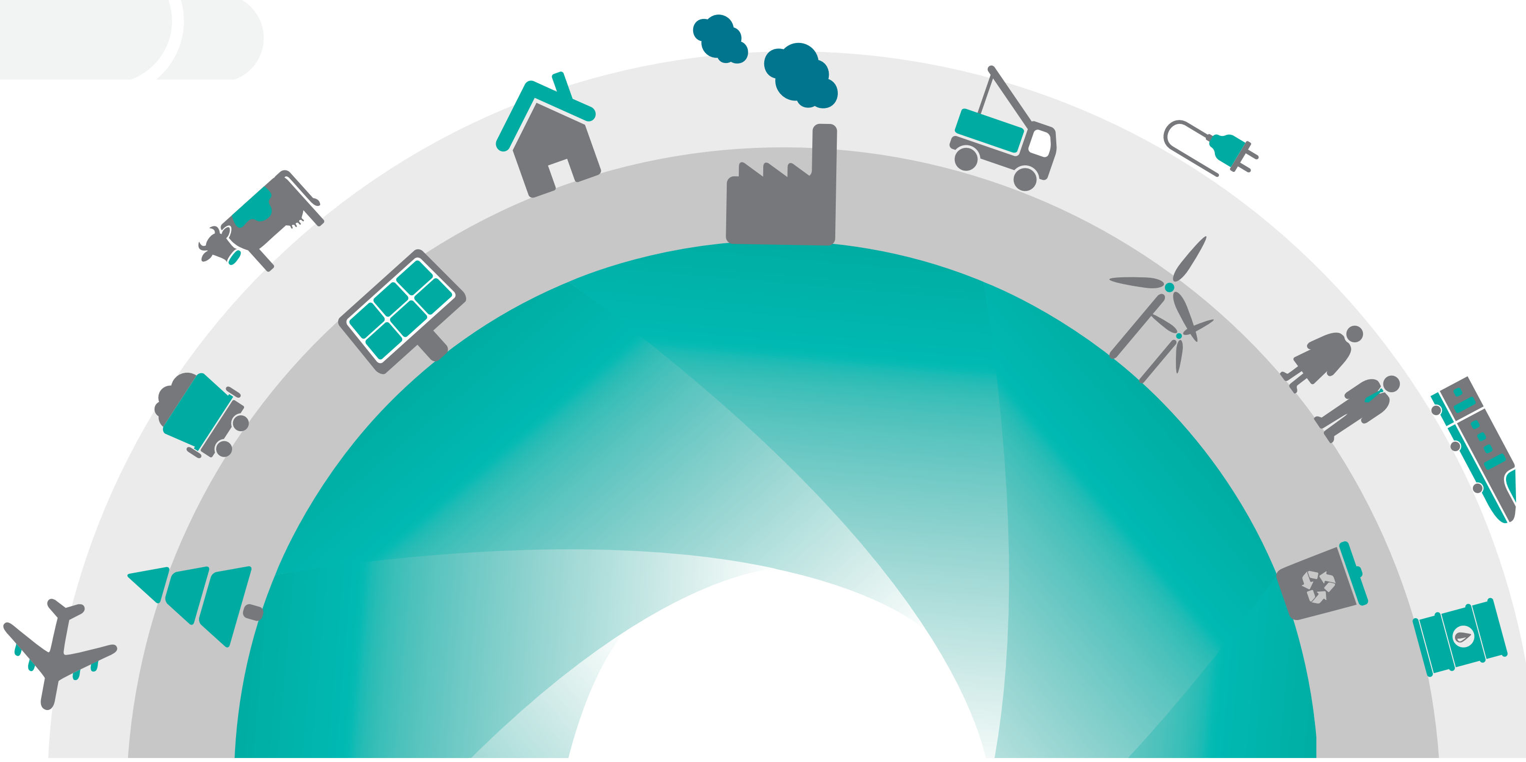
GREENHOUSE GAS PROTOCOL

# Policy and Action Standard

*An accounting and reporting standard for estimating the greenhouse gas effects of policies and actions*



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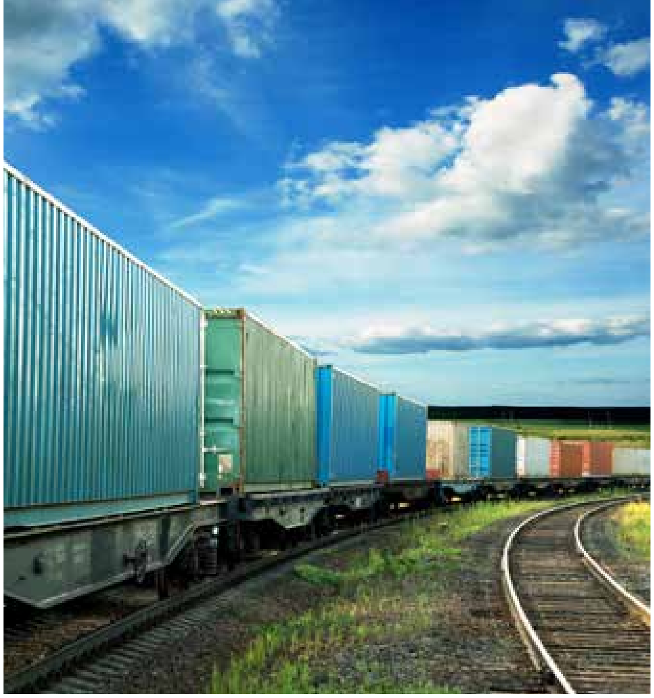


# 1 Introduction

**Greenhouse gas (GHG) emissions are driving climate change and its impacts around the world. According to climate scientists, global greenhouse gas emissions must be cut by as much as 72 percent below 2010 levels by 2050 to have a likely chance of limiting the increase in global mean temperature to 2 degrees Celsius above preindustrial levels (IPCC 2014). Every degree increase in temperature will produce increasingly unpredictable and dangerous impacts for people and ecosystems. As a result, there is an urgent need to accelerate efforts to reduce GHG emissions.**

National and subnational governments, financial institutions, and private sector organizations are planning and implementing a variety of policies and actions to reduce GHG emissions. As they do so, they are seeking to assess and communicate the effects of policies and actions on GHG emissions—both before adoption to inform the design of policies and actions and after implementation to understand whether the intended effects were achieved.

## 1.1 Purpose of this standard

The GHG Protocol *Policy and Action Standard* provides a standardized approach for estimating and reporting the change in GHG emissions and removals resulting from policies and actions.

This standard helps answer the following questions:

- What effect is a given policy or action likely to have on GHG emissions in the future?
- Is a given policy or action on track and delivering expected results?
- What effect has a given policy or action had on GHG emissions?

The standard was developed with the following objectives in mind:

- To help users assess the GHG effects of specific policies and actions in an accurate, consistent, transparent, complete, and relevant way
- To help policymakers and other decision makers develop effective strategies for managing and reducing GHG emissions through a better understanding of the emissions impacts of policies and actions

- To support consistent and transparent public reporting of emissions impacts and policy effectiveness[1]
- To create more international consistency and transparency in the way the GHG effects of policies and actions are estimated

## 1.2 How the standard was developed

This standard was developed by the Greenhouse Gas Protocol (GHG Protocol). The GHG Protocol is a multistakeholder partnership of businesses, NGOs, governments, academic institutions, and others convened by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD). Launched in 1998, the mission of the GHG Protocol is to develop internationally accepted GHG accounting and reporting standards and tools, and to promote their adoption in order to achieve a low emissions economy worldwide. All GHG Protocol standards and guidance are available at www.ghgprotocol.org.

In June 2012, WRI launched a two-year process to develop the *Policy and Action Standard*. A 30-member Advisory Committee provided strategic direction throughout the process. The first draft of the *Policy and Action Standard* was developed in 2012 by two Technical Working Groups consisting of over 50 members, then reviewed by members of a Review Group, including during three stakeholder workshops. In 2013, the second draft was pilot tested on 27 policies and actions in 20 countries and cities across a range of sectors to determine how the standard worked in practice. Pilot countries included Bangladesh, Belgium, Chile, China, Colombia, Costa Rica, Germany, India, Indonesia, Israel, Japan, Mexico, South Africa, South Korea, Tunisia, the United Kingdom, and the United States. The standard was revised based on pilot testing feedback and circulated for public comment in July 2014.

## 1.3 Intended users

This standard is intended for a wide range of organizations and institutions. The primary intended users are analysts and policymakers assessing government policies and actions at any level, including national, state, provincial, or municipal. Other intended users include donor agencies and financial institutions, research institutions, non-governmental organizations, and businesses. Throughout this standard, the term "user" refers to the entity implementing the standard.

The following examples show how different types of users can use the standard:

- **Governments:** Estimate the GHG effects of planned policies and actions to inform decision making, monitor progress of implemented policies and actions, and retrospectively evaluate GHG effects to learn from experience.
- **Donor agencies and financial institutions:** Estimate the GHG effects of finance provided, such as grants or loans to support GHG reductions and low emissions development strategies.[2]
- **Businesses:** Estimate GHG effects of private sector actions larger than individual projects, such as company-wide energy efficiency programs implemented by electric utilities; voluntary commitments; implementation of new technologies, processes, or practices; or private sector financing and investment.[3]
- **Research institutions and NGOs:** Estimate the GHG effects of any of the above types of policies or actions to assess performance or provide support to decision makers.

## 1.4 Applicability of the standard

In this standard, "policies" and "actions" refer to interventions taken or mandated by a government, institution, or other entity, and may include laws, directives, and decrees; regulations and standards; taxes, charges, subsidies, and incentives; information instruments; voluntary agreements; implementation of new technologies, processes, or practices; and public or private sector financing and investment.

