source: own illustration

The main questions regarding reporting related to the status of the mitigation action are:

- Does the BUR document the steps that have already been completed?
- Does the BUR report on steps ahead and the timeline for the remaining steps planned?

Box 21
Examples of legislative milestones from India and the United States

The following table compares milestones for the implementation of laws in different phases in the context of India and United States. For mitigation actions that are based on legislation, it is important to understand these milestones in the national context and to know where the action stands in this process.

STAGE IN THE LEGISLATIVE PROCESS	EXAMPLES OF MILESTONES FROM THE INDIAN CONTEXT	EXAMPLES OF MILESTONES FROM THE U.S. CONTEXT
Initiating phase	■ Notice of motion issued to introduce the bill ■ Bill introduced through official First Reading ■ Bill referred to Standing Committee	■ Bill introduced in the House ■ Bill assigned a specific number ■ Bill printed publicly in its introduced form
Amending phase	■ Bill put through Second Reading to discuss principles and objective ■ Bill through committee hearing or clause-by-clause hearing ■ Final draft of bill written	■ Bill sent to Committee ■ Bill sent to sub-committee ■ Committee report written ■ Bill put through public hearings ■ Bill undergone mark-up ■ Bill sent to floor for debate
Finalizing phase	■ Bill put through an official Third Reading (to vote on bill in its final form) ■ Final bill sent to second house for readings and voting ■ Final bill approved by President or state authority ■ Bill published in official gazette in its final form	■ Final bill voted on in House ■ Bill sent to Senate ■ Bill voted on in Senate ■ Bill sent to Joint Committee (if needed) ■ Bill sent to the President ■ Final Law published

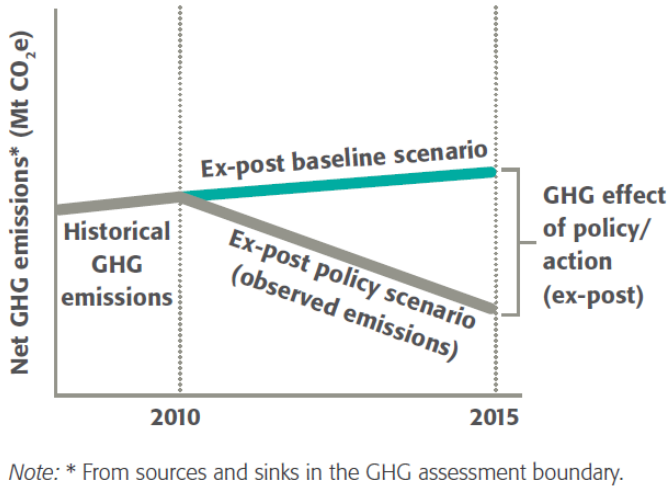
Source: Barua, Fransen & Wood (2014).

4.4.2. UNDERSTANDING IMPACTS ALREADY ACHIEVED

Determining results achieved by implemented actions involves a backward looking (ex-post) assessment as illustrated in figure 31. Estimating the GHG effects ex-post involves a comparison of the outcome of the mitigation action with an estimate of what would most likely have happened in the absence of that policy or action (i.e. the baseline scenario) (WRI, 2014c). This type of analysis is currently much less frequent than the assessment of expected results of mitigation actions (Hogan et al., 2012).

The analysis steps required for ex-post assessment follow the same process as the ex-ante assessment presented in section 4.3. Also for ex-post evaluation the process described here aims to allow for the application of a wide variety of methods and applies to all sectors and types of mitigation actions. This section highlights similarities and differences and introduces a number of additional methodologies available specifically for ex-post analysis.

Figure 29
The principle of ex-post determination of achieved effects



Source: WRI (2014c).
Abbreviations: GHG = greenhouse gas, Mt CO_2e = megatonnes of carbon dioxide equivalent.

Relationship to ex-ante assessment methodology

In principle, the assessment follows the same logical process as the determination of expected effects. There are, however, a number of differences and additional methodologies available for ex-post assessment, which are described below. Similar to the ex-ante assessment the baseline needs to be determined based on what would have been the most likely development in the absence of the action. Mitigation scenario emissions are, however, given in the form of observed emissions (GHG inventory).

For ex-ante assessments both baseline and policy scenario need to be developed, while for ex-post assessment only the baseline needs to be determined, while mitigation scenario emissions are given by the GHG inventory. For ex-post assessments more information is normally available than for ex-ante assessments, especially on the development of key parameters of the calculation. The difficulty lies in determining which parameters would have developed differently without the intervention.

Methods for ex-post assessment

The comparison of the outcome of the mitigation action with an estimate of what would most likely have happened in the absence of that policy or action, can be done in one of two ways:

- **Scenario method**: A comparison of a baseline scenario (the conditions most likely to occur in the absence of the policy or action) with a policy scenario (the conditions most likely to occur in the presence of the policy or action) for the same group or region (same methodology as for ex-ante assessments);
- **Comparison group method**: A comparison of one group or region affected by the policy or action with an equivalent group or region that is not affected by the policy or action.

4.4.3. ADDITIONAL STEPS TO INFORM DECISION-MAKING FOR EX-POST ASSESSMENT

In addition to estimating the GHG effect of the policy or action, users may take several additional steps to help inform decision-making, including those outlined below (WRI, 2014c).

Normalizing results

Normalization is a process to make conditions from different time periods comparable. It is useful if the objective is to compare policy effectiveness by removing fluctuations not influenced by the policy, such as weather variations. For example, the effectiveness of a building insulation programme in reducing emissions from home heating depends on weather conditions. If one year in the GHG assessment period is warmer than another year, the GHG effect of the policy in the warm year is reduced compared to a colder year because less heating energy is needed in the warmer year. In this case, emissions from home heating decline in both the baseline scenario and policy scenario.

Harmonizing top-down and bottom-up assessments

Both top-down and bottom-up methods have limitations, and each approach results in specific types of effects that need to be corrected. Typically, only either a top-down or bottom-up assessment is carried out for individual mitigation actions. However, it is possible to carry out both methods in parallel. Harmonizing bottom-up and top-down assessments is useful to compare and control the differences between the different methods.

Comparing to the greenhouse gas inventory

Comparing the results of the ex-post GHG assessment to the annual GHG emissions inventory for the relevant jurisdiction(s) or organization(s) can be useful. It helps to understand any differences in the reported GHG effects based on a GHG assessment (as a result of the policy or action) and the changes in GHG emissions that are reflected in the inventory (as a result of the policy or action, as well as other factors). A comparison can also be a useful quality control measure to evaluate the reliability of the GHG assessment. This is typically only possible with top-down indicators or a combination of bottom-up and top-down methods.

Decomposition analysis

Decomposition analysis is used to understand the various factors that lead to changes in overall GHG emissions (as demonstrated in a sectoral or jurisdictional GHG inventory) over time. Decomposition analysis is a method used to subdivide emissions into individual drivers, which can be individually tracked to understand why emissions change over time. For example, residential energy use in a country can be divided into its constituent parameters (e.g. number of houses x average size of houses (m^2 per house) x energy efficiency (energy use per m^2)) to track the trends in individual parameters and determine which parameter(s) are contributing most to the overall change in energy use or emissions. Similarly, transportation emissions can be disaggregated into parameters that can be individually tracked, such as (distance travelled (km) x fuel efficiency (litres of fuel consumed per km) x carbon intensity of fuels (t CO_2e per litre)).

This is very similar to the progress indicators as defined in section 3.3. The focus of the analysis is, however, different. While progress indicators mainly aim to provide a good indication whether implementation is on track, decomposition analysis aims to fully understand all elements influencing results. It is thus normally more comprehensive.

Combining ex-ante and ex-post assessments (rolling monitoring)

In addition to the monitoring of performance indicators, ex-ante and ex-post monitoring may be combined in a ‘rolling monitoring’ approach. Under this approach, the projection provided by the ex-ante assessment is continuously overwritten with the results from ex-post assessment, which allows for a comparison of the original expectations and the final result, as well as possible adjustments of targets or policies.

4.4.4. REPORTING ON RESULTS ACHIEVED BASED ON PROGRESS INDICATORS

The reporting of results achieved could also be based on performance indicators (see section 3.3). The advantage of reporting based on progress indicators is that data is often more readily available and the cause and effect relationship between mitigation actions and the indicators reported may be easier to demonstrate.

Many progress indicators will support an understanding of how far the implementation process has progressed, as illustrated in Table 12.

While some indicators provide a good proxy for reporting on GHG emission impacts, many, however, will not be sufficient to arrive at a thorough understanding of the impacts of the action and require additional indicators or a full GHG impact assessment to support understanding.

Table 12
Progress indicators for Mexico's Light-Duty Vehicle Standard

IMPLEMENTATION FUNCTION	EXPECTED DATE OF ATTAINMENT	INDICATOR	RESPONSIBLE AUTHORITY	DATA SOURCE	MONITORING FREQUENCY
Collect information specified in NOM 163 for 2012-model vehicles sold (voluntary for 2012)	October 30, 2013	Number of automakers who submit information/total number of automakers regulated by standard	PROFEPA	Interviews with PROFEPA officials	Annual
Collect information specified in NOM 163 for 2013-model vehicles sold (voluntary for 2013)	April 30, 2014	Number of automakers who submit information/total number of automakers regulated by standard	PROFEPA	Interviews with PROFEPA officials	Annual
Collect information specified in NOM 163 for 2014-model vehicles sold	April 30, 2015	Number of automakers who submit information/total number of automakers regulated by standard	PROFEPA	Interviews with PROFEPA officials	Annual
Collect information specified in NOM 163 for 2015-model vehicles sold	April 30, 2016	Number of automakers who submit information/total number of automakers regulated by standard	PROFEPA	Interviews with PROFEPA officials	Annual
Collect information specified in NOM 163 for 2016-model vehicles sold	April 30, 2017	Number of automakers who submit information/total number of automakers regulated by standard	PROFEPA	Interviews with PROFEPA officials	Annual
On-site emission testing to ensure compliance	On-going (2013–2016)	Number of tests conducted on an annual basis	PROFEPA	Interviews with PROFEPA officials	Quarterly
Apply penalties to automakers who fail standards	On-going (2013–2016)	Number of penalties assigned/ number of failed compliance tests	SEMARNAT/ PROFEPA	Interviews with PROFEPA officials	Quarterly
Issue emissions certificates to automakers who comply with standards	2017	Number of emissions certificates issued	PROFEPA/ verification agencies	Interviews with PROFEPA officials	2017

Source: Barua, Fransen & Wood (2014).
Note: The functions and indicators in this table are not comprehensive; they are for illustrative purposes only.
Abbreviation: PROFEPA = Procuraduría Federal de Protección al Ambiente (Federal Attorney for Environmental Protection).

Box 22
Important elements for reporting on implementation progress in the biennial update report

- **Status** of the mitigation action within the selection, design and implementation cycle;
- **Concrete steps** required to ensure full implementation;
- **Progress indicators** selected to monitor implementation;
- **Sources** for progress indicator values and information;
- **Methodology choices** and **assumptions** for ex-post analysis, if applicable.

4.5. REPORTING THE SUSTAINABLE DEVELOPMENT IMPACTS OF MITIGATION ACTIONS

This section discusses the assessment and reporting of sustainable development impacts of mitigation actions. It provides examples of existing methodologies and tools to assess impacts in different fields.

4.5.1. SUSTAINABLE DEVELOPMENT IMPACTS

Impacts on sustainable development and climate change mitigation are very context specific. Whether a mitigation action supports sustainable development and climate change jointly or whether there are serious trade-offs between economic and social factors and climate change is difficult to conclude.[11]

[11] See Klein et al. (2007) for a more extensive discussion.

Box 23
Defining 'sustainable development'

The discussion around sustainable development has a long history. While there is not one generally agreed definition of the term, most definitions build on the definition first published in the **Brundtland Report** (World Commission on Environment and Development, 1987):

> *"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts:*
>
> - *the concept of needs, in particular the essential needs of the world's poor, to which overriding priority should be given; and*
> - *the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs."*

The **World Bank**[a] for example works with a different definition that covers similar concepts:

> *"Sustainable development recognizes that growth must be both inclusive and environmentally sound to reduce poverty and build shared prosperity for today's population and to continue to meet the needs of future generations. It must be efficient with resources and carefully planned to deliver immediate and long-term benefits for people, planet, and prosperity."*

[a] *See <http://www.worldbank.org/en/topic/sustainabledevelopment>.*

There is no agreed definition of sustainable development and no agreed methodology to evaluate sustainable development impacts in their totality. Most approaches are qualitative, based on three pillars:

- Economic growth;
- Environmental stewardship
- Social inclusion.

The newly released *Prototype Global Sustainable Development Report* (United Nations, 2014) introduces an additional dimension in differentiating the pillar (see **Error! Reference source not found.**):

- What is to be developed?
- What is to be sustained?

Table 13
Coverage of the three pillars of sustainable development

		Social	Economic	Environmental
What is to be developed?	People	+++	++	+
	Economy	++	+++	+
	Society	+++	+	+
What is to be sustained?	Nature	+	+	+++
	Life support	+	++	++
	Community	+++	+	+

Note: The plus signs indicate the level to which each pillar is captured. +++: strong focus; ++: focus; +: related but not a focus.