The terms "policy" and "action" may refer to interventions at various stages along a policy-making continuum, from (1) broad strategies or plans that define high-level objectives or desired outcomes (such as increasing energy efficiency by 20 percent by 2020); to (2) specific policy instruments to carry out a strategy or achieve desired outcomes (such as an energy efficiency standard for appliances); to (3) the implementation of technologies, processes, or practices (sometimes called "measures") that result from policy instruments (such as the replacement of old appliances with more efficient ones).

This standard is primarily designed to assess specific policy instruments and the implementation of technologies, processes, or practices (at a scale larger than an individual project). Users that intend to assess the effects of broad strategies or plans, such as low emissions development plans or strategies framed in terms of desired outcomes, should first define the individual policy instruments or technologies, processes, or practices that will be implemented to achieve the strategy or plan. Broad strategies or plans can be difficult to assess since the level of detail needed to estimate GHG effects may not be available without further specificity, and different policies or actions used to achieve the same goal could have different GHG effects.

The standard is applicable to policies and actions:

- At any level of government (national, subnational, municipal) in all countries and regions
- In any sector (such as agriculture, forestry, and other land use [AFOLU]; energy supply; industry; residential and commercial buildings; transportation; or waste) as well as cross-sector policy instruments (such as emissions trading programs or carbon taxes)
- Intended to mitigate GHG emissions or intended to achieve objectives unrelated or contrary to climate change mitigation (but that have an effect, either positive or negative, on GHG emissions)
- That are planned, adopted, or implemented, or are extensions, modifications, or eliminations of existing policies or actions

This standard may be useful for estimating the GHG effects of nationally appropriate mitigation actions (NAMAs) that are framed as policies or programs, as well as policies and measures under the United Nations Framework Convention on Climate Change (UNFCCC).[4]

Users should follow project-level methodologies such as *The GHG Protocol for Project Accounting* (2005) for actions at the level of an individual mitigation project. Section 1.9 provides more information on projects.

## 1.5 Scope of the standard

This standard includes steps related to estimation of GHG effects, as well as specific steps on monitoring, reporting, and verification. It details a general process that users should follow when conducting an assessment, but it does not prescribe specific calculation methodologies, tools, or data sources.

The standard includes both requirements and guidance. The requirements represent the accounting and reporting steps that users must follow if they choose to implement the standard and wish to report that their assessment is in conformance with it. Users may choose to implement the standard in part rather than in full. However, users must follow all applicable accounting and reporting requirements in order for the assessment to be in conformance with the standard.

The standard is policy-neutral.[5] It does not provide guidance on what type of policy or action to implement but only how to estimate the emissions effects associated with its implementation.

The standard covers both ex-ante assessment—the estimation of expected future GHG effects of a policy or action—and ex-post assessment—the estimation of historical GHG effects of a policy or action.

## 1.6 When to use the standard

The standard may be used at multiple points in time throughout a policy[6] design and implementation process, including:

- **Before policy implementation:** To estimate expected future effects of a policy or action (through ex-ante assessment)
- **During policy implementation:** To estimate achieved effects to date, ongoing performance of key performance indicators, and expected future effects of a policy or action
- **After policy implementation:** To estimate what effects have occurred as a result of a policy or action (through ex-post assessment)

Depending on individual objectives and when the standard is applied, users may implement the steps related to ex-ante assessment, ex-post assessment, or both. The most comprehensive approach is to apply the standard first before implementation, annually (or regularly) during policy implementation, and again after implementation. Users carrying out an ex-ante assessment only may skip Chapters 10 and 11. Users carrying out an ex-post assessment only may skip Chapter 9.

Figure 1.1 outlines a sequence of steps to monitor and assess GHG effects at multiple stages in a policy design and implementation process. In this example, the process is iterative, whereby policy development is informed by previous experience. Figure 1.1 is an example only. Not all steps may be relevant to all users.

## 1.7 Considerations for implementing the standard

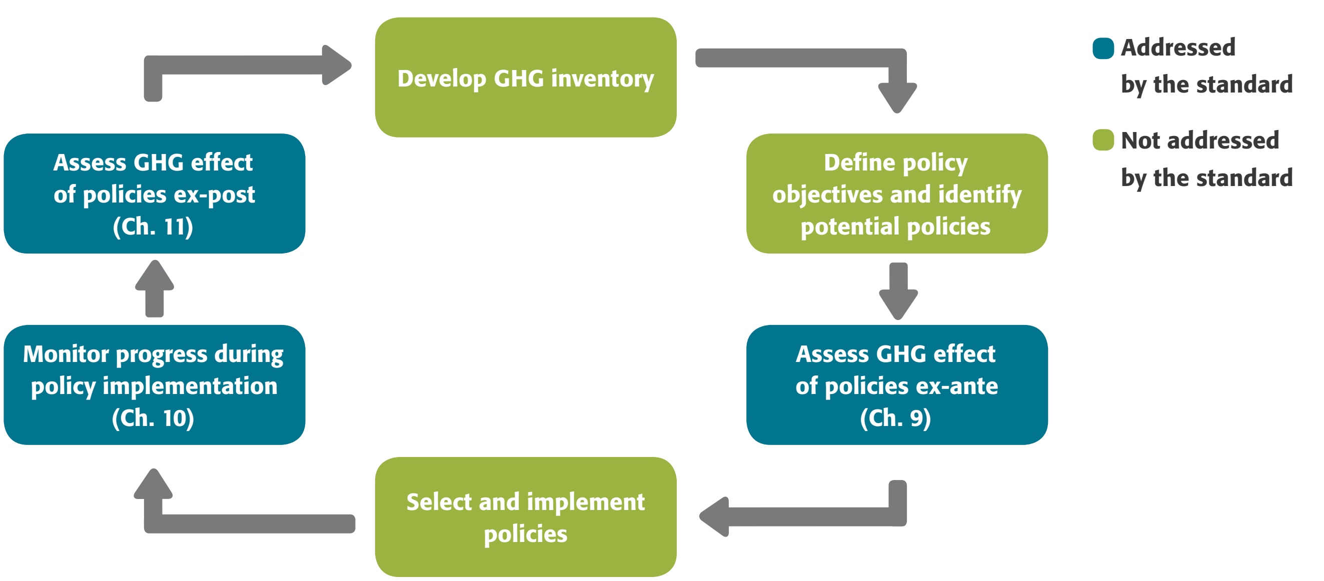
Before using the standard, users should consider establishing a working group of experts and stakeholders with relevant and diverse skills and expertise. The time and human resources required to implement the standard depends on a variety of factors, including the complexity of the policy or action being assessed, the scope of the assessment, the extent of data collection needed and whether relevant data has already been collected, whether analysis related to the policy or action has previously been done, and the desired level of accuracy and completeness needed to meet the user's objectives.

## 1.8 Relationship to GHG inventories

National, subnational, and company/organizational GHG inventories are critical for tracking changes in overall GHG emissions at a national, subnational, or organizational level. GHG inventories are also needed to identify and prioritize mitigation opportunities. All jurisdictions and organizations should develop a GHG inventory as a first step to managing GHG emissions, following established standards such as the IPCC *Guidelines for National Greenhouse Gas Inventories* (2006) for national governments, the WRI/C40/ICLEI *Global Protocol for Community-Scale Greenhouse Gas Emission Inventories* (2014) (along with the IPCC *Guidelines*) for cities and subnational jurisdictions, or the GHG Protocol *Corporate Accounting and Reporting Standard* (2004) for companies and organizations.

However, changes in GHG inventories over time do not explain why emissions have grown or declined over time or reveal the effects of individual policies or actions. Emissions may change as a result of a variety of factors, such as a combination of many different policies that increase and decrease emissions, as well as a range of non-policy factors (for example, changes in economic activity, energy prices, or weather). By attributing changes in emissions to specific policies and actions, this standard can inform policy selection and design and enable an understanding of policy effectiveness. Policy/action accounting should be

**Figure 1.1 Assessing GHG effects throughout a policy design and implementation process**



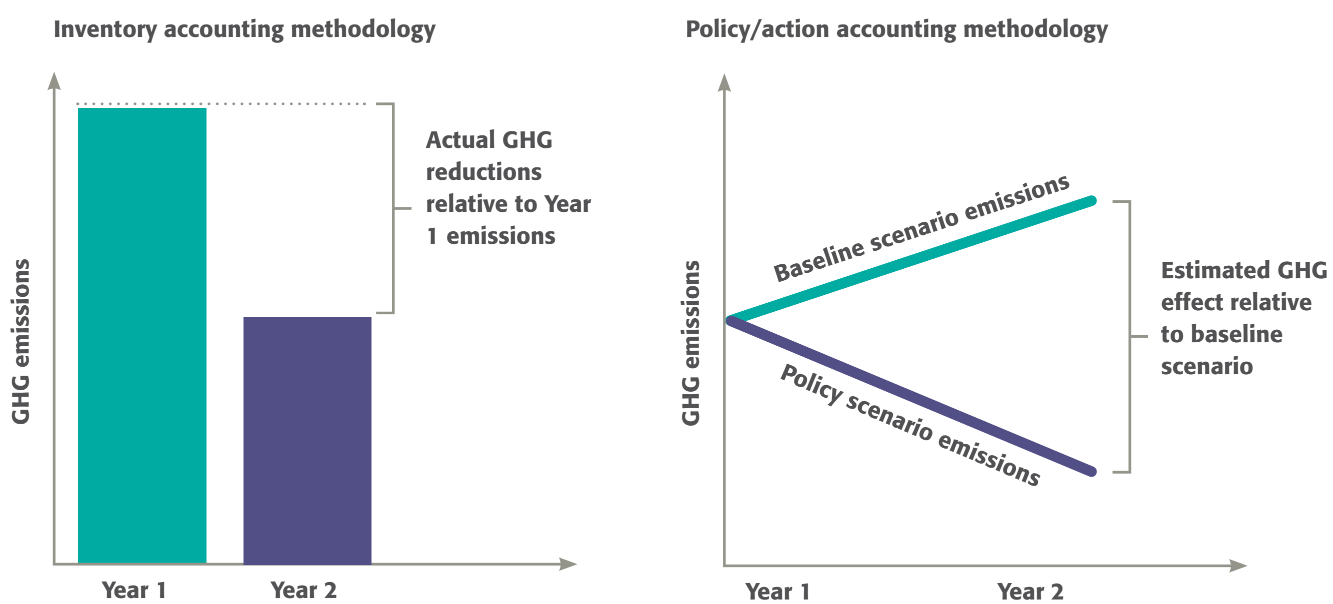
carried out as a complement to developing and updating a GHG inventory on a regular basis. See Table 1.1 for a comparison of GHG inventory and policy/action accounting.

To the extent possible, users should apply the same basic calculation methods, such as those provided in the IPCC *Guidelines for National Greenhouse Gas Inventories*, to calculate source- or sector-level emissions for both GHG inventories and GHG assessments of policies and actions. Common methods can improve comparability between the GHG assessment for a policy or action and the GHG inventory, even if the effect of individual policies and actions may not be visible in the GHG inventory. See Figure 1.2 for an illustration of the difference between inventory accounting, on the one hand, and policy and action accounting, on the other.

**Table 1.1 Comparison of GHG inventory and policy/action accounting**

| Type of accounting | Purpose | Limitations |
|---|---|---|
| **GHG inventory accounting** | • Comprehensive accounting of a jurisdiction's or organization's GHG emissions impact on the atmosphere<br>• Provides information on the sources of emissions and trends over time<br>• Necessary to track overall progress toward GHG reduction goals | • May not explain why emissions change over time<br>• Does not reveal the effects of individual policies |
| **Policy/action accounting** | • Attributes changes in emissions to specific policies and actions<br>• Informs policy design and evaluation | • Not a comprehensive accounting of total emissions; overall emissions may increase even if individual policies and actions are reducing emissions (compared to a baseline scenario) |

**Figure 1.2 Comparison of inventory accounting and policy/action accounting**



## 1.9 Relationship to *The GHG Protocol for Project Accounting*

The *Policy and Action Standard* is based on an accounting framework and a sequence of steps similar to those of *The GHG Protocol for Project Accounting* (or *Project Protocol*). Both involve estimating changes in GHG emissions from the implementation of an action relative to a baseline scenario that represents what would have happened in the absence of that action (as illustrated in Figure 1.2). However, they apply to different scales: in general, the *Project Protocol* should be used for small-scale interventions, such as those occurring at a single site, while this standard should be used for interventions at a broader scale.[7] Table 1.2 illustrates the differences in their applicability, objectives, and methodological approach.

Some types of interventions—such as projects of the same type implemented at multiple sites, infrastructure programs, or implementation of new technologies, practices, or processes—may blur the line between projects and policies. In situations where multiple standards are applicable, users should consider their objectives. For example, project-level methodologies are typically designed for crediting or offsetting.

## 1.10 Relationship to the GHG Protocol *Mitigation Goal Standard*

The GHG Protocol *Policy and Action Standard* and GHG Protocol *Mitigation Goal Standard* (2014) are relevant to policies and goals undertaken by governments and are intended to support evaluating and reporting progress toward GHG mitigation objectives. The two standards were developed simultaneously as part of the same standard development process in order to ensure harmonization of overlapping topics, where they exist, such as development of baseline scenarios, uncertainty assessment, verification procedures, and accounting and reporting principles.

The user's objectives should drive the use of one or both of the standards. The *Policy and Action Standard* enables users to estimate the expected change in emissions and removals resulting from specific policies and actions. The *Mitigation Goal Standard* enables users to evaluate and report overall progress toward national or subnational GHG reduction goals (see Table 1.3).

While each standard can be implemented independently, the standards can also be used together. For example, users can apply the *Mitigation Goal Standard* to understand the level of GHG reductions needed to meet a given GHG mitigation goal and then use the *Policy and Action Standard* to estimate the GHG effects of selected policies and actions to determine if they are collectively sufficient to meet the goal. Conversely, users can first apply

**Table 1.2 Comparison of the *Project Protocol* and the *Policy and Action Standard***

| Standard | Applicability | Objectives | Differences in approach |
|---|---|---|---|
| ***Project Protocol*** | Individual mitigation projects, such as an individual solar photovoltaic installation | Focused primarily on crediting or offsetting | Provides detailed guidance on project-specific baselines, including addressing additionality of projects |
| ***Policy and Action Standard*** | Policies and actions at a larger scale than an individual project, such as renewable energy policies at the sectoral or jurisdiction level;<br>policies and actions that increase or decrease emissions | Intended to support broader objectives (described in Chapter 2) | Provides guidance on estimating interactions between policies or actions; defining a baseline scenario at a larger scale than a project; and identifying and estimating various indirect effects at a broader scale, such as international leakage of emissions |

the *Policy and Action Standard* to estimate expected GHG reductions from various mitigation policies and actions to understand the range of possible GHG reductions, then use the *Mitigation Goal Standard* to set a mitigation goal and track and report progress.

## 1.11 Sector-specific guidance

This standard provides a general framework of principles, concepts, and procedures applicable to all sectors and types of policies and actions. To complement this general standard, sector-specific guidance and examples for five sectors—AFOLU, energy supply, residential and commercial buildings, transportation, and waste—are available at www.ghgprotocol.org/policy-and-action-standard.

## 1.12 Calculation models and tools

The standard details a general process that users should follow when estimating the GHG effects of policies and actions, but it does not prescribe specific calculation methodologies or tools that should be used. Users should supplement the standard with models, calculation tools, spreadsheets, or other methods to carry out calculations.

To help users apply the standard, the GHG Protocol website provides a list of calculation tools and resources relevant to estimating the effects of policies and actions (available at www.ghgprotocol.org/policy-and-action-standard). The GHG Protocol website also provides GHG calculation tools that allow users to calculate GHG emissions from specific sources (available at www.ghgprotocol.org/calculation-tools).

This standard can be used in tandem with models by providing an overarching framework to guide the GHG assessment process, including defining the scope of the assessment and making deliberate assumptions and transparently reporting those assumptions. The standard may also be useful to inform model development. Use of models in the absence of a standard may result in a lack of consistency and transparency regarding methods and assumptions.

**Table 1.3 Comparison of the *Policy and Action Standard* and the *Mitigation Goal Standard***

| Standard | Description |
|---|---|
| ***Policy and Action Standard*** | How to estimate the greenhouse gas effects of policies and actions. Types of policies and actions include regulations and standards; taxes and charges; subsidies and incentives; information instruments; voluntary agreements; and implementation of new technologies, processes, or practices. |
| ***Mitigation Goal Standard*** | How to assess and report overall progress toward national, subnational, and sectoral GHG reduction goals. Types of mitigation goals include GHG reductions from a base year, reductions to a fixed level of emissions (such as carbon neutrality), reductions in emissions intensity, and GHG reductions from a baseline scenario. |

## 1.13 Cost-effectiveness or cost-benefit analysis

This standard estimates the change in GHG emissions and removals caused by a policy or action, in tonnes of $CO_2e$. GHG estimates can be combined with information on costs and used as part of a cost-effectiveness analysis or cost-benefit analysis. Appendix D provides guidance on using the results in a cost-effectiveness analysis, cost-benefit analysis, or multicriteria analysis.

## 1.14 Estimating non-GHG effects or co-benefits

This standard may be used to assess the broader environmental, social, and economic impacts of a policy or action, rather than GHG effects only. The basic procedures outlined in this standard are applicable, especially for non-GHG effects most clearly linked to GHG emissions in terms of data needs, such as energy use, waste generation, or local air pollution. For example, estimating GHG reductions from promotion of public transit requires information on how many passengers no longer travel by private vehicle, which is needed to calculate fuel savings and GHG reductions. The same information can be used to estimate money saved by not purchasing that fuel, and reduced emissions of local air pollutants, such as particulate matter, ground-level ozone, $SO_2$, and $NO_x$.

Users that estimate non-GHG effects should follow the steps in each chapter for each non-GHG effect of interest. When doing so, users should supplement this standard with additional estimation methods and data sources related to each non-GHG effect. Additional methods and data will be necessary to assess impacts less related to GHG emissions, such as public health impacts or broader economic impacts, such as changes in GDP or jobs. Non-GHG effects may also be described qualitatively rather than estimated. Appendix C provides examples of various non-GHG effects that may be estimated along with GHG effects.

## 1.15 Terminology: shall, should, and may

This standard uses precise language to indicate which provisions of the standard are requirements, which are recommendations, and which are permissible or allowable options that users may choose to follow. The term **"shall"** is used throughout this standard to indicate what is required in order for a GHG assessment to be in conformance with the standard. The term **"should"** is used to indicate a recommendation, but not a requirement. The term **"may"** is used to indicate an option that is permissible or allowable. The term "required" is used in the guidance to refer to requirements in the standard. "Needs," "can," and "cannot" are used to provide guidance on implementing a requirement or to indicate when an action is or is not possible.