Source: United Nations (2014).

Based on these pillars, themes and indicators are defined, as illustrated in Table 14 and Abbreviation: NMVOCs = non methane volatile organic compound, NOx = nitrogen oxides, SOx = sulphur oxides, SPM = suspended particulate matter, ….

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To fully understand the implications of mitigation actions on sustainable development an in-depth analysis of the cause–effect relationships is useful. In principle, most of the analysis steps for understanding mitigation effects, as discussed in sections 4.3 and 4.4, are also useful for understanding sustainable development impacts.

For the assessment of sustainable development impacts – as for GHG impacts – it is essential to address unintended and indirect effects. These can either reinforce the intended effects of an action or, in the worst case, counter-balance or even outweigh them.

4.5.2. AVAILABLE TOOLS

Currently available tools provide good guidance on the understanding and reporting of sustainable development benefits from mitigation actions. Existing tools and methodologies usually address specific aspects of sustainable development, depending on the purpose for which they were designed and depending on their main objective: climate or development.

At the United Nations Conference on Environment and Development in Rio de Janeiro, where the UNFCCC was established, countries were encouraged to develop indicators of sustainable development that could provide a solid basis for decision-making at all levels (United Nations, 2007). Following this, indicators on sustainable development were, for example, incorporated into the UNFCCC's Clean Development Mechanism (CDM).

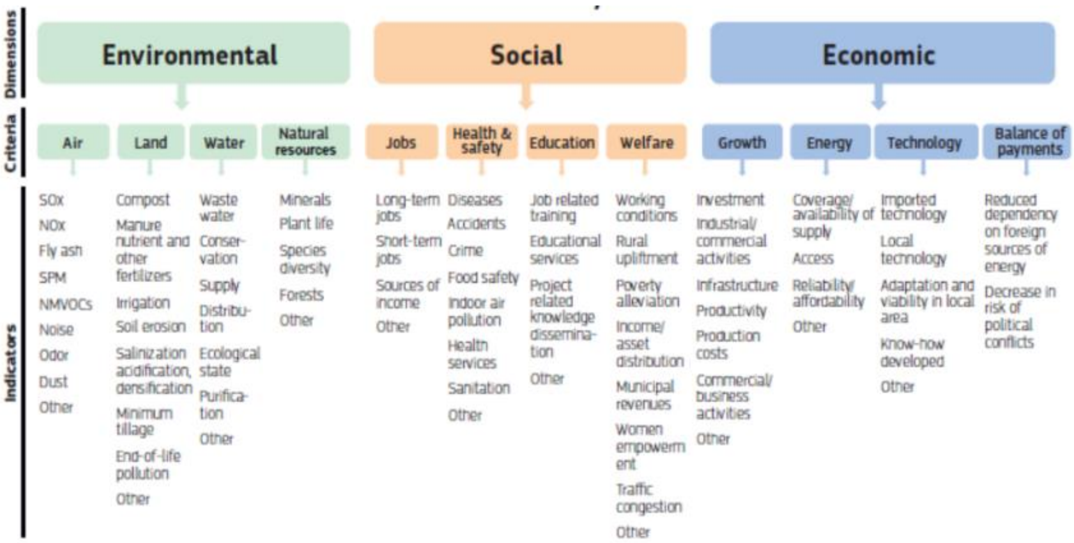
Clean Development Mechanism Sustainable Development Tool

The CDM Executive Board developed a tool for describing sustainable development co-benefits of CDM project activities and programmes of activities. The use of this tool is, however, voluntary and no monitoring requirements for sustainable development are in place (UNFCCC, 2014).[12]

The tool is available as a Word document and as online tool and includes three sections:

- Selection of project activity or programme of activities;
- Sustainable development co-benefits (according to taxonomy shown in Abbreviation: NMVOCs = non methane volatile organic compound, NOx = nitrogen oxides, SOx = sulphur oxides, SPM = suspended particulate matter, ….
-);
- Third party assessment and contact information.

Figure 30
Taxonomy of sustainable development impacts for the Clean Development Mechanism Sustainable Development Tool



Source: Holm Olsen (2012).
Abbreviation: NMVOCs = non methane volatile organic compound, NO_x = nitrogen oxides, SO_x = sulphur oxides, SPM = suspended particulate matter, ….

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[12] More information is available at: <http://cdm.unfccc.int/DNA/Reference/tools/index.html>.

Box 24

Example of reporting sustainable development benefits using the Clean Development Mechanism Sustainable Development Tool

Improved cook stove programme in India

The example shows the application of the Clean Development Mechanism Sustainable Development Tool to an improved cook stove programme in India. The reporting has two elements: an overview with a rating and a detailed description of different sustainable development elements under assessment.

Overview

B. Social co-benefits:

		Slightly	Partly	Highly	N/A
Jobs	New long-term jobs				•
	New short-term jobs		•		
	New sources of income generation		•		
	Other employment opportunities				•
Health &Safety	Disease prevention			•	
	Reducing accidents				•
	Reducing crime				•
	Preserving food				•
	Reducing health damaging indoor air pollution			•	
	Enhancing health services				•

Detailed description

	Indicator	Specification	Extent
Jobs	The CDM PoA creates new job opportunities including income generation as follows:		
	New long term jobs		*NA*
	New short-term jobs	*Project management activities such as deployment, monitoring and maintenance mechanisms would create short term employment opportunities in rural communities*	*Partly*
	Income generation	*Usage of improved cook stoves reduces the time spent in foraging for fuel wood thus freeing up time, improving community health and allows able members to be to be involved in other economic activities*	*Partly*
Health& safety	The CDM PoA results in health and safety improvements as follows:		
	Reduction of diseases, disease prevention	*Improved cook stoves technologies normally result in complete combustion of fuel wood thus reducing smoke emitted and reducing disease burden as a result of indoor air pollution. The project improves community health through reduction of respiratory disease and other health hazards.*	*High*

Source: Bureau Veritas Certification India Ltd (2013).
Abbreviation: CDM PoA = Clean Development Mechanism Programme of Activities

The Gold Standard

This standard was established in 2003 to strengthen the additionality of emission reductions and the contribution to sustainable development in the host country. It certifies renewable energy, energy efficiency, waste management and land use and forest carbon projects. Projects are required to score their contribution to sustainable development against a set of indicators fixed in a sustainable development matrix that is based on the same three pillars defined in section 4.5.1 (The Gold Standard, 2012a):

Environment:

- Air quality;
- Water quality and quantity;
- Soil condition;
- Other pollutants;
- Biodiversity.

Social development:

- Quality of employment;
- Livelihood of the poor;
- Access to affordable and clean energy services;
- Human and institutional capacity.

Economic and technological development:

- Quantitative employment and income generation;
- Access to investment;
- Technology transfer and technological self-reliance.

In the second version, a ‘do no harm’ check was introduced with the purpose of linking the Gold Standard to the Millennium Development Goals.[13] The assessment is based on the safeguarding principles of the United Nations Development Programme and includes the following areas (The Gold Standard, 2012c):

- Human rights;
- Labour standards;
- Environmental protection;
- Anti-corruption.

[13] More information is available at: <http://www.goldstandard.org/energy/rules-requirements>.

The standard also requires an extensive stakeholder consultation process, where the community defines the most important indicators of social, economic and environmental success and third-party verification (The Gold Standard, 2012b).

Indicators of Sustainable Development

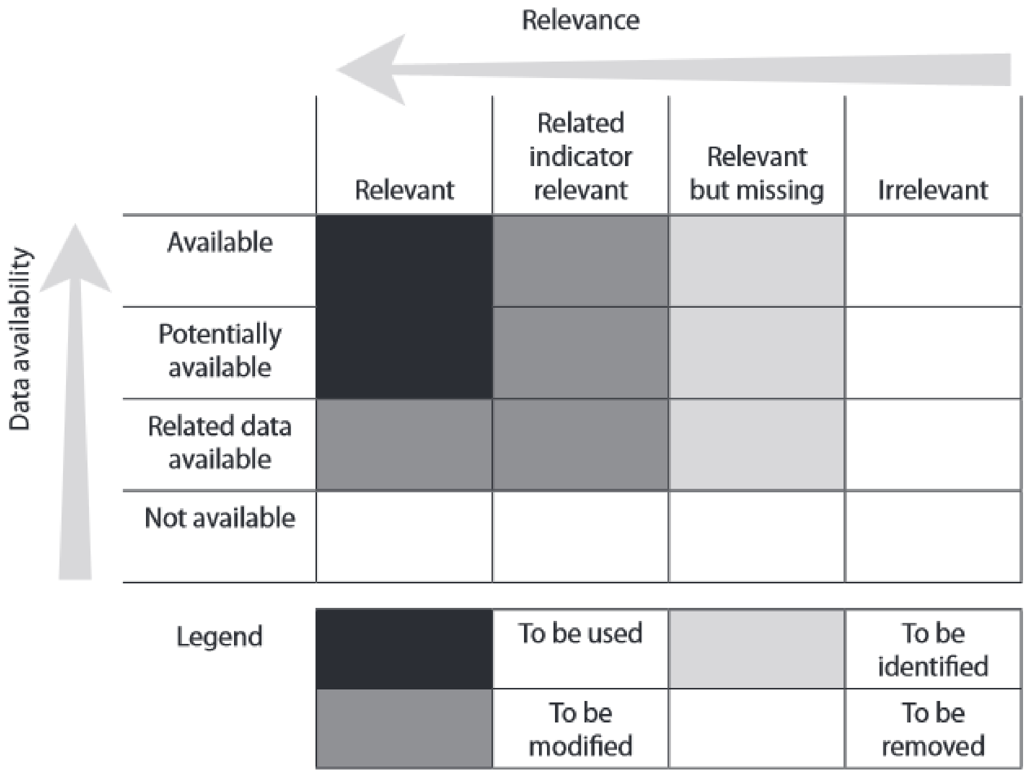
These indicators from the United Nations Department of Economic and Social Affairs (UNDESA) are available in the third edition (United Nations, 2007). They present an extensive list of indicators clustered in themes, as illustrated in Table 14. UNDESA also proposes a method to adapt the full list of indicators to the national context and the specific needs of the action to be assessed, based on a matrix as illustrated in **Error! Reference source not found.**.

Table 14
Indicator themes for the Commission for Sustainable Development Sustainability Indicators (2007)

CSD indicator themes		
• Poverty	• Natural hazards	• Economic development
• Governance	• Atmosphere	• Global economic partnership
• Health	• Land	• Consumption and production patterns
• Education	• Oceans, seas and coasts	
• Demographics	• Freshwater	
	• Biodiversity	

Source: United Nations (2007).
Abbreviation: CSD = Commission for Sustainable Development.

Figure 31
Matrix for adapting Commission for Sustainable Development indicators of sustainable development



Source: United Nations (2007).

Development Impact Assessment toolkit

The Low Emission Development Strategies Global Partnership (LEDS) provides a toolkit that guides users with a simple five-step process to help in the selection of appropriate tools and resources for a given activity:

a) **Identify the policy or programme of interest:** What policy or programme am I considering?

b) **Define impacts to consider:** What impacts am I interested in identifying and evaluating?

c) **Identify the options for examining impacts:** What tools and methodologies, both quantitative and qualitative, are available for impact analysis?

d) **Conduct the analysis.**

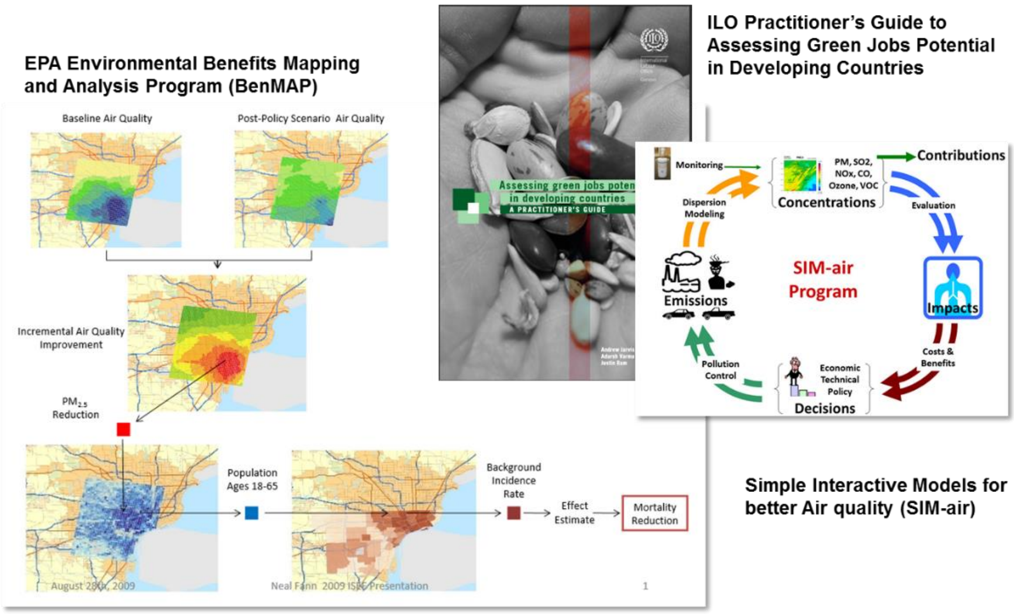
e) **Share the results.**

The toolkit does not as such provide an overall evaluation, but rather provides a number of useful tools to assess individual elements of sustainable development.