## 1.16 Limitations

**Using results that are sufficiently accurate for the stated objectives:** This standard incorporates a range of approaches to allow users to manage trade-offs between the accuracy of the assessment and available time, resources, and capacity, in the context of individual objectives (described further in Chapter 3). Depending on the methods used, the results of the assessment may or may not be sufficiently accurate for effective decision making. Several challenges involved in estimating the GHG effects of policies and actions—such as the need to estimate effects relative to a counterfactual baseline scenario and estimating interactions between related policies—can result in high uncertainty. Understanding the uncertainty of the results (described in Chapter 12) can help identify where more effort is needed to gather accurate data, and ensure that the uncertainty of the results is communicated appropriately. Given the uncertainties, the results of the assessment should be interpreted as "estimates" of the effect of policies and actions.

**Comparing results:** Users should exercise caution when comparing the results of GHG assessments. Differences in reported emissions impacts may be a result of differences in methodology rather than real-world differences. Additional measures are necessary to enable valid comparisons, such as consistency in the timeframe of the assessments, the types of effects included in the GHG assessment boundary, baseline assumptions, calculation methodologies, methods for assessing policy interactions, and data sources. Additional consistency can be provided through GHG reporting programs or more detailed sector-specific guidance (see Section 1.11). To understand whether comparisons are valid, all methodologies and data sources used must be transparently reported. Comparable results can best be achieved if GHG assessments are undertaken by the same entity in order to ensure consistency of methodology between assessments. For more information on comparability, see Chapter 4.

**Aggregating results:** Users should also exercise caution when aggregating the results of GHG assessments for different policies or actions. GHG effects should not be directly aggregated across policies or actions if they affect the same emissions sources or sinks and potential interactions exist between them that have not been accounted for. In such a case, the sum would either over or underestimate the GHG effects resulting from the combination of policies. For example, users should not aggregate the effects of a local energy efficiency policy and a national energy efficiency policy in the same country, since the combined effect of the two policies is likely not equal to the sum of the individual effects, as a result of overlapping sources. (Chapter 5 provides more information on policy interactions.) Results should also not be aggregated across policies if the methodologies, assumptions, and data sources are not comparable or if the baseline scenarios developed for each policy were not developed to enable accurate aggregation (further described in Appendix B).

**Potential crediting of GHG reductions:** The results from using this standard are not sufficient to support crediting of GHG reductions from policies or actions for sale in the carbon market. Additional specifications would be necessary, such as more detailed, sector-specific calculation methods to lead to more consistent and comparable results; greater emphasis on the principle of conservativeness (described in Chapter 4) and provisions to ensure additionality; programmatic decisions about eligibility of credit-generating activities; and registries and procedures to ensure that each emission reduction is counted toward no more than one goal or compliance obligation. For guidance on quantifying project-level GHG reductions to generate credits, see *The GHG Protocol for Project Accounting*.

## Endnotes

1. Where this standard refers to policy effectiveness, it is limited to effectiveness in reducing GHG emissions, as well as achieving or improving any specific non-GHG effects that users choose to include in the assessment, rather than a broader definition of policy effectiveness.
2. The standard does not provide a methodology for allocating GHG reductions among various donors or financial institutions.
3. Companies may find some of the concepts and guidance useful to estimate the GHG effects of private sector actions, but may need to adapt concepts to the business context or supplement with additional methodologies. Companies seeking to quantify GHG reductions associated with mitigation projects should refer to *The GHG Protocol for Project Accounting*.
4. Under the UNFCCC, NAMAs are undertaken "by developing country Parties in the context of sustainable development, supported and enabled by technology, financing and capacity building, in a measurable, reportable and verifiable manner." To quantify GHG reductions from NAMAs framed as individual projects, see *The GHG Protocol for Project Accounting*. For NAMAs framed as jurisdiction-level GHG reduction goals, see the GHG Protocol *Mitigation Goal Standard*.
5. "Policy-neutral" means the methodology is generic and applicable to any policy type, rather than designed for any specific policy instruments, programs, or policy framework.
6. Where the word "policy" is used, it is used as shorthand to refer to both policies and actions.
7. Users following the *Project Protocol* should also refer to two sector-specific guidelines as applicable: the GHG Protocol *Guidelines for Quantifying GHG Reductions from Grid-Connected Electricity Projects* (2007) and *The Land Use, Land-Use Change, and Forestry Guidance for GHG Project Accounting* (2006). Both are available at www.ghgprotocol.org. Users may also consider other project-level methodologies, such as those developed under the Clean Development Mechanism (CDM), available at http://cdm.unfccc.int/methodologies.

# 2 Objectives of Estimating the GHG Effects of Policies and Actions

**Assessing the GHG effects of policies and actions is a key step toward developing effective GHG reduction strategies and reducing emissions. Quantitative GHG assessment supports evidence-based decision making by enabling policymakers and stakeholders to understand the relationship between policies and actions and expected or achieved changes in GHG emissions.**

A GHG assessment should begin by defining the objectives of the assessment. Examples of objectives for assessing the GHG effects of a policy or action are listed below.

### Before policy implementation:

- Choose among policy options based on their expected GHG effects
- Improve the design of policies by understanding the GHG effects of different design choices
- Understand potential GHG reductions from policy options to inform GHG reduction goals
- Report on expected future GHG effects of policies and actions being considered or implemented (for domestic or international purposes)
- Attract and facilitate financial support for mitigation actions by estimating potential GHG reductions

### During or after policy implementation:

- Understand whether policies and actions are effective in delivering the intended results
- Inform and improve policy implementation
- Decide whether to continue current activities or implement additional policies
- Learn from experience and share best practices
- Evaluate the contribution of policies and actions toward broader GHG reduction goals
- Ensure that policies and actions are cost-effective and that limited resources are invested efficiently
- Report on the GHG effects of policies and actions over time (for domestic or international purposes)
- Meet funder requirements to report GHG reductions from mitigation actions

Users should estimate the GHG effects of policies and actions with a sufficient level of accuracy and completenes s to meet the stated objectives of the assessment. The level of accuracy and completeness needed may vary by objective.

As mentioned in Chapter 1, the assessment may be designed to assess non-GHG effects of policies and actions to meet a wider range of objectives. The assessment may also incorporate information on costs to facilitate an understanding of cost-effectiveness.

GHG assessments may be carried out on policies and actions that have objectives unrelated or contrary to climate change mitigation, including those that increase GHG emissions. Policymakers and analysts may choose to assess the GHG effects of all major policies and actions to understand or minimize GHG increases, not only to assess GHG mitigation policies.[1]

Users **shall** report the objective(s) and the intended audience(s) of the GHG assessment. Possible audiences may include policymakers, the general public, NGOs, companies, funders, financial institutions, analysts, research institutions, and the UNFCCC.

Box 2.1 provides a case study of defining the objectives of an assessment.

**Box 2.1 Objectives of assessing the GHG effects of the City of Cape Town's Electricity Saving Campaign**

The City of Cape Town, South Africa, launched an electricity-saving information campaign in 2009. The campaign is designed to educate consumers and businesses and encourage a range of behavior-changing actions (such as installing solar water heaters) that would result in electricity savings and save consumers money.

The city decided that it needed to monitor and evaluate the results of the campaign, including its GHG emission effects. The Energy Research Centre at the University of Cape Town worked with the City of Cape Town and prepared recommendations on how to carry out such an assessment.

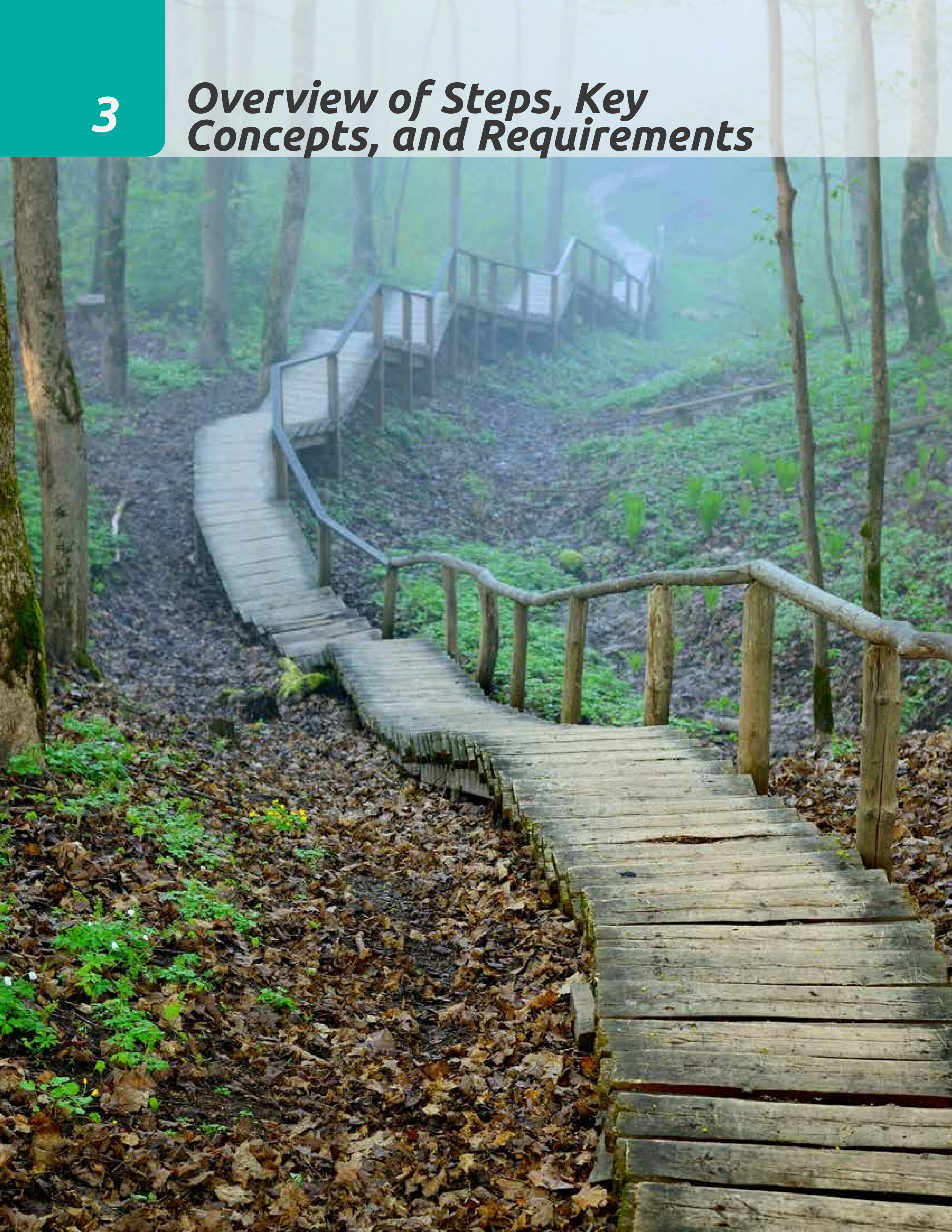
The city's specific objectives were the following:

- Determine whether the campaign was a justifiable use of financial and human resources (on the basis of reduced electricity consumption and associated GHG emission reductions)
- Inform how future elements of the campaign could be designed to increase its effectiveness
- Understand the drivers behind changes in electricity consumption and behavior and the impact of the campaign in driving such changes
- Understand city performance in meeting electricity reduction targets and GHG targets
- Report on emissions reductions, since $CO_2$ emissions reporting is part of the city's electricity and financial savings reporting
- Communicate the benefits of the campaign to stakeholders
- Provide accurate data to feed into the South African National Climate Change Response Database, which is part of the national climate change monitoring and evaluation system

## Endnote

1. For an example of applying the standard to a non-mitigation policy, see Box 8.3 in Chapter 8.

# 3 Overview of Steps, Key Concepts, and Requirements



**This chapter provides an overview of the steps involved in policy and action accounting and reporting, an introduction to key concepts, an example of following the steps in the standard, and a checklist of accounting requirements.**

## 3.1 Overview of steps

This standard is organized according to the steps a user follows in accounting for and reporting changes in GHG emissions from a policy or action. See Figure 3.1 for an overview of steps in the standard. Depending on when the standard is applied, users may skip Chapters 9, 10, or 11. For example, if the standard is applied before a policy is implemented, users may skip Chapters 10 and 11.

## 3.2 Key concepts

This section describes several key concepts used in this standard.

### 3.2.1 Policies and actions

"Policies" and "actions" refer to interventions taken or mandated by a government, institution, or other entity and may include laws, directives, and decrees; regulations and standards; taxes, charges, subsidies, and incentives; information instruments; voluntary agreements; implementation of new technologies, processes, or practices; and public or private sector financing and investment; among others.

"Policies" and "actions" are treated equivalently in all steps in the standard, so no further distinction is made between what constitutes a policy versus an action. However, users may choose to define "policies" as distinct from "actions" depending on their objectives and context. For example, policies could be defined as instruments (such as regulations, taxes, subsidies, and information instruments) that enable or incentivize concrete actions to be implemented (such as replacement of technology or changes in behavior).[1] "Actions" may also be defined more broadly. Section 1.4 provides more information on the relationship between broad strategies or plans, policy instruments, and the implementation of technologies, processes, or practices. Users may assess either an individual policy/action or a package of related policies/actions.[2]

**Figure 3.1 Overview of steps**

| Overall steps | Detailed steps | Chapter |
|---|---|---|
| Define policy/action | Define the policy or action to be assessed; choose ex-ante or ex-post assessment | 5 |
| Identify effects | Identify all potential GHG effects of the policy or action; include them in a map of the causal chain | 6 |
| | Define the GHG assessment boundary around significant effects; identify the sources/sinks in the boundary | 7 |
| Estimate effects | Estimate baseline emissions for all affected sources/sinks included in the boundary | 8 |
| | Ex-ante assessment: Estimate policy scenario emissions for affected sources/sinks; subtract baseline emissions to estimate GHG effect | 9 |
| | Identify key performance indicators; monitor performance over time | 10 |
| | Ex-post assessment: Estimate policy scenario emissions for affected sources/sinks; subtract baseline emissions to estimate GHG effect | 11 |
| | Assess uncertainty (relevant to Chapters 8, 9, 10, and 11) | 12 |
| Verify | Verify results (optional) | 13 |
| Report | Report results and methodology used | 14 |

### 3.2.2 GHG assessment

This standard uses the term "GHG assessment" to refer to the estimation of changes in GHG emissions resulting from a policy or action. In other contexts, "GHG appraisal" is sometimes used to describe ex-ante GHG assessment and "GHG evaluation" is used to describe ex-post GHG assessment. This standard uses "GHG assessment" to refer to both cases.

### 3.2.3 GHG effects and non-GHG effects

GHG effects are changes in GHG emissions or removals that result from a policy or action. Emissions are releases of greenhouse gases into the atmosphere, while removals are removals of GHG emissions from the atmosphere through sequestration or absorption.

Non-GHG effects are changes in environmental, social, or economic conditions other than GHG emissions or climate change mitigation that result from the policy or action. For example, a home insulation subsidy may lead to both GHG effects (reduced GHG emissions from reduced home energy use) as well as non-GHG effects (increased household disposable income resulting from energy savings). Chapter 6 provides more information on GHG effects and non-GHG effects. For additional examples of non-GHG effects, see Appendix C.

### 3.2.4 GHG assessment boundary

The GHG assessment boundary defines the scope of the assessment in terms of the range of GHG effects (and non-GHG effects, if relevant) that are included in the GHG assessment. This standard encourages a comprehensive assessment that includes the full range of effects considered to be significant. Chapter 7 provides guidance on defining the GHG assessment boundary.

### 3.2.5 GHG assessment period

The GHG assessment period is the time period over which GHG effects resulting from the policy or action are assessed. The GHG assessment period may differ from the policy implementation period—the time period during which the policy or action is in effect—and should be as comprehensive as possible to capture the full range of effects based on when they are expected to occur. Chapter 7 provides more information on defining the GHG assessment period.

### 3.2.6 Attributing changes in emissions to policies and actions

This standard is designed to support users in attributing changes in GHG emissions and removals to a specific policy or action (or package of policies or actions) to understand how effective various policies are in reducing emissions. Attributing changes in emissions to specific policies and actions can be difficult, since GHG emissions can change as a result of a variety of factors, including (1) the policy or action being assessed; (2) other policies or actions that directly or indirectly affect the same emissions sources; and (3) various external drivers that affect emissions, such as changes in economic activity, population, energy prices, weather, autonomous technological improvements, or structural shifts in the economy.

For example, a city may implement a GHG mitigation policy in the electricity sector and then observe that energy-related emissions in the following year have declined. However, the fact that emissions have decreased does not mean that the policy has caused the decrease in emissions. A correlation between a policy being implemented and emissions decreasing is not sufficient to establish causation. In actuality, emissions may have declined because an economic downturn reduced demand for electricity, not because the policy has been successful. Further analysis is required to understand why emissions have changed.

To estimate a change in emissions resulting from a policy or action, users follow three basic steps:

1. Define the baseline scenario and estimate baseline scenario emissions (Chapter 8)
2. Define the policy scenario and estimate policy scenario emissions (Chapter 9 or 11)
3. Subtract baseline scenario emissions from policy scenario emissions to estimate the GHG effect of the policy or action (Chapter 9 or 11)

See Equation 3.1 for the basic equation for estimating the GHG effect of a policy or action.

Attributing changes in emissions to specific policies and actions is distinct from tracking changes in overall emissions through a GHG inventory, which does not explain why emissions have changed. Attributing changes in emissions to policies is also distinct from tracking trends in key performance indicators. Monitoring trends in indicators can demonstrate changes in the targeted outcomes of the policy or action, which is helpful to understand whether a policy or action is on track and being implemented as planned but does not explain why the changes in indicators are occurring or demonstrate the effectiveness of a policy. To meet certain objectives, tracking performance indicators may be sufficient. (Chapter 10 provides guidance on monitoring performance indicators over time.)

### 3.2.7 Baseline scenario and policy scenario

Estimating the change in GHG emissions resulting from a given policy or action requires a reference case, or baseline scenario, against which the change is estimated. The baseline scenario represents the events or conditions most likely to occur in the absence of the policy or action being assessed. The baseline scenario is not a historical reference point but is instead an assumption about conditions that would exist over the policy implementation period if the policy or action assessed were not implemented. The baseline scenario depends on assumptions related to other policies or actions that are also implemented, as well as various external drivers and market forces that affect emissions, such as changes in economic activity, population, energy prices, weather, autonomous technological improvements, and structural shifts in the economy. Chapter 8 provides guidance on developing the baseline scenario.

**Equation 3.1 Estimating the GHG effect of a policy or action**

**Total net change in GHG emissions resulting from the policy or action (t $CO_2$e) =**
**Total net policy scenario emissions (t $CO_2$e) – Total net baseline scenario emissions (t $CO_2$e)**

*Note:* "Net" refers to the aggregation of emissions and removals. "Total" refers to the aggregation of emissions and removals across all sources and sinks included in the GHG assessment boundary.

In contrast to the baseline scenario, the policy scenario represents the events or conditions most likely to occur in the presence of the policy or action being assessed. The policy scenario is the same as the baseline scenario except that it includes the policy or action (or package of policies/actions) being assessed. The difference between the policy scenario and the baseline scenario represents the effect of the policy or action. Chapters 9 and 11 provide guidance on developing the policy scenario, either ex-ante or ex-post.