The most relevant elements are supported by the proposed process, but users can also freely browse the tools database.[14]

Box 25
Examples of tools from the Development Impact Assessment toolkit that analyse sustainable development benefits

The Development Impact Assessment toolkit provides a wide range of tools for different purposes. They span all areas of analysis related to sustainable development benefits.



Source: Development Impacts Assessment Working Group (Undated).
Abbreviation: CO = carbon monoxide, EPA = Environmental Protection Agency, ILO = International Labour Organisation, NO_x *= nitrogen oxides, PM = particulate matter,* SO_2 *= sulphur dioxide, VOC = volatile organic compound*

4.5.3. LINKING ACTIONS TO THE OVERALL DEVELOPMENT STRATEGY

Mitigation options that improve productivity of resource use (energy, water, land) generally yield sustainable development benefits. Climate-related policies (e.g. energy efficiency) are often economically beneficial, improve energy security, reduce local pollution and create jobs. Opportunities for mitigation–sustainable development synergies are especially promising in waste management, transportation and buildings (decreased energy use and reduced pollution).

Reducing deforestation can yield biodiversity, soil and water conservation benefits, but may result in economic loss and reduced agricultural (or forestry) production.

[14] Toolkit available at: <http://en.openei.org/wiki/LEDSGP/DIA-Toolkit>.

Capitalizing on synergies is especially relevant where economic and social development are the top priorities.

Box 26
Important elements for reporting on sustainable development impacts in biennial update reports

- **Benefits** and potentially **negative impacts**
- **Intended** and **unintended** effects
- **Methods, tools** and **assumptions** used
- **Sources** for data and information used
- **Rationale** for the selection of the approach to reporting sustainable development impacts

4.6. REPORTING ON ECONOMIC AND SOCIAL CONSEQUENCES OF THE IMPLEMENTATION OF RESPONSE MEASURES

This section introduces the concept of economic and social consequences of response measures, the context within the UNFCCC and outlines reporting needs. The specific analysis underlying the reporting on economic and social consequences of the implementation of response measures may require specialized experts to review the transparency of reported information.

4.6.1. THE UNFCCC CONTEXT

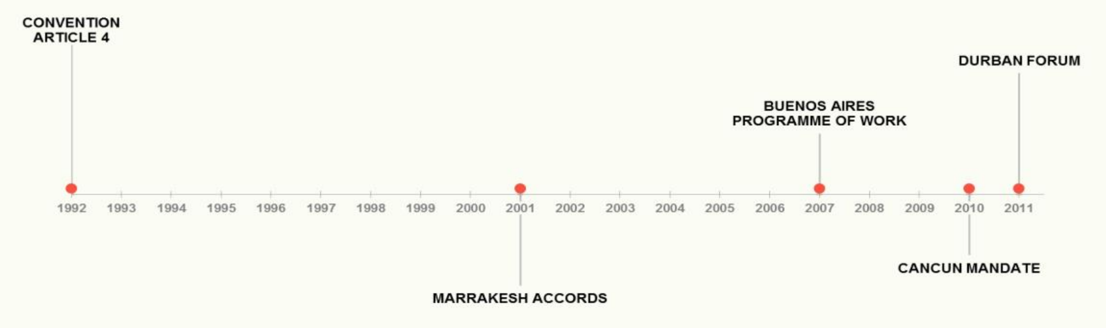
The basis for reporting on the impact of the implementation of response measures is Article 4, paragraph 8 of the Convention (United Nations, 1992):

> "*In the implementation of the commitments in this Article, the Parties shall give full consideration to what actions are necessary under the Convention, including actions related to funding, insurance and the transfer of technology, to meet the specific needs and concerns of developing country Parties arising from the adverse effects of climate change and/or the impact of the implementation of response measures…"*

In 2001 the Marrakesh Accords further detailed the implementation of Article 4, paragraph 8 of the Convention and provided the basis for further work FCCC/CP/2001/13/Add.1). The Conference of the Parties at its tenth session (COP

10) in Buenos Aires then decided a work programme related to response measures in decision 1/CP.10: The Buenos Aires programme of work on adaptation and response measures (FCCC/CP/2004/10/Add.1).

Figure 32
Time line of UNFCCC decisions related to impacts of response measures



Source: own illustration based on UNFCCC decisions

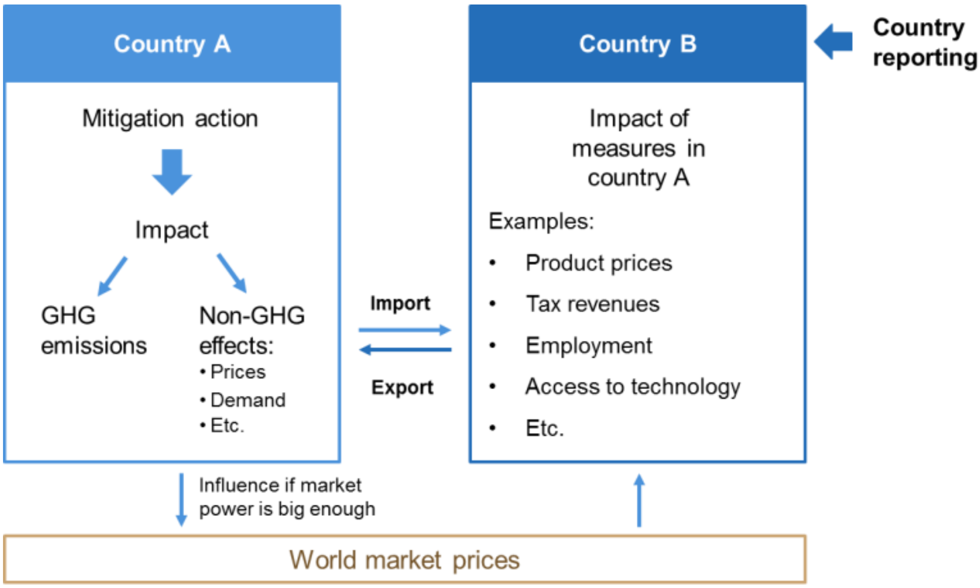
COP 16 in Cancun for the first time provided a mandate for a forum on the topic and the forum on the impact of the implementation of response measures was established the following year in Durban (FCCC/CP/2011/9/Add.2).[15]

4.6.2. THE CONCEPT OF IMPACTS OF THE IMPLEMENTATION OF RESPONSE MEASURES

The concept of analysing, reporting and addressing economic and social consequences of response measures to climate change, is based on the understanding that mitigation measures taken in one country can produce impacts in other countries. **Error! Reference source not found.** illustrates the basic dynamics.

[15] More information on the forum on the impact of the implementation of response measures is available at: <https://unfccc.int/cooperation_support/response_measures/items/7418.php>.

Figure 33
The concept of impacts of the implementation of response measures



Abbreviation: GHG = greenhouse gas.
Source: own illustration

Given the high level of global integration of most countries, activities in individual countries or groups of countries can have wider impacts.[16] Relatively direct impacts can take place through changed import and export structures. These can then have other, more indirect, effects within the trade partner country. Another potential impact can be on world market prices, for such products where a more or less uniform world market price exists. Depending on the market power of the country or group of countries, implementing mitigation measures can potentially influence world market prices.

4.6.3. IMPACT ASSESSMENT OF THE IMPLEMENTATION OF RESPONSE MEASURES

Impacts of the implementation of response measures can in principle be positive or negative, depending on the measure and the specific circumstances of different countries. Examples of types of impacts from response measures include (see **Error! Reference source not found.**):

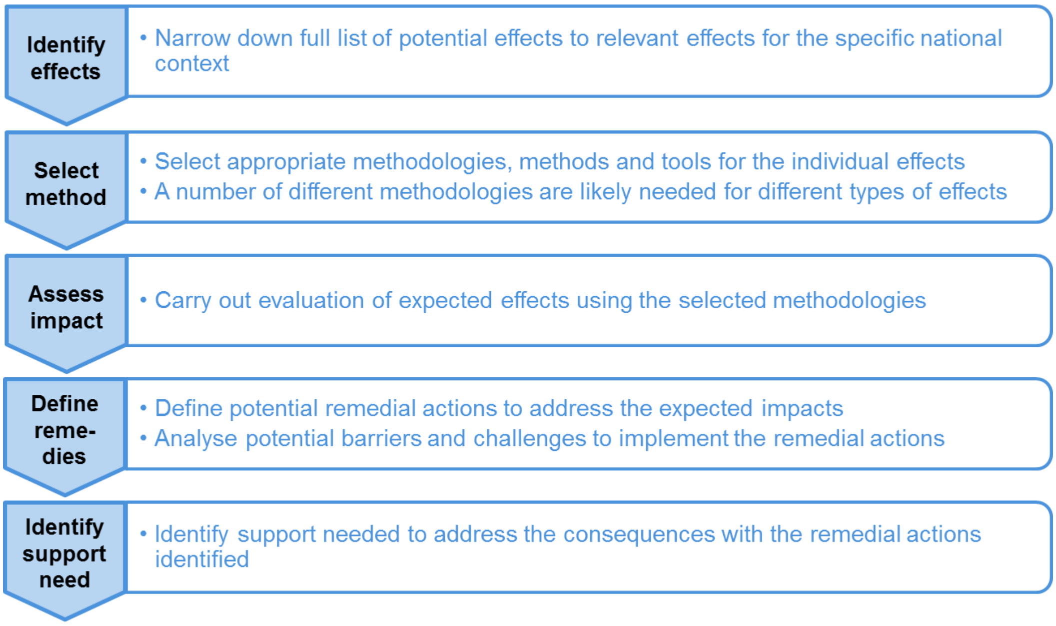
- Trade impacts;
- Fiscal impacts;
- Impact on investment;
- Employment;
- Access to technology.

[16] Information on mitigation actions taken by country A are assumed to be reported under the UNFCCC or made public in other ways, so that country B is aware of such actions.

The assessment process

Depending on the types of effects, a wide variety of methodologies, methods and tools can be used to evaluate impacts. The common denominator for this type of assessment is the process for carrying out the analysis, as illustrated in **Error! Reference source not found.**. The content of each of the steps will vary significantly, while all assessments should follow the steps as described.

Figure 34
Process for assessing impact of response measures



Source: own illustration

For individual steps very similar methodologies and tools to those described in sections 4.3 and 4.4 for the assessment of mitigation effects could be applied. For example, the causal chain can be useful in establishing the clear cause and effect relationship between actions and effects.

A key difference in the assessment compared to the evaluation of GHG impacts is the wide variety of effects and the additional steps required after impacts have been determined. A robust analysis should not stop at identifying and quantifying expected or experienced impacts, but should analyse ways to address them. This includes the identification of potential remedial actions, barriers and challenges in implementing them and support needs arising from them. Support needs could be of financial or technical nature or related to capacity constraints.

Box 27
Important elements for reporting on impacts of the implementation of response measures in biennial update reports

- **Qualitative** description of **expected impacts** from the implementation of response measures
- **Quantification** of expected impacts
- **Methods**, **tools** and **assumptions** used to determine quantified impacts
- **Remedies** identified to address expected impacts
- **Support requirements** to implement identified remedies

5. GUIDANCE ON DOMESTIC MEASUREMENT, REPORTING AND VERIFICATION ARRANGEMENTS

This chapter aims to provide guidance on important elements related to domestic measurement, reporting and verification (MRV) arrangements. Reporting on such arrangements is voluntary. However, if reported, information should be consistent with the requirements for domestic MRV of domestically supported nationally appropriate mitigation actions (FCCC/CP/2013/10/Add.2/Rev.1).

5.1. MEASUREMENT, REPORTING AND VERIFICATION OF MITIGATION ACTIONS

This section introduces the principles of the existing guidelines, some of the basic definitions and the rationale for domestic MRV arrangements.

5.1.1. PRINCIPLES

COP 19 in Warsaw adopted general guidelines for domestic MRV of domestically supported nationally appropriate mitigation actions by developing country Parties. They aim to provide guidance on voluntary use, based on the following principles:

> *"These guidelines are general, voluntary, pragmatic, non-prescriptive, non-intrusive and country-driven, take into account national circumstances and national priorities, respect the diversity of nationally appropriate mitigation actions (NAMAs), build on existing domestic systems and capacities, recognize existing domestic measurement, reporting and verification systems and promote a cost-effective approach."* (FCCC/CP/2013/10/Add.2/Rev.1)

The guidelines provide the basis for reporting on domestic MRV arrangements for mitigation actions within the biennial update report (BUR).

5.1.2. DEFINITIONS

Measurement, reporting, and verification are terms that refer to three key elements of the policy infrastructure needed to monitor and track progress of mitigation actions (Hogan et al., 2012):

5.1.2.1. Measurement

General definition: Direct measurement of impacts of efforts to address climate change, including the level of GHG emissions and removals, emission reductions and other co-benefits.

Measurement under the Convention for non-Annex I Parties: Such measurement occurs at the national level. Initially it referred to measurement of GHG emissions by sources and removals by sinks through the national greenhouse gas inventories, which are reported in national communications.

Based on the decisions[17] adopted at COP 16 and 17, non-Annex I Parties now need to measure the specific effects of national mitigation actions and the support received, and provide this information including a national inventory report, as part of their BURs.

5.1.2.2. Reporting

General definition: Presentation and transmission of data, measurements and associated analysis.

Reporting under the Convention for non-Annex I Parties: For non-Annex I Parties, reporting is implemented through the national communications and BURs.

Parties, are required to report on their actions to address climate change in the national communications,[18] which include information on:

- GHG inventories;
- Adaptation and mitigation actions and their effects;
- Support received.

5.1.2.3. Verification

General definition: Evaluation of the emission, abatement and other information that is measured and reported to ensure accuracy.

Verification under the Convention for non-Annex I Parties: For non-Annex I Parties this is addressed at the international level through the international consultation and analysis (ICA) of BURs, which is a mechanism to increase the transparency of mitigation actions and support received (decision 2/CP.17, annex IV and decision 20/CP.19).

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[17] Decision 1/CP.16 and 2/CP.17, annex III.

[18] National communications are to be submitted every four years and to be prepared following the guidance contained in the “Guidelines for the preparation of national communications from Parties not included in Annex I to the Convention” (decision 17/CP.8). BURs, to be submitted every two years, provide an update to the information presented in national communications and also include information on mitigation actions, needs and support received (decision 2/CP.17, annex III). The first round of submission is due by December 2014.

At the national level verification is implemented through domestic MRV mechanisms to be established by non-Annex I Parties, general guidelines for which were adopted in 2013 at COP 19.[19] Provisions for verification at the domestic level that are part of the domestic MRV system are to be reported in BURs. Special provisions have been adopted for verification of REDD-plus[20] activities.

5.1.3. WHY MEASUREMENT, REPORTING AND VERIFICATION FOR MITIGATION ACTIONS?

A robust MRV system can achieve many benefits beyond meeting an obligation under the international climate regime. It serves to support policymakers in multiple ways. Robust MRV allows the evaluation of progress on mitigation actions to enable corrective action where needed and thus ensures that efforts produce the best possible outcome. It informs future mitigation actions and supports the communication of successes – both domestically and internationally (Hogan et al., 2012).

Tracking more than greenhouse gas emissions

An MRV system to support mitigation actions goes beyond the GHG inventory to include tracking of progress on implementation:[21]

- **GHG inventory data**: Emissions data gathered within the national GHG inventory process is an important, but not sufficient, source of information. It provides ex-post information on total performance of the country, but does not provide insights into the effectiveness of individual measures or packages of measures.
- **Milestones for implementation**: Tracking implementation progress through milestones can be useful to assess by when effects can be expected or have started, and also to compare to original plans.
- **Progress indicators**: Tracking indicators as defined in a monitoring plan can help to keep track of developments and provide the basis for ex-post evaluation of mitigation actions.

Monitoring of mitigation measures therefore requires additional data as well as additional methodologies, compared to the monitoring of GHG emissions alone.

Continuous monitoring can combine the analysis steps described in sections 4.3 and 4.4 on ex-ante and ex-post assessments and allow for a rolling monitoring that tracks achieved progress to date. It can also be used to evaluate expected future impacts based on the latest available information. The type of information required therefore corresponds to the parameters identified for those types of assessments.

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[19] Decision 21/CP.19

[20] In decision 1/CP.16, paragraph 70, the Conference of the Parties encouraged developing country Parties to contribute to mitigation actions in the forest sector by undertaking the following activities: reducing emissions from deforestation; reducing emissions from forest degradation; conservation of forest carbon stocks; sustainable management of forests; and enhancement of forest carbon stocks.

[21] See section 3.3 for a discussion on progress indicators and section 4.4 for a discussion on progress of implementation.

5.2. ELEMENTS OF MEASUREMENT, REPORTING AND VERIFICATION ARRANGEMENTS

This section introduces different important elements of MRV arrangements.

Guidelines on domestic MRV arrangements were agreed in Warsaw at COP 19 (FCCC/CP/2013/10/Add.2/Rev.1). From these and from experience a number of important elements for effective MRV arrangements can be identified:

- **Institutions**: Defining which institutions are involved in domestic MRV activities, what their respective roles and responsibilities are, how they should interact, how they should intervene in case of problems and who bears overall responsibility.
- **Processes**: Defining the overall process of collecting, processing, reporting and verifying data. This includes determining which role individual institutions play within this process.
- **Methodologies and tools**: Identifying which methodologies and tools are used to collect, process and store data (see section 4.1).

Each of the elements, which are further elaborated below requires a tailor made solution that fits the national context. Nevertheless, all elements should be addressed within domestic MRV arrangements to enable an effective domestic monitoring of activities.

Box 28
Key elements for good practice measurement, reporting and verification arrangements

Transparency: Provide clear and sufficient information on data sources, data flows, aggregation methods and on the institutional set-up.

Comparability: Enable comparison of data across time and across mitigation actions. Where feasible comparability to other countries can be useful to benchmark own performance.

Reliability: Degree to which sources, data collection methods and verification procedures used to obtain the data are dependable and sustainable over time.

Usefulness: Data should be relevant for the purpose and serve the decision-making needs of users.

Timeliness: To allow relevance for policymaking and potentially corrective actions, data should be made available in a timely manner.

Completeness: The degree to which the collected data is statistically representative of or calculated data covers the relevant activity. Data gaps should be clearly identified.

Source: Based on Hogan et al. (2012); WRI (2014a).

5.2.1. INSTITUTIONS

The institutional arrangements for MRV are fundamental to ensure that nationally appropriate procedures for collecting, processing, reporting and archiving required data and information are established. They assist countries to (UNFCCC, 2013a):

- Meet reporting requirements under the Convention;
- Further build national capacities and ensure sustainability of MRV processes;
- Inform national and international policymakers, at different levels;
- Assist in institutionalizing activities relating to MRV of climate change actions.

The institutional setup created for the GHG inventory is in most cases the most appropriate starting point for MRV of mitigation actions. This can ensure that existing expertise is utilized, but bears the danger of overloading available capacities, if this is not adequately addressed. Depending on the exact indicators to be tracked, additional institutions may need to be involved, or a broadening of scope for data collection of institutions within the inventory process may be sufficient.

Responsibility for data collection and processing is often distributed across a range of different institutions, based on sectoral expertise, geographic coverage and technical expertise. To create a well-functioning institutional system, experiences show that important elements are (Gonzanlez Miguez, 2012; UNFCCC, 2013b): [22]

- A solid, sustainable network of institutions with the required variety of expertise;
- Clear responsibilities with a single body assigned for overall coordination;
- Good coordination and clear lines of communication;
- Continuity of staff and succession planning;
- A high level of ownership by the participating stakeholders;
- Limited reliance on external consultants and experts.

Guidance for the setup of institutional arrangements has been provided by the Consultative Group of Experts (CGE) as part of the updated CGE training materials for BURs (UNFCCC, 2013b), and the resource guide for preparing national communications for non-Annex I Parties (UNFCCC, 2013c). A template for reporting institutional arrangements is also part of this training material package (UNFCCC, undated c).

[22] For further discussion on institutional setup and case studies see: MAPT National GHG Inventory Case Study Series. Available at: <https://sites.google.com/site/maptpartnerresearch/national-ghg-inventory-case-study-series>.

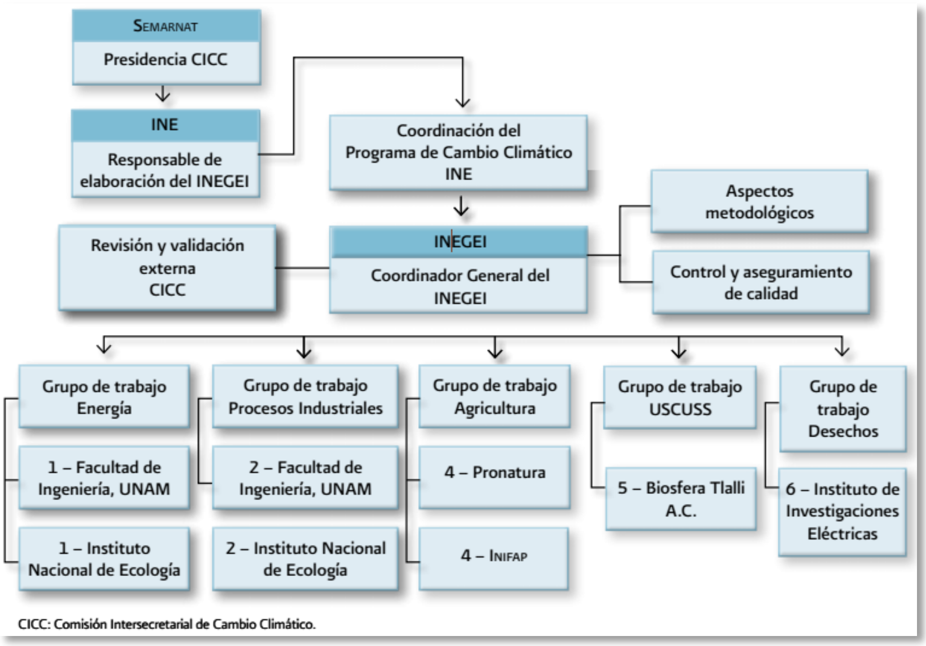
Box 29

Examples of reporting on the institutional setup for the greenhouse gas inventory

The two examples below show different ways to report on the institutional arrangements for the development of a greenhouse gas (GHG) inventory or, in the case of South Africa, the operation of the software tool used for GHG data management. They provide not only examples for different ways of reporting, one graphical, one tabular, but also provide different levels of detail and information.

To provide an overview of involved institutions, the graphical presentation is very useful. A tabular format can then supplement this information with more detail on responsibilities. Flow charts that illustrate the information flows can also be a useful additional tool.

Mexico: organizational chart



South Africa: tabular format

Role / Responsibility	National					Provincial					District/Metro				Local			
	AQO	Staff	Auditor	Compliance Officer	Viewer	AQO	Staff	Auditor	Compliance Officer	Viewer	AQO	Staff	Auditor	Viewer	AQO	Staff	Auditor	Viewer
Create Authority User	X	X				X					X				X			
Create Facility User	X	X				X	X				X	X			X	X		
Manage Sources	X	X				X	X				X	X			X	X		
Review/Assign Master List Source	X	X				X	X				X	X			X	X		
Review Master List Source	X	X				X	X				X	X			X	X		
Approve Master List Source	X	X				X	X				X	X			X	X		
e-notify Master List Source	X	X				X	X				X	X			X	X		
Audit/Assign Audit	X	X				X	X				X	X			X	X		
Audit Only	X		X					X					X				X	
Issue compliance	X	X		X		X	X		X		X	X			X	X		
System Configuration	X																	
View Only					X					X								X

Source: Comisión Intersecretarial de Cambio Climático (2012).

5.2.2. PROCESS FOR MEASUREMENT, REPORTING AND VERIFICATION OF MITIGATION ACTIONS

In line with requirements for the GHG inventory, MRV of mitigation actions requires processes in place that ensure that all relevant functions are carried out at the right time, by the appropriate institutions. **Error! Reference source not found.** provides an overview of the key stages involved in the arrangements for a sustainable MRV setup.

Figure 35
Key stages of sustainable institutional arrangements

PLANNING	Appointing teams, identifying contributing organizations	Establishing coordination mechanisms, agreeing to approval process	Planning funding allocation and budget, etc
PREPARATION	Holding first coordination meeting, consulting stakeholders, agreeing to milestones and timelines	Overseeing schedule and milestones, holding check-in meetings	Collecting and validating any relevant data
REPORTING	Reviewing first drafts	Compiling and finalizing all information, editing and creating document, preparing for approval process and submission	
DOCUMENTING AND ARCHIVING	Establishing procedures to ensure regular and systematic documentation and archiving in order to enhance transparency and ensure sustainability of the process		
EVALUATION	Identifying lessons learned, strengths and weaknesses, opportunities for improvement		
NATIONAL CONSULTATION PROCESS	Validation of the report through consultation with national stakeholders		
APPROVAL AND SUBMISSION	Getting the report approved by relevant approving government authority and submitting it to the UNFCCC secretariat		

Source: UNFCCC (2013a).

The individual elements of these stages can also be seen as a learning cycle as illustrated in **Error! Reference source not found.**. This cycle details individual steps in planning and preparation, and includes the following steps:

- **Planning and preparation** of the institutional arrangements, including appointing the teams, establishing responsibilities and allocating the budget on a sustainable basis, not ad-hoc or annual;
- **Selection** of appropriate methodologies, methods and tools;
- **Collection** of data from different sources;
- **Processing** of data using the selected methods and tools to aggregate to defined categories and geographic levels;
- **Reporting** of results within a coherent document, including the required documentation and archiving of data and information;
- **Verification** of results though formal verification or consultation with national stakeholders;

- **Learning** from experiences, based on an evaluation of lessons learned, strengths and weaknesses, to identify opportunities for continuous improvement.