### 3.2.8 Ex-ante and ex-post assessment

A GHG assessment is classified as either ex-ante or ex-post depending on whether it is prospective (forward-looking) or retrospective (backward-looking):

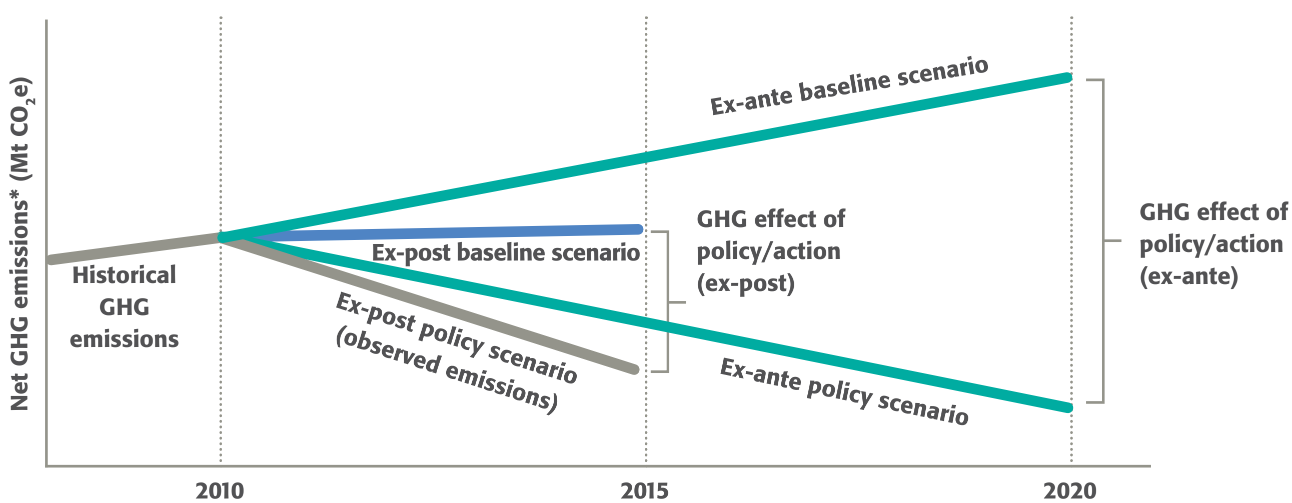
- **Ex-ante assessment:** The process of estimating expected future GHG effects of a policy or action
- **Ex-post assessment:** The process of estimating historical GHG effects of a policy or action

Ex-ante assessment can be carried out before or during policy implementation, while ex-post assessment can be carried out either during or after policy implementation. Users may carry out an ex-ante assessment, an ex-post assessment, or both, depending on objectives. In general, effective GHG management involves both ex-ante and ex-post assessment.

Figure 3.2 illustrates the relationship between ex-ante and ex-post assessment. In the figure, a policy comes into effect in 2010. A user carries out an ex-ante assessment in 2010 to estimate the expected future GHG effects of the policy through 2020 by defining an ex-ante baseline scenario and an ex-ante policy scenario. The difference between the ex-ante policy scenario and the ex-ante baseline scenario is the estimated GHG effect of the policy (ex-ante). In 2015, the user carries out an ex-post assessment of the same policy to estimate the historical GHG effects of the policy to date, by observing actual emissions over the policy implementation period—that is, the ex-post policy scenario—and defining a revised ex-post baseline scenario. The difference between the ex-post policy scenario and the ex-post baseline scenario is the estimated GHG effect of the policy (ex-post).

If conditions unrelated to the policy or action unexpectedly change between 2010 and 2015, the ex-post baseline scenario will differ from the ex-ante baseline scenario. For example, the ex-post and ex-ante baseline scenarios will differ if observed fuel prices or rates of economic growth differ from ex-ante forecasts made in 2010, or if significant new policies are introduced. The ex-post policy scenario may differ from the ex-ante policy scenario for the same reasons, or if the policy is less effective in practice than it

**Figure 3.2 Ex-ante and ex-post assessment**




*Note:* * Net GHG emissions from sources and sinks in the GHG assessment boundary.

was assumed to be. In such cases, the ex-ante and ex-post estimates of the policy's GHG effect will differ.

In an ex-ante assessment, the baseline scenario and policy scenario are both hypothetical or forecasted, rather than observed. In an ex-post assessment, only the baseline scenario is hypothetical, since the ex-post policy scenario can be observed.

### 3.2.9 Bottom-up and top-down approaches

Multiple types of data and estimation methods can be used to estimate the GHG effects of policies and actions, including both bottom-up and top-down approaches.

#### Bottom-up and top-down data

- Bottom-up data are measured, monitored, or collected (for example, 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 production output.
- 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.

#### Bottom-up and top-down methods

- Bottom-up methods (such as engineering models) calculate or model the change in GHG emissions for each source, project, or entity affected by the policy or action, then aggregate across all sources, projects, or entities to determine the total change in GHG emissions.
- Top-down methods (such as econometric models or regression analysis) use statistical methods to calculate or model changes in GHG emissions and can be applied to either bottom-up or top-down data.

Both bottom-up and top-down data and methods are valuable for different purposes. Hybrid approaches that combine elements of both bottom-up and top-down approaches may also be used. The GHG Protocol website provides a list of calculation tools and resources relevant to estimating the effects of policies and actions (available at www.ghgprotocol.org/policy-and-action-standard).

### 3.2.10 Choosing the desired level of accuracy and completeness among a range of methodological options

In many cases, users will confront a choice in the methodological options available to estimate changes in emissions. Often the methodological options present a trade-off between accuracy or completeness, on one hand, and the cost of implementation, on the other. In such cases, this standard allows for a range of methods with varying levels of accuracy and completeness, rather than a single method.

Users should determine the desired level of accuracy and completeness of the GHG assessment based on a range of factors, including the following:

- Objectives of the assessment, intended uses of the results, and the level of accuracy and completeness required to meet stated objectives
- Relative significance of the policy or action being assessed
- Data availability
- Capacity, resources, and time available to carry out the assessment

Users should estimate the GHG effects of policies and actions with a sufficient level of accuracy and completeness to meet the stated objectives. More rigorous methods enable a wider set of uses than less rigorous methods. The results of a comprehensive and accurate assessment can be used to meet the widest range of applications, since users and stakeholders can generally have high confidence that the results represent an accurate and complete estimate of the GHG effects of a given policy or action. In general, more rigorous approaches should be applied to policies and actions that are most significant in terms of expected GHG impact or are otherwise most relevant to decision makers and stakeholders.

In contrast, less rigorous approaches may be used to roughly estimate the GHG effect of a policy or action, requiring fewer resources to implement than a more accurate and complete assessment. However, the results of simplified approaches should be limited to a smaller range of applications and objectives for which a lower level of accuracy and completeness is sufficient, such as certain internal planning or reporting purposes where indicative estimates of GHG effects are acceptable. Users should exercise caution in using the results from a simplified assessment to claim that a specific policy or action results in specific GHG reductions, without further understanding the associated uncertainty. Users may consider implementing simplified approaches in the short term and more rigorous approaches in the longer term.

Subsequent chapters provide tables outlining a range of methodological options, including Chapter 8 for estimating baseline emissions, Chapter 9 for estimating GHG effects ex-ante, Chapter 11 for estimating GHG effects ex-post, and Chapter 12 for assessing uncertainty.

### 3.2.11 Policy interactions

An individual policy or action may interact with other policies and actions to produce total effects that differ from the sum of the individual effects of each individual policy. Policies and actions can interact in either overlapping or reinforcing ways or can be independent of each other. Potential interactions should be considered at multiple points during the GHG assessment, including when deciding whether to assess an individual policy or action or a package of related policies and actions. For more information, see Chapter 5. Guidance on assessing policy interactions is provided in Appendix B.

### 3.2.12 Avoiding double counting of GHG reductions

Multiple actors in society may implement similar or overlapping policies or actions and each may claim GHG reductions resulting from their policies or actions. GHG accounting for policies and actions is intended to support the simultaneous action of multiple entities to reduce emissions throughout society. However, users should avoid double counting of emission reductions. Users can minimize the potential for double counting by using more accurate and complete methods described in subsequent chapters. In particular, users should develop a baseline scenario that includes all other implemented (and adopted, if applicable) policies, actions, and GHG mitigation projects in the baseline scenario that have a significant effect on emissions (further described in Chapter 8). Users may also group related policies or actions together and assess them as a package (further described in Chapter 5).

If double counting between policies is suspected, GHG reductions from overlapping policies and actions should not be aggregated to determine total emissions or reductions in a given jurisdiction or geographic region. When reporting results, users should acknowledge any potential overlaps and possible double counting with other policies and actions to ensure transparency and avoid misinterpretation of data. Where applicable, coordination of GHG accounting for policies and actions by a single agency within a jurisdiction can also help reduce potential for double counting (for example, by specifying the same methodology and identifying potential overlaps).

If GHG reductions take on a monetary value or receive credit in a GHG trading or crediting program, users should take additional measures to avoid double counting or double claiming of credits, including specifying whether the reductions are claimed by the implementing jurisdiction or are sold to another jurisdiction; specifying exclusive ownership of reductions through contractual agreements; and recording all transactions in domestic or international registries, such as an international transaction log. For guidance on avoiding double counting of transferable emission units such as offset credits across jurisdictional boundaries, refer to the GHG Protocol *Mitigation Goal Standard*.