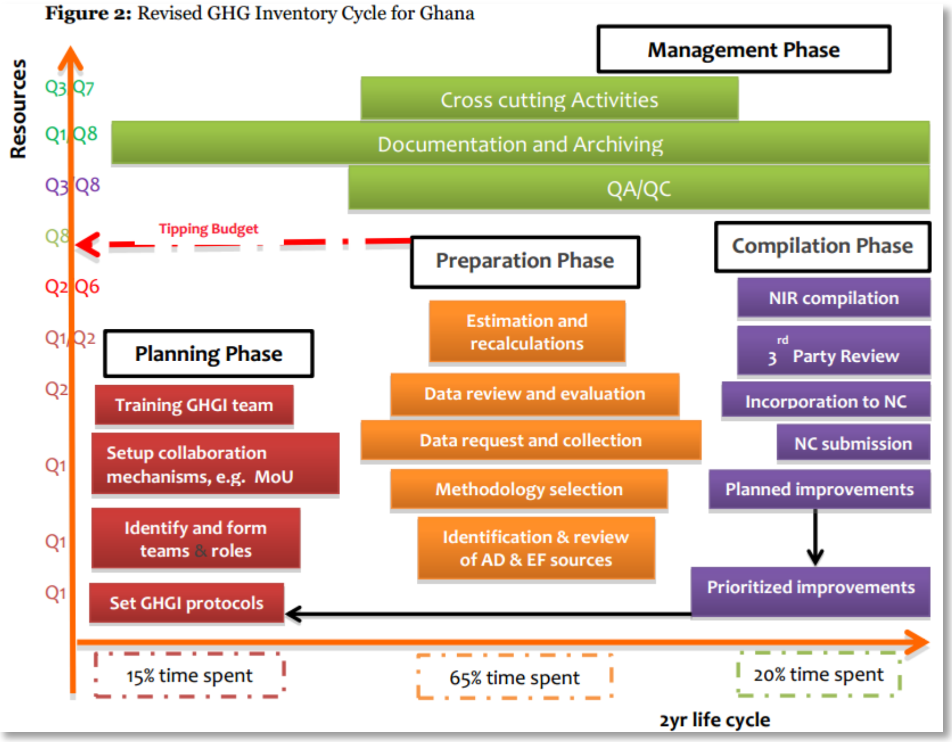
Box 30

Example of reporting on the process for developing the greenhouse gas inventory

Revised greenhouse gas inventory cycle for Ghana

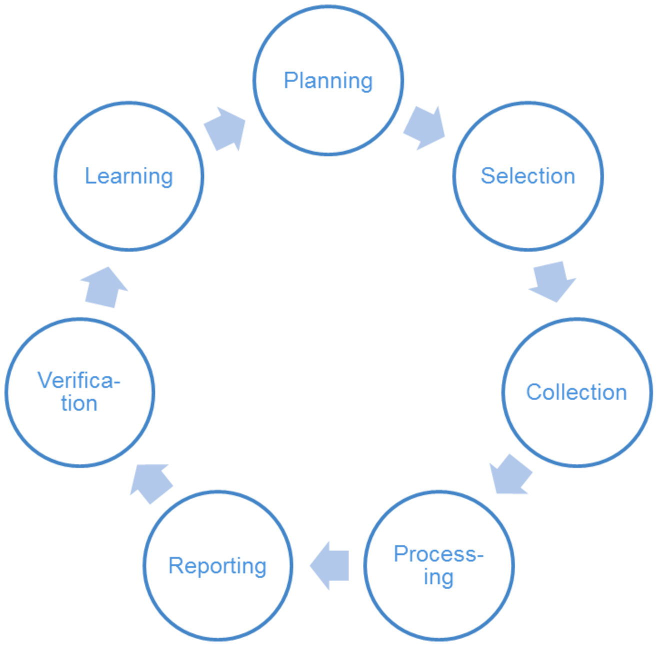
The graph below shows a visualization of the inventory preparation planning for Ghana. It divides the steps into different phases and includes the feedback-loop that allows lessons learned to impact the design of the subsequent cycle.

Figure 2: Revised GHG Inventory Cycle for Ghana



Source: Baffoe (2014).
Abbreviations: AD = activity data, EF = emission factors, NC = national communication QA/QC = Quality assurance/quality control, ,

Figure 36
Process cycle for measurement, reporting and verification of mitigation actions



Source: Based on Manzini et al. (2013); UNFCCC (undated b)

Frequency of monitoring

Regular monitoring will support policymakers and enhance understanding of cause and effect relationships between mitigation actions and their impacts. More frequent monitoring activities also help to build institutional capacity by allowing rapid learning from past experiences and continuous refinement of processes and methodologies used (UNFCCC, undated d).

The process requires resources in terms of availability of involved personnel as well as financial and technical resources. These resources may not be readily available in developing countries, and even with international support, the specific capacities required may need time to develop. The frequency of monitoring activities will thus largely depend on the specific country context.

To ensure a meaningful and robust MRV system countries should strive to establish regular monitoring with a frequency adjusted to the available resources. Such a regular system can then over time be increased in frequency, with increasing availability of resources and increasing needs.

Quality assurance and quality control

QA/QC is an important element in enhancing the confidence of decision makers and stakeholders in the reported results and is encouraged. QA/QC processes are required for different steps within the overall monitoring cycle, including data collection, processing and reporting. The difference compared to verification normally lies in the question of who carries out the quality assessment. QA/QC processes are normally carried out internally, by other departments or agencies involved in the preparation process, while verification is classically carried out externally, by external experts or national stakeholders. Reporting on the QA/QC processes in place enhances confidence in the results of the analysis.

Box 31
Setting up a monitoring plan

A useful tool for the planning of MRV activities for mitigation actions is to create a monitoring plan. This plan defines a number of important process and methodology related issues, such as:

Planning and preparation:

- Entity(ies) or person(s) responsible for monitoring activities and roles and responsibilities of relevant personnel;
- Competencies required and any training needed to ensure personnel have necessary skills;

Selection of methodologies:

- Monitoring frequency;
- Units of measure;
- Whether the data is measured, modelled, calculated or estimated; the level of uncertainty in any measurements or estimates; and how this uncertainty will be accounted for;
- Sampling procedures (if applicable);
- Methods for generating, storing, collating and reporting data on monitored parameters;
- Databases, tools or software systems to be used for collecting and managing data;

Collection of data:

- Sources of data (either existing data sources or additional data collected specifically to monitor the indicators);

Processing of data:

- Procedures for internal auditing, quality assurance and quality control (QA/QC);
- Record keeping and internal documentation procedures needed for QA/QC, including responsibilities, locations and length of time the data will be archived;

Verification:

- Whether the data is verified, and if so, verification procedures used;
- Any other relevant information.

Source: Based on WRI (2014c).

Box 32
Useful information on domestic measurement, reporting and verification arrangements

Useful information to facilitate the sharing of information and best practices could include:

- Overall **description** of the institutional arrangements, including location, coordination and engagement processes, and the governmental and nongovernmental stakeholders involved;
- **Relationship** to the broader climate change development process and other institutional arrangements related to the Convention;
- Any **lessons learned** or recommended practices, including recruiting and maintaining a permanent national coordinating body, etc.;
- Description of any **adjustments** or changes made to existing or new institutional arrangements as a result of biennial update reports;
- **Cost implications** of the institutional arrangement process;
- Any **capacity-building needs** undertaken as part of the institutional arrangements process;
- **Constraints and gaps**, and related financial, technical and capacity needs, including a description of the support needed and received.

Source: UNFCCC (2013d).

6. INFORMATION ON INTERNATIONAL MARKET MECHANISMS

This chapter provides an overview of international market mechanisms and outlines how they influence the effects of mitigation actions in developing countries. Experts should be able to evaluate what kind of information is required. This information should enable the experts to understand the potential impact of such mechanisms on the achieved or expected effects that are reported from the mitigation actions. While the focus is on international mechanisms, this chapter will also explore the role of regional and national market-based mechanisms and their impact on the results of mitigation actions in developing countries.

6.1. OVERVIEW OF INTERNATIONAL MARKET MECHANISMS

6.1.1. CHARACTERISTICS OF INTERNATIONAL MARKET MECHANISMS

Market mechanisms are instruments used to control GHG emissions by putting a price on these emissions. All market mechanisms rely on a fixed cap on emissions for a given area. The scope of this area can be at an economy-wide level or only cover certain sectors.

A variety of different market mechanisms exist, but all have certain characteristics in common:

- **A cap on emissions** for a given combination of area and sectoral scope. This can be at a country level or cover a subnational region or groups of countries or regions. All national emissions can be addressed or only selected sectors within the economy;
- **Generation of units** represented by tonnes of emitted GHG emissions, which allows the control of the cap to be achieved and enables trade between covered entities (states or installations);
- **A price for emissions** that develops from the demand and supply of units;
- **A set of rules and regulations** that govern the mechanism and determine participants, eligibility for trading, issuance and management of units, accounting, etc.

6.1.2. TYPES OF MARKET MECHANISMS

Market mechanisms can take different forms, depending on who is creating the mechanism, who is participating and what the scope and main purpose of the mechanism is. There are different types of market mechanisms:

International emissions trading is a mechanism established under the Convention. It is one of the three Kyoto mechanisms, by which an Annex I Party may transfer Kyoto Protocol units to, or acquire units from, another Annex I Party. An Annex I Party must meet specific eligibility requirements to participate in emissions trading (UNFCCC, undated a). Participants are thus Parties with a quantified emission reduction target. The goal is to limit total emissions of the group to a specified level, but allow flexibility between countries as to who achieves the required reductions, thus taking advantage of regional differences in cost for emission reductions. Emissions accounting and trading happens at the country level.

International offset mechanisms are also established under the Convention and include the clean development mechanism (CDM) and joint implementation (JI). In contrast to emission trading the two mechanisms work at the project level.

The clean development mechanism allows industrialized countries to a meet a part of their emission reduction targets under the Kyoto Protocol. The mechanism is established in Article 12 of the Kyoto Protocol with a dual purpose (United Nations, 1998):

> *The purpose of the clean development mechanism shall be to assist Parties not included in Annex I in achieving sustainable development and in contributing to the ultimate objective of the Convention, and to assist Parties included in Annex I in achieving compliance with their quantified emission limitation and reduction commitments under Article 3.*

Box 33
Sustainable development impacts of international market mechanisms

To enhance the effects on sustainable development of the clean development mechanism (CDM) a tool to voluntarily report sustainable development impacts of CDM projects or programmes was developed. This tool, as well as other options to assess and report impacts on sustainable development, is discussed in section 4.5. This section will therefore concentrate on the information requirements to understand the interaction of international market mechanisms with the greenhouse gas impacts of reported mitigation actions within the biennial update report.

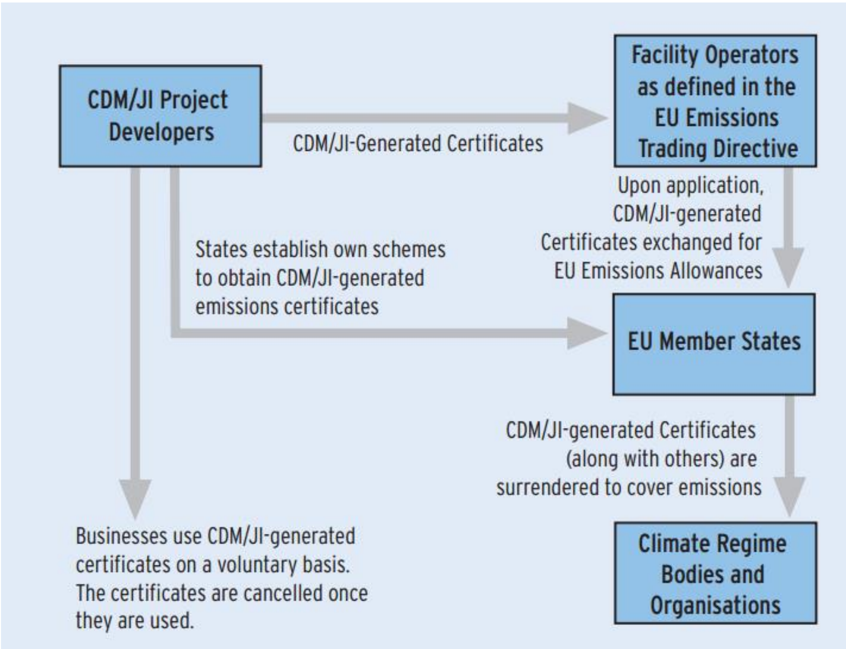
The CDM generates certified emission reduction (CER) credits, each equivalent to one tonne of CO_2, by implementing emission reduction projects in developing countries. These CERs can be traded and sold, and used by Parties towards meeting their target. All credits issued under the CDM are tracked in the CDM registry (UNFCCC, undated e).

Over time, sources for demand of CERs have diversified. The mechanism was originally established to support fulfilment of obligations of Parties under the Kyoto Protocol. Additional demand for CERs has also come from offset provisions of domestic cap and trade schemes. Voluntary offsetting by private entities has started to create further demand for CERs. Abbreviations: CDM/JI = clean development mechanism/Joint implementation, EU = European

illustrates these different demand sources using the EU as an example (Sterk & Arens, 2010).

Overall demand has largely been dominated by the European Union Emissions Trading System (EU-ETS), with Japan as the next major buyer to fulfil their obligations under the first commitment period of the Kyoto Protocol (Kachi, Taenzler & Sterk, 2012). Although the mechanism is an element of the Kyoto Protocol, developing countries engaged in CDM activities should report this in their BUR to avoid the double counting of emissions (see also section 6.2).

Figure 37
Example of different demand segments within the European Union



Source: Sterk & Arens (2010).
Abbreviations: CDM/JI = clean development mechanism/Joint implementation, EU = European

Joint implementation enables emission reduction offset projects between developed country partners. It follows similar procedures and has a similar setup to the CDM. The difference is in the partners involved. As the mechanism doesn't apply to developing countries it is only mentioned here for the sake of completeness and is not explained further.

Box 34
The principle of offsets

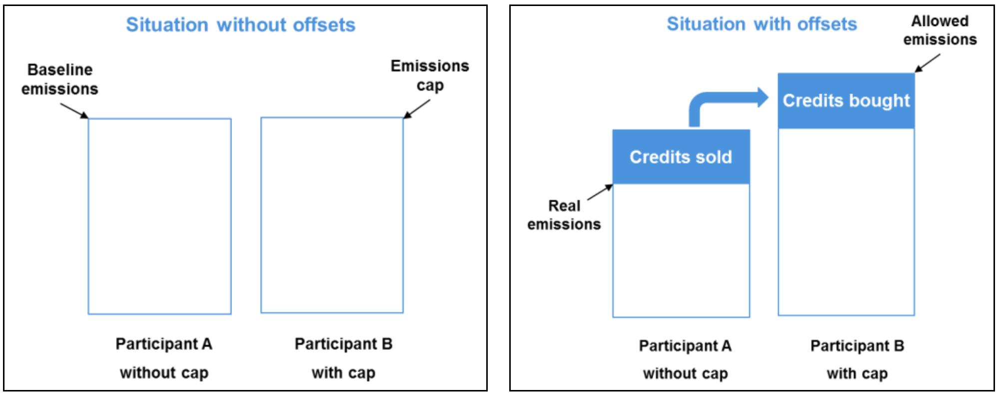
Offsets allow each tonne of emission reduction achieved in one area to justify one tonne of emissions in another area. This is illustrated in **Error! Reference source not found.**. In total, these activities thus have no net benefit for the atmosphere and do not contribute to reducing global emissions. The relevant area can be:

> **Geographic**: like for example the Clean Development Mechanism (CDM), where emission reductions in developing countries allow emissions above the allocated assigned amount for industrial countries;

> **Sectoral**: like for example domestic offset schemes, where emission reductions in a sector not covered by a cap and trade system can be used to allow emissions above the allocated amount in the capped sectors. An example for this is the Australian Emissions Trading System with its Carbon Farming Initiative.

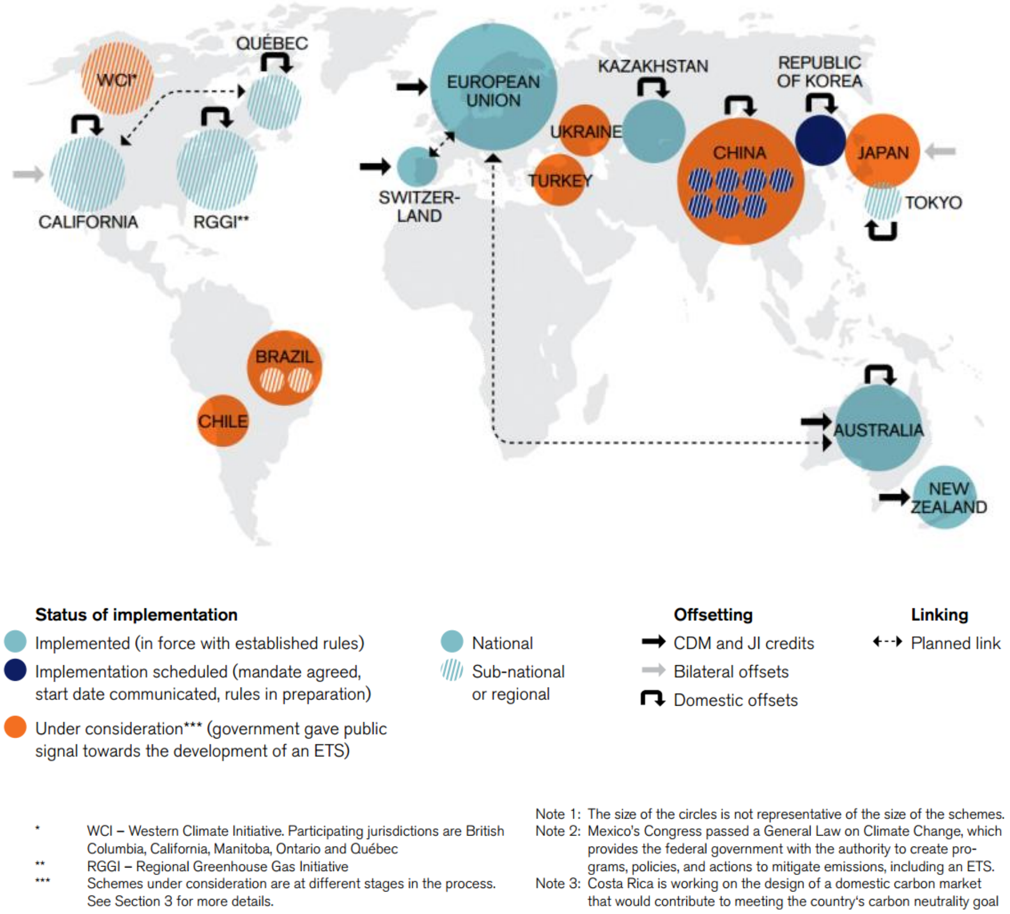
The purpose of offsets is not to reduce global emissions, but mainly to enable emission reductions that are set through other mechanisms or are on a voluntary basis to achieve their targets at lower cost.

The principle of offsets



Domestic or regional emission trading systems are established by the respective governments. A wide range of such trading systems currently exists, is emerging or is under consideration (see Figure **38**) (Höhne et al., 2013). Participants are determined individually and usually cover a set of high emitting sectors in the countries or regions. Like international emissions trading the purpose of the mechanism is to cap total emissions covered under the scheme. Emissions accounting happens at installation level and is normally aggregated at the level of the mechanism in a central registry. As with international mechanisms, it is important to understand the potential impact of such systems on the achieved or expected results of mitigation actions reported in BURs. This is especially important, if the systems include elements of trading or offsetting.

Figure 38
Map of existing, emerging and potential emission trading schemes



Source: Höhne et al. (2013).

Apart from in-built offset mechanisms as discussed below, emission trading schemes are increasingly working towards linking the different schemes, which enables units to be traded across systems. So far such linkages are only established between different systems in industrialized countries, but could potentially also be established between developing country systems or across industrialized and developing country systems.

Bilateral offset mechanisms are similar to domestic offset mechanisms but promote emission reduction projects in other countries, rather than domestically. Most of these project activities are likely to be placed in developing countries, due to the often lower cost of emission reductions. In this sense, bilateral offset mechanisms could be termed ‘bilateral CDM’. The level of use of such mechanisms would likely be driven by demand, although host countries would determine the amount of credits transferred. Rules are either determined by the country generating the demand or are mutually agreed.

6.1.3. EMERGING MECHANISMS

So far, developing countries have only been involved in market-based mechanisms that are generating offsets. Although these mechanisms also aim to support sustainable development in the host countries, they have not contributed to the joint effort to further reduce emissions. Complementing other means of support for nationally appropriate mitigation actions, the Parties to the Cancun Agreements decided to *"consider the establishment of one or more market-based mechanisms… to promote"*, amongst others, *"a net decrease and/or avoidance of global greenhouse gas emissions."* (FCCC/CP/2010/7/Add.1) At the same time the effort was meant to become broader than the project-based mechanisms and address "broad segments of the economy" (FCCC/CP/2010/7/Add.1).

COP 17 in Durban defined a new market mechanism (NMM) and established a work programme to elaborate modalities and procedures for the mechanism FCCC/CP/2011/9/Add.1), which was then detailed a year later at Doha FCCC/CP/2012/8/Add.1).

The main differences to currently established mechanisms are:

- The mechanism contains an offsetting component and a component that aims to achieve a net decrease and/or avoidance of GHG emissions;
- The scope is broader and aims to address a larger share of national emissions.

Additionally there are a number of open issues related to the governance of the mechanism:

- There is yet no agreed rule set to govern the mechanism and no agreement on whether to follow a centralized approach, as for the CDM, or a more decentralized approach;
- It is unclear whether established governance structures will be utilized to manage the new mechanism and whether the management will continue to be centralized or will take a more decentralized approach.

So far, there has been no agreement on the exact structure of the new mechanism. A range of different options have been proposed by Parties and have been discussed in the literature. Table **15** provides an overview of the proposed types of new mechanisms.

Table 15
Types of proposed new mechanisms

		What	Proposed by
Project based	Individual performance approach	Similar to CDM and JI	China, Japan
Sectoral crediting	Group performance approach	Decoupled from specific activities, credits are awarded if emissions from sector are kept below a predefined level	AOSIS, EU, Norway, Papua New Guinea
Sectoral	Group performance	Decoupled from specific activities or	AOSIS, EU, Norway,

		What	Proposed by
trading	approach	policies, allowances are issued ex-ante based on a sectoral target, with penalty for missing target	Papua New Guinea
NAMA crediting	Group or individual performance approach	Crediting of specific NAMAs based on sectoral thresholds	Republic of Korea (Switzerland)

Abbreviations: AOSIS = Alliance of Small Island States, CDM = Clean Development Mechanism, EU = European Union, JI = joint implementation, NAMA = nationally appropriate mitigation action.
Source: Wehnert, Harms & Sterk (2013).

There are many design options for each of the proposed types of mechanism and each has their advantages and disadvantages, depending on the criteria evaluated.[23] Most of them, however, have the common feature that they present relatively complex systems, and that interaction with other, non-market based national mitigation actions remains difficult to assess. The next section will explore these interactions in more detail.

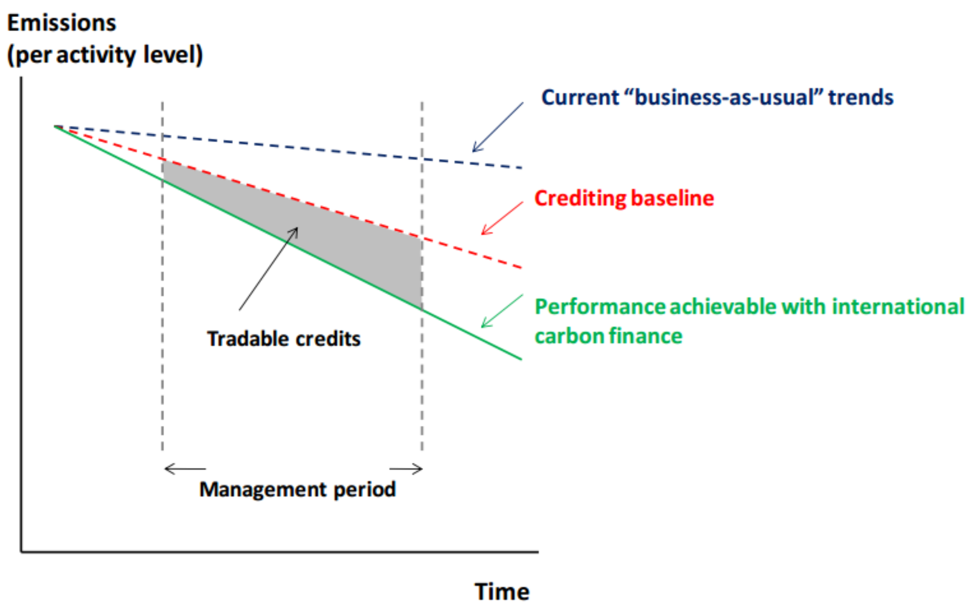
[23] The discussions on the different concepts, especially sectoral concepts, has a long history. Some of the basic concepts were discussed as early as 2007. For more detail on individual concepts see for example Baron, Buchner & Ellis (2009); Bradley et al. (2007); Wehnert, Harms & Sterk (2013).

Box 35
Market mechanisms and baselines

A number of market mechanisms require the setting of baselines to determine the amount of emission reduction units issued. This includes the Clean Development Mechanism, domestic and bilateral offsets, as well as most potential new market mechanisms, except sectoral trading, where the target could be set using a baseline, but could also be otherwise determined.