## 3.3 Example of following the steps in the standard

Table 3.1 provides an example of following the various steps in the standard for an illustrative policy—a subsidy for home insulation. In practice, a GHG assessment following this standard would be more comprehensive. Subsequent chapters provide more detail using the same policy example to illustrate the various steps throughout the standard.

**Table 3.1 Example of carrying out the various steps in the standard for an illustrative policy**

| Chapter | Simplified example for an illustrative subsidy for home insulation |
|---|---|
| **Chapter 2: Objectives** | The objectives are: (1) to inform the design of a government subsidy for home insulation before implementation; and (2) to track and report on the policy's effectiveness during implementation. |
| **Chapter 5: Defining the Policy or Action** | The policy to be assessed is a government subsidy for home insulation. An individual policy is assessed, rather than a package of related policies. |
| **Chapter 6: Identifying Effects and Mapping the Causal Chain** | The subsidy aims to incentivize consumers to purchase and install more insulation, which is expected to reduce natural gas and electricity use in homes, thereby reducing GHG emissions. The energy savings is also expected to result in consumers having more disposable income, leading to the consumption of more goods and services, thereby increasing emissions. (Figure 6.6 in Chapter 6 illustrates the causal chain.) |
| **Chapter 7: Defining the GHG Assessment Boundary** | The reductions in $CO_2$ emissions from reduced natural gas use and reduced electricity use are expected to be significant, so they are included in the GHG assessment boundary. The increase in emissions from increased production of goods and services is expected to be insignificant based on initial estimates, so it is excluded from the boundary. (Box 7.3 provides more detail on the GHG assessment boundary.) |
| **Chapter 8: Estimating Baseline Emissions** | The baseline scenario is assumed to be the continuation of historical residential energy consumption trends, dependent on projected changes in household income and current rates of home insulation, absent the subsidy. To estimate baseline emissions from natural gas use, the emissions estimation method is assumed to be:<br><br>Baseline emissions for household natural gas combustion (t $CO_2$e/year) = historical natural gas use (MMBtu/year) × (1+ % change in GDP) × baseline emission factor (t $CO_2$e/MMBtu)<br><br>The estimated values of the parameters in this equation are assumed to be:<br>• Average annual historical natural gas use (1,000,000 MMBtu/year)<br>• Average annual change in GDP (2%)<br>• Baseline emission factor (0.2 t $CO_2$e/MMBtu)<br>Baseline emissions in a given year are calculated as: 1,000,000 MMBtu/year ×1.02 x × 0.2 t $CO_2$e/MMBtu = 204,000 t $CO_2$e/year |
| **Chapter 9: Estimating GHG Effects Ex-Ante** | To estimate policy scenario emissions, the same emissions estimation method is used, but the assumed parameter values in the policy scenario are different. The emissions estimation method is:<br><br>Policy scenario emissions for household natural gas combustion (t $CO_2$e) = policy scenario natural gas use (MMBtu/year) × policy scenario emission factor (t $CO_2$e/MMBtu)<br><br>Policy scenario natural gas use is estimated to be 910,000 MMBtu/year, based on the assumption that 30% of households will install insulation as a result of the subsidy and that insulation will reduce household natural gas use by 30%, so the policy will lead to a 9% reduction (0.3 × 0.3) in residential natural gas use. The policy scenario emission factor is assumed to be the same as in the baseline scenario (0.2 t $CO_2$e/MMBtu), since the policy does not affect the emissions intensity of natural gas.<br><br>Policy scenario emissions in a given year are calculated as: 910,000 MMBtu/year × 0.2 t $CO_2$e/MMBtu = 182,000 t $CO_2$e/year.<br><br>The GHG effect of the policy in the same year is estimated ex-ante to be a reduction of 22,000 t $CO_2$e/year (policy scenario emissions of 182,000 – baseline emissions of 204,000). |

**Table 3.1 Example of carrying out the various steps in the standard for an illustrative policy (continued)**

| Chapter | Simplified example for an illustrative subsidy for home insulation |
|---|---|
| **Chapter 10: Monitoring Performance over Time** | Key performance indicators are identified, including the number of homes that have applied for the subsidy. Monitoring reveals that only 20% of homes have applied for the subsidy, so the total GHG reduction is likely to be lower than estimated ex-ante. Data needed for ex-post assessment are also collected, including GDP and a representative sample of residential energy use. |
| **Chapter 11: Estimating GHG Effects Ex-Post** | The parameter values in the baseline calculation are updated with actual data for the identified baseline drivers—that is, actual rather than predicted GDP data. Similarly, for the policy scenario calculations, the parameter value for energy use is based on observed energy use and data on the actual number of homes that installed insulation, rather than forecasted estimates. GDP grew at 3% rather than 2% over the period, while the emissions estimation method and the values of other parameters remained the same.<br>Ex-post baseline emissions are calculated as: 1,000,000 MMBtu x 1.03 × 0.2 t $CO_2$e/MMBtu = 206,000 t $CO_2$e/year (rather than 204,000 t $CO_2$e/year as estimated ex-ante).<br>Residential energy use decreased by 6% rather than 9%, so ex-post policy scenario emissions are calculated to be: 940,000 MMBtu × 0.2 t $CO_2$e/MMBtu = 188,000 t $CO_2$e/year (rather than 182,000 t $CO_2$e/year as estimated ex-ante).<br>The GHG effect of the policy is estimated ex-post to be a reduction of 18,000 t $CO_2$e/year (policy scenario emissions of 188,000 – baseline emissions of 206,000). The estimated reduction ex-post is less than the 22,000 t $CO_2$e reduction estimated ex-ante. |
| **Chapter 12: Assessing Uncertainty** | Uncertainty is assessed in both qualitative and quantitative terms and sensitivity analyses are carried out to identify which parameters are most sensitive to changes in assumptions. The uncertainty range is estimated to be a GHG reduction of 18,000 t $CO_2$e/year +/- 6,000 t $CO_2$e/year. |
| **Chapter 13: Verification** | The results of the GHG assessment are verified by an accredited third-party verifier.<br>Limited assurance is attained. |
| **Chapter 14: Reporting** | The results and the methodology are reported, following the reporting requirements in Chapter 14. |

## 3.4 Requirements in the standard

Subsequent chapters include accounting and reporting requirements to help users develop a GHG assessment that represents a true and fair account of the GHG effects of a policy or action. Table 3.2 provides a summary checklist of the accounting requirements included in the standard. A box at the beginning of each chapter also summarizes the accounting requirements in each chapter. Chapter 14 provides a summary checklist of reporting requirements.

As noted in Chapter 1, the term "shall" is used throughout the standard to indicate requirements. "Should" is used to indicate a recommendation but not a requirement, while "may" is used to indicate an option that is permissible or allowable. Table 3.2 compiles all the "shall" statements related to accounting, while "shall" statements related to reporting are compiled in Chapter 14.

**Table 3.2 Checklist of accounting requirements**

| Chapter | Accounting requirement |
|---|---|
| **Chapter 4: Accounting and Reporting Principles** | • GHG accounting and reporting shall be based on the principles of relevance, completeness, consistency, transparency, and accuracy. |
| **Chapter 5: Defining the Policy or Action** | • Clearly define the policy or action (or package of policies/actions) that is assessed. |
| **Chapter 6: Identifying Effects and Mapping the Causal Chain** | • Identify all potential GHG effects of the policy or action.<br>• Separately identify and categorize in-jurisdiction effects and out-of-jurisdiction effects, if relevant and feasible.<br>• Identify all source/sink categories and greenhouse gases associated with the GHG effects of the policy or action.<br>• Develop a map of the causal chain. |
| **Chapter 7: Defining the GHG Assessment Boundary** | • Include all significant GHG effects, source/sink categories, and greenhouse gases in the GHG assessment boundary.<br>• Define the GHG assessment period based on the GHG effects included in the GHG assessment boundary. |
| **Chapter 8: Estimating Baseline Emissions** | If applying the scenario method:<br>• Define a baseline scenario that represents the conditions most likely to occur in the absence of the policy or action for each source or sink category included in the GHG assessment boundary.<br>• Estimate baseline emissions and removals over the GHG assessment period for each source/sink category and greenhouse gas included in the GHG assessment boundary.<br>• Apply global warming potential (GWP) values provided by the IPCC based on a 100-year time horizon.<br>If applying the comparison group method:<br>• Identify an equivalent comparison group for each source or sink category included in the GHG assessment boundary.<br>• Estimate emissions and removals from the comparison group and the policy group over the GHG assessment period for each source/sink category and greenhouse gas included in the GHG assessment boundary.<br>• Apply GWP values provided by the IPCC based on a 100-year time horizon. |
| **Chapter 9: Estimating GHG Effects Ex-Ante** | If carrying out an ex-ante assessment:<br>• Define a policy scenario that represents the conditions most likely to occur in the presence of the policy or action for each source or sink category included in the GHG assessment boundary.<br>• Estimate policy scenario emissions and removals over the GHG assessment period for each source/sink category and greenhouse gas included in the GHG assessment boundary, based on the GHG effects included in the boundary.<br>• Apply the same GWP values used to estimate baseline emissions.<br>• Estimate the GHG effect of the policy or action by subtracting baseline emissions from policy scenario emissions for each source/sink category included in the GHG assessment boundary. |

**Table 3.2 Checklist of accounting requirements (continued)**

| Chapter | Accounting requirement |
| --- | --- |
| **Chapter 10: Monitoring Performance over Time** | If monitoring performance over time:<br>• Define the key performance indicators that will be used to track performance of the policy or action over time (and parameters for ex-post assessment, if relevant).<br>• Create a plan for monitoring key performance indicators (and parameters for ex-post assessment, if relevant).<br>• Monitor each of the parameters over time, in accordance with the monitoring plan. |
| **Chapter 11: Estimating GHG Effects Ex-Post** | If carrying out an ex-post assessment:<br>• Estimate policy scenario emissions and removals over the GHG assessment period from each source/sink category and greenhouse gas included in the GHG assessment boundary.<br>• Apply the same GWP values used to estimate baseline emissions.<br>• Estimate the GHG effect of the policy or action by subtracting baseline emissions from policy scenario emissions for each source/sink category included in the GHG assessment boundary. |
| **Chapter 12: Assessing Uncertainty** | • Assess the uncertainty of the results of the GHG assessment, either quantitatively or qualitatively.<br>• Conduct a sensitivity analysis for key parameters and assumptions in the assessment. |
| **Chapter 14: Reporting** | • See Chapter 14 for a list of reporting requirements. |

## Endnotes

1. Concrete actions are sometimes called "measures."
2. In most steps throughout the standard, the term "policy or action" is used to refer to either case, since the basic approach is the same.
3. In project accounting, users typically calculate "GHG reductions" as the difference between baseline emissions and project emissions. Equation 3.1 is used in this standard because it enables calculation of changes in emissions (whether positive or negative), rather than GHG reductions, to be consistent with the overall methodology. Negative results indicate GHG reductions achieved by the policy or action, while positive results indicate an increase in GHG emissions resulting from the policy or action.