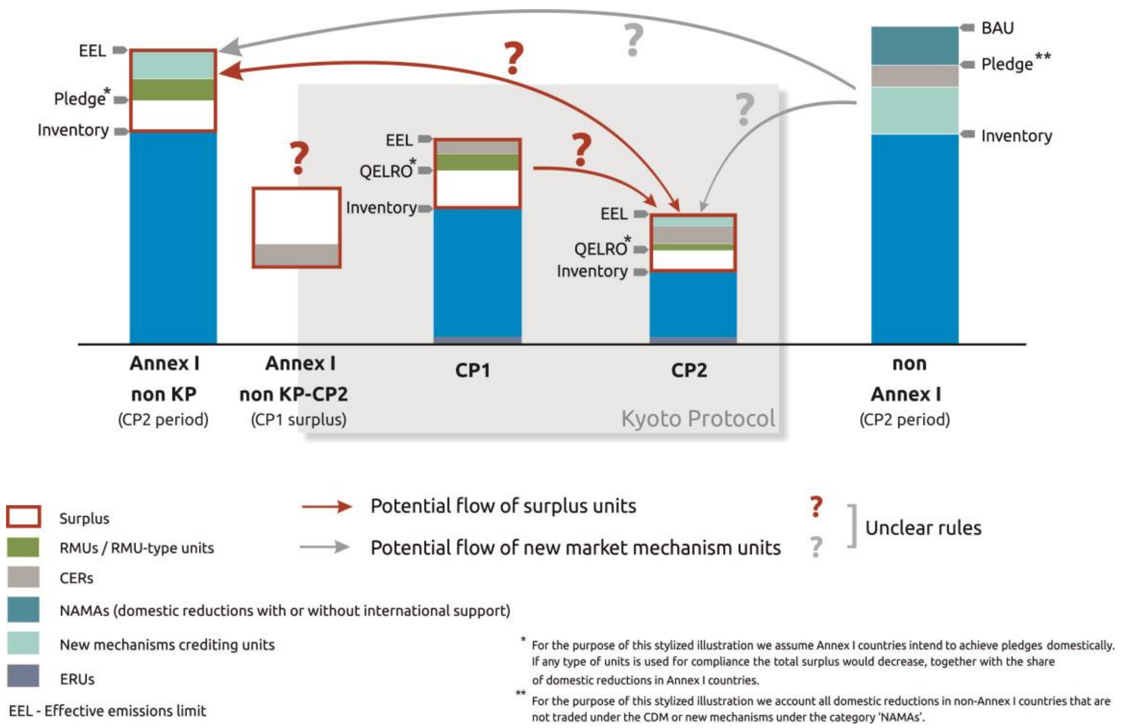
Error! Reference source not found. illustrates an example of developing an ambitious baseline for sectoral crediting. For the development and reporting of baselines used for crediting, international rules and regulations will need to be developed. The steps outlined in section 4.2 will need to be followed with the highest degree of accuracy and the highest level of detail that is feasible and be supplemented by additional guidance. Only this will generate the required confidence, by all involved Parties, that actual emission reductions are achieved with the mechanism.

The principle of setting a crediting baseline



Together with the already existing system of mechanisms and units, potential new units coming from new market mechanisms provide a complex picture of how units could interact and impact the overall environmental effectiveness of the UNFCCC – especially with the lack of clarity around rules. Figure 39 provides an overview of this situation. The illustration cannot cover all intricacies, but aims to demonstrate the complexity of the situation. Non-UNFCCC mechanisms further complicate this picture.

Figure 39
Schematic overview of potential units' interaction in the second commitment period of the Kyoto Protocol



Abbreviations: BAU = business as usual, CER = certified emission reductions, CP = commitment period, EEL = effective emissions limit, ERU = emission reduction unit, KP = Kyoto protocol, QELRO = quantified emission limitation and reduction objectives, RMU = removal unit,

Source: Vieweg et al. (2012).

6.2. INTERACTION WITH NATIONAL MITIGATION EFFORTS

The Durban decisions emphasized the need to ensure real reductions from market mechanisms (see 2/CP.17, para 79 below). This provides the foundation for the need to report on international market mechanisms and provides the benchmark for analysis.

> *[2/CP.17, paragraph 79]*
>
> *………*
>
> *Emphasizes that various approaches, including opportunities for using markets, to enhance the cost-effectiveness of, and to promote, mitigation actions, bearing in mind different circumstances of developed and developing countries, must meet standards that deliver real, permanent, additional and verified mitigation outcomes, avoid double counting of effort, and achieve a net decrease and/or avoidance of greenhouse gas emissions;*
>
> *………*

Already today we see systems in existence or emerging, with differences in rules and regulations, creating potential overlaps. Problems arise if activities overlap in sectoral and geographic coverage. This happens for example if a country decides to implement a mitigation action at the sectoral scale for waste management across the entire country, while project-based activities are addressing individual installations within the same sector.

The negotiations on the Framework for various approaches (FVA) aim to address such concerns. The purposes of the framework, as outlined in a note by the co-chairs of the contact group, is, among others (SBSTA, 2013):

- To regulate the international transfer of units and outcomes;
- To facilitate, build, assess and compare existing and emerging approaches;
- To promote the robust functioning of the carbon market;
- To track and record mitigation and avoidance units and outcomes;
- To avoid double counting;
- To ensure environmental integrity.

Ensuring a well-functioning carbon market and securing the environmental integrity of this market are the key objectives for the FVA, determining the different purposes as outlined in the co-chair’s note. Double counting is the most prominent effect discussed to ensure the environmental integrity of mechanisms and many of the potential purposes of the FVA are linked to avoiding double counting. However, further aspects of the interaction of market mechanisms with the results of national mitigation actions require some discussion. The unclear nature of mitigation actions, as well as new market mechanisms, creates a complex matrix of potential interactions.

Double counting compromises the environmental effectiveness of mitigation activities. It describes a situation where emission reductions are attributed twice. There are different situations in which this can occur (Kollmuss, Fuessler & Herren, 2013):

- **Reductions result in more than one unit**: One tonne of reduced GHG emissions could be credited under different offset mechanisms, for example under the CDM, bilateral offset mechanisms and/or NMM;

- **Reductions are counted by host and buyer country**: emission reductions achieved under an offset mechanism could be counted towards both host country and buying country reduction efforts. Within the CDM this is theoretically not possible due to the central registry, where attribution of credits is clear. Some developing countries have, however, indicated their intention to use international market mechanisms towards meeting their pledge;
- **Credits are counted towards mitigation and support obligations**: Buying countries could count the funds used to buy international credits towards their obligation to contribute to financial support for developing countries, as well as towards their mitigation target. There are different views on the legitimacy of this form of double counting.

Box 36
Units within market mechanisms

The following examples provide insight into the complexity of the landscape of different units generated within different systems.

Units under the UNFCCC

Assigned Amount Units (AAU). A Kyoto Protocol unit equal to 1 tonne of carbon dioxide equivalent (CO_2e). Each Annex I Party issues AAUs up to the level of its assigned amount, established pursuant to Article 3, paragraphs 7 and 8, of the Kyoto Protocol. Assigned amount units may be exchanged through emissions trading.

Emission Reduction Units (ERU). A Kyoto Protocol unit equal to 1 t CO_2e. ERUs are generated for emission reductions or removals from joint implementation projects.

Certified Emission Reductions (CER). A Kyoto Protocol unit equal to 1 t CO_2e. CERs are issued for emission reductions from Clean Development Mechanism (CDM) project activities. Two special types of CERs, called temporary certified emission reductions (tCERs) and long-term certified emission reductions (lCERs) are issued for emission removals from afforestation and reforestation CDM projects.

Removal Units (RMU). A Kyoto Protocol unit equal to 1 t CO_2e. RMUs are generated in Annex I Parties through land use, land-use change and forestry activities that absorb CO_2.

Examples of offset units generated outside the UNFCCC

Voluntary Emission Reductions (VER). Verified emission reductions are commonly understood as tradable emission reductions that have been generated according to defined standards and requirements other than the Kyoto Protocol. Such credits are usually used by organizations, companies, businesses and private stakeholders to offset some or all of their emissions.

Joint Crediting Mechanism (JCM) Credits. Credits generated under the Joint Crediting Mechanism established by the Government of Japan. The credits generated in host countries are intended to transfer greenhouse gas reduction technologies and contribute to the achievement of Japan's emission reduction target.

Examples of compliance units generated outside the UNFCCC

European Emission Allowances (EUA). General allowances issued under the European Union Emissions Trading System (EU-ETS) representing 1 t CO_2e of emissions allowed for fixed installations and used for compliance under the EU-ETS.

European Aviation Allowances (EUAA). EU-ETS allowances applying to the aviation sector, used for compliance under the EU-ETS.

New Zealand Units (NZU). Allowances issued under the New Zealand ETS, representing 1 t CO_2e of emissions, used for compliance under the New Zealand ETS system.

Sources: European Commission (undated); Government of New Zealand (undated); Ministry of the Environment, Japan (2014); TÜV Süd (undated); UNFCCC (undated a).

As there are yet no internationally agreed rules on how to avoid double counting, transparent reporting on all forms of participation in market-based mechanisms is essential. This includes information on the type of mechanism, in which role a country participated (host or buyer), and the amount and price of units.

Impact of market mechanisms on results of national mitigation actions

To ensure that the provisions of decision 2/CP.17, paragraph 79 (see above) are met, action should be taken to ensure that market mechanisms generate real reductions and avoid double counting. There are various options available to do this: such activities can be excluded from the assessment boundary for mitigation actions in the host country, or if included in the boundary, credits or units transferred can be deducted from the total impact estimated. This applies to existing mechanisms as well as NMMs and a potential future linking of emission trading involving developing countries.

NMMs are envisaged to encompass elements that constitute a contribution of the host country. These ‘own contributions’ are results of mitigation actions of the host country and should be reported in the BUR of the host country. The new mechanism will need to clarify methodologies for this differentiation and for reporting. The first pilot schemes that may become operational over the next years, will likely not yet have clear guidance and should aim to provide clear information on the two different elements and methodologies used to determine the own contribution.

Impact of national mitigation actions on market-based mechanisms

At the same time, we must consider the effect of mitigation actions at a broader economy-wide or sectoral scale on market mechanisms. In particular, policy-based mitigation actions will likely influence the framework for most project-based activities. They impact the baselines for such activities and will likely make projects less attractive for investment, as the additionality aspect of the credits decreases (Jung et al., 2010).[24]

National circumstances, types of mitigation actions and different forms of market mechanisms create a complex situation, where no general assessment of impacts is possible. An individual analysis is needed of the impacts of mitigation actions on existing or new market mechanisms operating in the same area.

[24] The attractiveness of market-based mechanisms also highly depends on the price for credits. Additional market mechanisms, especially mechanisms aimed at increasing the scale of actions, will likely increase the supply of credits. Unless this additional supply is met by an increased demand, prices would be further reduced, thus further reducing the incentives for investment within the market mechanisms (Kollmuss, Fuessler & Herren, 2013; Schneider & Cames, 2012).

Box 37

Important elements for reporting on international market mechanisms in biennial update reports

- The type(s) of market mechanism a country engages in
- The type of activity, i.e. project-based or other, for example sector-based
- A short description of activities carried out under the mechanism
- The sector(s) covered under the mechanism
- Expected and achieved impacts of activities
- Expected and realized use of generated credits
- Implementing **partners**

GLOSSARY

Activities: When used as a type of indicator: the administrative activities involved in implementing the mitigation action (undertaken by the authority or entity that implements the policy or action), such as permitting, licensing, procurement or compliance and enforcement. Examples include energy audits and provision of subsidies.

Activity data: A quantitative measure of a level of activity that results in greenhouse gas emissions. Activity data is multiplied by an emissions factor to derive the greenhouse gas emissions associated with a process or an operation. Examples of activity data include kilowatt-hours of electricity used, quantity of fuel used, output of a process, hours equipment is operated, distance travelled and floor area of a building.

Article 4: An article of the Convention stipulating general commitments assumed by all Parties, developing or developed.

Article 12: An article of the Convention that describes the how Parties are to communicate information related to implementation of the Convention.**Baseline emissions**: An estimate of greenhouse gas emissions, removals, or storage associated with a baseline scenario.

Baseline scenario: A reference that aims to represent likely developments under a given policy framework as accurately as possible.

Baseline value: The value of a parameter in the baseline scenario.

Biennial update reports (BURs): A report submitted by Parties not included in Annex I to the Convention, which provide updates on actions undertaken by the Party to implement the Convention, including the status of its greenhouse gas emissions and removals by sinks, as well as actions to reduce emissions or enhance sinks.

Bottom-up data: Data that is measured, monitored or collected (for example, using a measuring device such as a fuel meter) at the source, facility, entity or project level.

Bottom-up methods: Methods (such as engineering models) that calculate or model the change in greenhouse gas emissions for each source, project or entity, then aggregate across all sources, projects or entities to determine the total change in greenhouse gas emissions.

Business as usual: Assumes that future development trends follow those of the past and no changes in policies will take place.

Calculated data: Data calculated by multiplying activity data by an emission factor, for example, calculating emissions by multiplying natural gas consumption data by a natural gas emission factor.

Capacity-building: In the context of climate change, the process of developing the technical skills and institutional capability in developing countries and economies in transition, to enable them to address and report effectively on the implementation of the Convention.

Causal chain: A conceptual diagram tracing the process by which the mitigation action leads to greenhouse gas effects through a series of interlinked logical and sequential stages of cause and effect relationships.

CO_2 equivalent (CO_2e): The universal unit of measurement to indicate the global warming potential of each greenhouse gas, expressed in terms of the global warming potential of one unit of carbon dioxide. It is used to evaluate different greenhouse gases against a common basis.

Conference of the Parties (COP): The supreme body of the Convention. It currently meets once a year to review the Convention's progress. The word ‘conference’ is not used here in the sense of ‘meeting’ but rather of ‘association’. The ‘Conference’ meets in sessional periods, for example, the ‘fourth session of the Conference of the Parties’.

Consultative Group of Experts on National Communications from non-Annex I Parties (CGE) : A expert group constituted under the Convention, with representation from Annex I and non-Annex I Parties as well as relevant international organizations, to provide technical advice and support to non-Annex I Parties on the process of and preparation of national communications and biennial update reports and also build the capacity of technical experts nominated by Parties to undertake technical analysis of biennial update reports under the international consultation and analysis process.

Drivers: Socioeconomic or other conditions or other policies or actions that influence the level of emissions or removals. For example, economic growth is a driver of increased energy consumption. Drivers that affect emissions activities are divided into two types: other policies or actions and non-policy drivers.

Dynamic: A descriptor for a parameter (such as an emission factor) that changes over time.

Effects: Changes that result from a mitigation action. See intermediate effects, greenhouse gas effects, and non-greenhouse gas effects.

Emission factor: A factor that converts activity data into greenhouse gas emissions data. For example, kg CO_2e emitted per litre of fuel consumed.

Emissions: The release of greenhouse gases and/or their precursors into the atmosphere over a specified area and period of time.

Emissions estimation method: An equation, algorithm or model that quantitatively estimates greenhouse gas emissions. For example, a simple emissions estimation method is the following equation: greenhouse gas emissions = emission factor × activity data. An emissions estimation method is comprised of parameters.

Estimated data: In the context of monitoring, proxy data or other data sources used to fill data gaps in the absence of more accurate or representative data sources.

Ex-ante assessment: The process of estimating expected future greenhouse gas effects of mitigation actions.

Ex-ante baseline scenario: A forward-looking baseline scenario, typically established prior to implementation of the mitigation action, based on forecasts of external drivers (such as projected changes in population, economic activity or other drivers that affect emissions), in addition to historical data.

Expert judgment: A carefully considered, well-documented qualitative or quantitative judgment made in the absence of unequivocal observational evidence by a person or persons who have a demonstrable expertise in the given field.

Ex-post assessment: The process of estimating historical greenhouse gas effects of mitigation actions.

Ex-post baseline scenario: A backward-looking baseline scenario that is established during or after implementation of the mitigation action.

Global warming potential (GWP): An index representing the combined effect of the differing times greenhouse gases remain in the atmosphere and their relative effectiveness in absorbing outgoing infrared radiation.

Greenhouse gas assessment: The estimation of changes in greenhouse gas emissions and removals resulting from a mitigation action, either ex-ante or ex-post.

Greenhouse gas assessment boundary: The scope of the assessment in terms of the range of greenhouse gas effects (and non- greenhouse gas effects, if relevant), sources and sinks, and greenhouse gases that are included in the assessment.

Greenhouse gas assessment period: The time period over which greenhouse gas effects resulting from the mitigation action are assessed.

Greenhouse gas effects: Changes in greenhouse gas emissions by sources and removals by sinks that result from a mitigation action.

Greenhouse gases (GHGs): The atmospheric gases responsible for causing global warming and climate change. The major GHGs are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Less prevalent – but very powerful – GHGs are hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride (SF_6).**Implementation:** Actions (legislation or regulations, judicial decrees, or other actions) that governments take to translate international accords into domestic law and policy.

Implementation period: The time period during which the mitigation action is in effect.

In-jurisdiction effects: Effects that occur inside the geopolitical boundary over which the implementing entity has authority, such as a city boundary or national boundary.

Indicator: See key performance indicator. **Inputs**: Resources that go into implementing a mitigation action, such as financing.

Intended effects: Effects that are intentional based on the original objectives of the mitigation action.

Interacting actions: Policies that produce total effects, when implemented together, that differ from the sum of the individual effects had they been implemented separately.

Intergovernmental Panel on Climate Change (IPCC): Established in 1988 by the World Meteorological Organization and the United Nations Environment Programme, the IPCC surveys worldwide scientific and technical literature and publishes assessment reports that are widely recognized as the most credible existing sources of information on climate change. The IPCC also works on methodologies and responds to specific requests from the Convention's subsidiary bodies. The IPCC is independent of the Convention.

Intermediate effects: Changes in behaviour, technology, processes or practices that result from a mitigation action.

International consultation and analysis (ICA): A process under the Convention, whereby the biennial update reports from developing country Parties are considered, through a technical analysis and a facilitative sharing of views, in manner that is non-intrusive, non-punitive and respectful of national sovereignty. It aims to increase transparency of mitigation actions and their effects.

Jurisdiction: The geographic area within which an entity's (such as a government's) authority is exercised.

Kyoto Protocol: An international agreement standing on its own, and requiring separate ratification by governments, but linked to the UNFCCC. The Kyoto Protocol, among other things, sets binding targets for the reduction of greenhouse gas emissions by industrialized countries.

Land use, land-use change, and forestry (LULUCF): A greenhouse gas inventory sector that covers emissions and removals of greenhouse gases resulting from direct human-induced land use, land-use change and forestry activities.

Leakage: An increase in emissions outside the jurisdictional boundary that results from a mitigation action implemented within that jurisdiction.

Long-term effects: Effects that are more distant in time, based on the amount of time between implementation of the mitigation action and the effect.**Macroeconomic effects**: Changes in macroeconomic conditions – such as gross domestic product, income, employment, or structural changes in economic sectors –resulting from the mitigation action.

Market effects: Changes in supply and demand or changes in prices resulting from the mitigation action.

Measured data: Direct measurement, such as directly measuring emissions from a smokestack.

Measurement, reporting and verification (MRV): A process/concept that entails reporting by Parties on their actions to implement the Convention, which are subjected to international verification, with a view to facilitate discussions on such implementation. The reporting and verification are undertaken on the basis of relevant guidelines adopted by the Conference of the Parties.

Mitigation: In the context of climate change, a human intervention to reduce the sources or enhance the sinks of greenhouse gases. Examples include using fossil fuels more efficiently for industrial processes or electricity generation, switching to solar energy or wind power, improving the insulation of buildings, and expanding forests and other 'sinks' to remove greater amounts of carbon dioxide from the atmosphere.

Mitigation actions: Activities that are expected to affect the emissions sources and sinks included in the GHG assessment boundary. These actions can be framed around economy-wide, sectoral or technology goals

Modelled data: Data derived from quantitative models, such as models representing emissions processes from landfills or livestock.

Model uncertainty: Uncertainty resulting from limitations in the ability of modelling approaches, equations or algorithms to reflect the real world.

Monitoring period: The time over which the mitigation action is monitored. This may include pre-action monitoring and post-action monitoring in addition to monitoring during the implementation period.

Montreal Protocol: The Montreal Protocol on Substances that Deplete the Ozone Layer, an international agreement adopted in Montreal in 1987.

National communication: A document submitted in accordance with the Convention (and the Protocol) by which a Party informs the Conference of Parties of activities undertaken to address climate change. Most developed countries have now submitted their fifth national communications; most developing countries have completed their second national communication and are in the process of preparing their third.

Nationally appropriate mitigation actions (NAMAs): At COP 16 in Cancun in 2010, it was agreed that developing countries will undertake nationally appropriate mitigation actions in the context of sustainable development, supported and enabled by technology, financing and capacity-building, aimed at achieving a deviation in greenhouse gas emissions relative to 'business as usual' emissions in 2020.

Net greenhouse gas emissions: The aggregation of greenhouse gas emissions (positive emissions) and removals (negative emissions).

Non-Annex I Parties: Parties not included in Annex I to the Convention, who are mostly developing countries.

Non-greenhouse gas effects: Changes in environmental, social, or economic conditions other than greenhouse gas emissions or climate change mitigation that result from a mitigation action, such as changes in economic activity, employment, public health, air quality and energy security.

Non-policy drivers: Conditions other than policies and actions, such as socioeconomic factors and market forces, that are expected to affect the emissions sources and sinks included in the greenhouse gas assessment boundary. For example, energy prices and weather are non-policy drivers that affect demand for air conditioning or heating.

Normalization: A process to make conditions from different time periods comparable, which may be used to compare policy effectiveness by removing fluctuations not influenced by the mitigation action, such as weather variations.

Other policies or actions: Policies, actions and projects – other than the mitigation action being assessed – that are expected to affect the emissions sources and sinks included in the greenhouse gas assessment boundary.

Out-of-jurisdiction effects: Effects that occur outside the geopolitical boundary over which the implementing entity has authority, such as a city boundary or national boundary.

Parameter: A variable such as activity data or an emission factor that is part of an emissions estimation method. For example, 'emissions per kilowatt-hour of electricity' and 'quantity of electricity supplied' are both parameters in the equation '0.5 kg CO_2e/kWh of electricity × 100 kWh of electricity supplied = 50 kg CO_2e'.

Parameter value: The value of a parameter. For example, 0.5 is a parameter value for the parameter 'emissions per kilowatt-hour of electricity'.

Parameter uncertainty: Uncertainty regarding whether a parameter value used in the assessment accurately represents the true value of a parameter.

Party: A state (or regional economic integration organization such as the European Union) that agrees to be bound by a treaty and for which the treaty has entered into force.

Peer-reviewed: Literature (such as articles, studies or evaluations) that has been subject to independent evaluation by experts in the same field prior to publication.

Performance/progress indicator: A metric that indicates the performance of a policy or action, such as tracking changes in targeted outcomes. For example, the quantity of wind power generated in a country may be used as an indicator for a production tax credit for wind power.

Policy scenario: A scenario that represents the events or conditions most likely to occur in the presence of the mitigation action (or package of mitigation actions) being assessed. The policy scenario is the same as the baseline scenario except that it includes the mitigation action (or package of actions) being assessed.

Policy scenario emissions: An estimate of greenhouse gas emissions and removals associated with the policy scenario.

Propagated parameter uncertainty: The combined effect of each parameter's uncertainty on the total result.

Protocol: An international agreement linked to an existing convention, but as a separate and additional agreement which must be signed and ratified by the parties to the convention concerned. Protocols typically strengthen a convention by adding new, more detailed commitments.

Proxy data: Data from a similar process or activity that is used as a stand-in for the given process or activity.

Rebound effect: Increases in energy-using activities or behaviour resulting from energy efficiency improvements.

Regression analysis: A statistical method for estimating the relationships among variables (in particular, the relationship between a dependent variable and one or more independent variables).

Reinforcing actions: Mitigation actions that interact with each other and that, when implemented together, have a combined effect, greater than the sum of their individual effects when implemented separately.

Removal: Removal of greenhouse gas emissions from the atmosphere through sequestration or absorption, such as when CO_2 is absorbed by biogenic materials during photosynthesis.

Scenario: A plausible description of how the future might develop, based on a coherent and internally consistent set of assumptions ('scenario logic') about the key relationships and driving forces (e.g. rate of technology change or prices).

Scenario uncertainty: Variation in calculated emissions resulting from methodological choices, such as selection of baseline scenarios.

Sensitivity analysis: A method to understand differences resulting from methodological choices and assumptions and to explore model sensitivities to inputs. The method involves varying the parameters to understand the sensitivity of the overall results to changes in those parameters.

Short-term effects: Effects that are nearer in time, based on the amount of time between implementation of the action and the effect.

Sink: Any process, activity or mechanism which removes a greenhouse gas, an aerosol or a precursor of a greenhouse gas from the atmosphere.

Source: Any process or activity which releases a greenhouse gas, an aerosol or a precursor of a greenhouse gas into the atmosphere.

Spillover effect: Out-of-jurisdiction effects that reduce emissions outside the jurisdictional boundary, or effects that amplify the result but are not directly driven by the mitigation action being assessed (also called multiplier effects).

Static: A descriptor for a parameter (such as an emission factor) that does not change over time.

Sustainable development: Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

Team of technical experts (TTE): A team of technical experts drawn from the UNFCCC roster of experts, responsible for conducting the technical analysis of biennial update reports from non-Annex I Parties under the international consultation and analysis process.

Technical analysis: The first part of the international consultation and analysis process, which aims to ensure that the information reported in a biennial update report is transparent. It is conducted by a team of technical experts, guided by the relevant provisions and principles of the Convention and modalities and guidelines contained in the decisions of the COP. A summary report is the outcome of this first part of the international consultation and analysis.

Technology transfer: A broad set of processes covering the flows of know-how, experience and equipment for mitigating and adapting to climate change among different stakeholders.

Top-down data: Macro-level statistics collected at the jurisdiction or sector level, such as energy use, population, gross domestic product or fuel prices.

Top-down methods: Methods (such as econometric models or regression analysis) that use statistical methods to calculate or model changes in greenhouse gas emissions.

Transparency: In the context of the technical analysis, refers to openness and clarity in the communication of information, to enable others to see, understand and replicate the information reported within the biennial update report.

Uncertainty: 1. Quantitative definition: Measurement that characterizes the dispersion of values that could reasonably be attributed to a parameter. 2. Qualitative definition: A general term that refers to the lack of certainty in data and methodology choices, such as the application of non-representative factors or methods, incomplete data on sources and sinks, or lack of transparency.

Unintended effects: Effects that are unintentional based on the original objectives of the mitigation action. Unintended effects may include a variety of effects, such as rebound effects, lack of compliance or enforcement, effects on behaviour once a mitigation action is announced but before it is implemented, and effects on members of society not targeted by the mitigation action.

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