# 4 Accounting and Reporting Principles

**Generally accepted GHG accounting principles are intended to underpin and guide GHG accounting and reporting to ensure that the reported GHG assessment represents a true and fair account of changes in GHG emissions resulting from a policy or action. The five principles described below are intended to guide users in estimating and reporting changes in GHG emissions, especially where the standard provides flexibility.**

### Checklist of accounting requirements

| Section | Accounting requirements |
|---|---|
| **Chapter 4: Accounting and Reporting Principles** | • GHG accounting and reporting shall be based on the principles of relevance, completeness, consistency, transparency, and accuracy. |

GHG accounting and reporting **shall** be based on the following five principles:

**Relevance:** Ensure the GHG assessment appropriately reflects the GHG effects of the policy or action and serves the decision-making needs of users and stakeholders—both internal and external to the reporting entity. Users should apply the principle of relevance when selecting the desired level of accuracy and completeness among a range of methodological options. Applying the principle of relevance depends on the objectives of the assessment (Chapter 2).

**Completeness:** Include all significant GHG effects, sources, and sinks in the GHG assessment boundary. Disclose and justify any specific exclusions.

**Consistency:** Use consistent accounting approaches, data collection methods, and calculation methods to allow for meaningful performance tracking over time. Transparently document any changes to the data, GHG assessment boundary, methods, or any other relevant factors in the time series.[1]

**Transparency:** Provide clear and complete information for internal and external reviewers to assess the credibility and reliability of the results. Disclose all relevant methods, data sources, calculations, assumptions, and uncertainties. Disclose the processes, procedures, and limitations of the GHG assessment in a clear, factual, neutral, and understandable manner through an audit trail with clear documentation. The information should be sufficient to enable a party external to the GHG assessment process to derive the same results if provided with the same source data.

**Accuracy:** Ensure that the estimated change in GHG emissions and removals is systematically neither over nor under actual values, as far as can be judged, and that uncertainties are reduced as far as practicable. Achieve sufficient accuracy to enable users and stakeholders to make appropriate and informed decisions with reasonable confidence as to the integrity of the reported information. Accuracy should be pursued as far as possible, but once uncertainty can no longer be practically reduced, conservative estimates should be used. Box 4.1 provides guidance on conservativeness.

In addition, users should follow the principle of comparability if relevant to the assessment objectives.

**Comparability (optional):** Ensure common methodologies, data sources, assumptions, and reporting formats such that the estimated change in GHG emissions and removals resulting from multiple policies or actions can be compared. The principle of comparability should be applied if the objective is for a single entity to assess and compare multiple policies or actions using the same methodology. If the objective is to compare the results of independent assessments of policies carried out by different entities, users should exercise caution in comparing the results of policy assessments based on this standard. Differences in reported emissions impacts may be a result of differences in methodology rather than real-world differences. Additional measures are necessary to enable valid comparisons, such as consistency in the timeframe of the assessments, the types of effects included in the GHG assessment boundary, baseline assumptions, calculation methodologies, methods for assessing policy interactions, and data sources. Additional consistency can be provided through GHG reporting programs or more detailed sector-specific guidance. To understand whether comparisons are valid, all methodologies, assumptions, and data sources used must be transparently reported.

*guidance*

In practice, users may encounter trade-offs between principles when developing a GHG assessment. For example, a user may find that achieving the most complete assessment requires using less accurate data for a portion of the assessment, which would compromise overall accuracy. Conversely, achieving the most accurate assessment may require excluding sources or effects with low accuracy, compromising overall completeness. Users should balance trade-offs between principles depending on their objectives. Over time, as the accuracy and completeness of data increases, the trade-off between these accounting principles will likely diminish.

### Box 4.1 Conservativeness

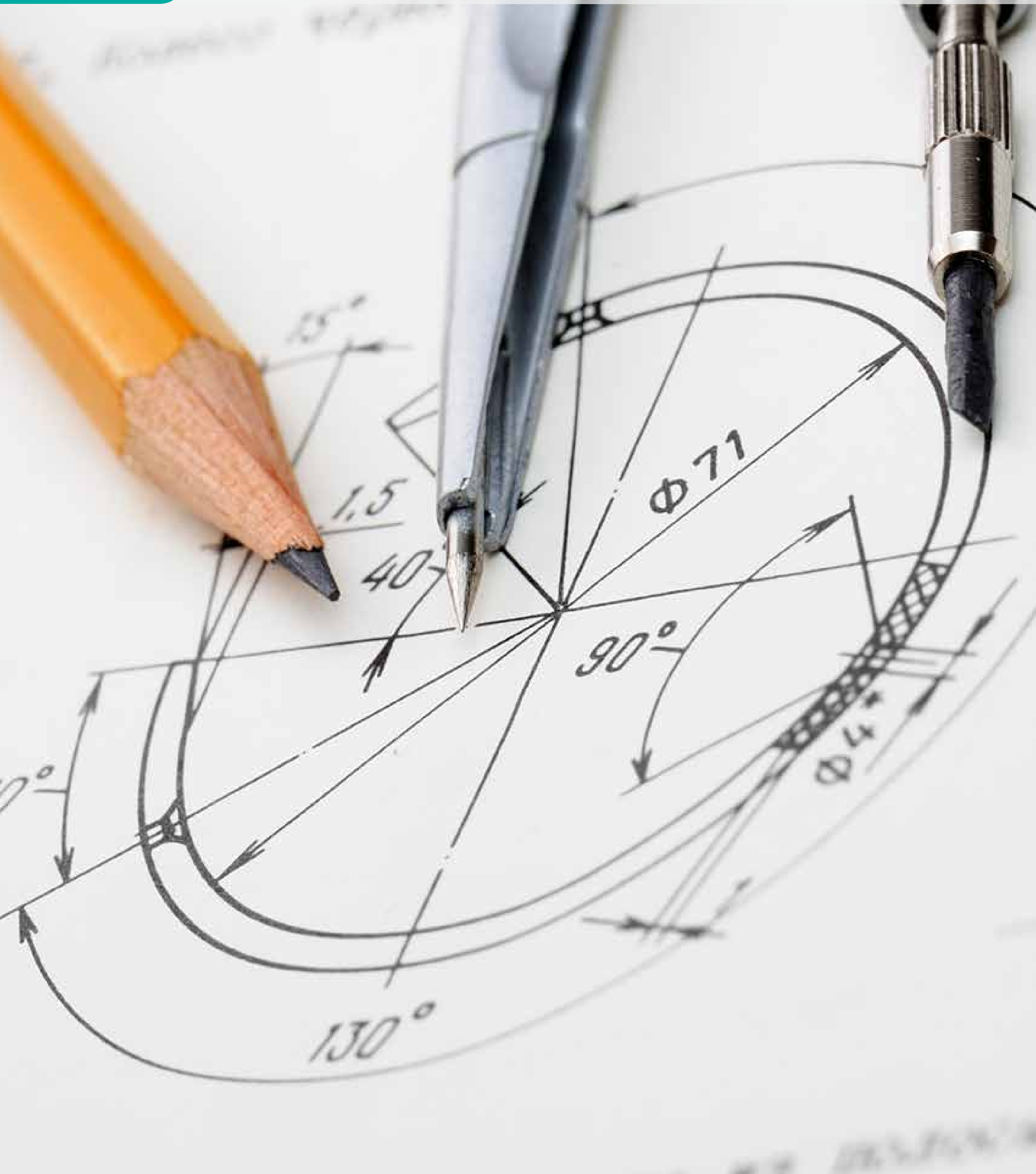
Conservative values and assumptions are those more likely to overestimate GHG emissions or underestimate GHG reductions resulting from a policy or action. Users should consider conservativeness in addition to accuracy when uncertainty can no longer be practically reduced, when a range of possible values or probabilities exists (for example, when developing baseline scenarios), or when uncertainty is high. Whether to use conservative estimates and how conservative to be depends on the objectives and the intended use of the results. The principle of relevance can help guide what approach to use and how conservative to be. For some objectives, accuracy should be prioritized over conservativeness in order to obtain unbiased results.

Conservativeness should not be used as a substitute for collecting accurate data where data exist and can be collected, or as a justification for not improving data collection systems to collect more accurate data. Users should apply sensitivity analysis when uncertainty is high to understand the range of possible outcomes using both more conservative and less conservative assumptions. Chapter 12 provides guidance on uncertainty and sensitivity analysis.

### Endnote

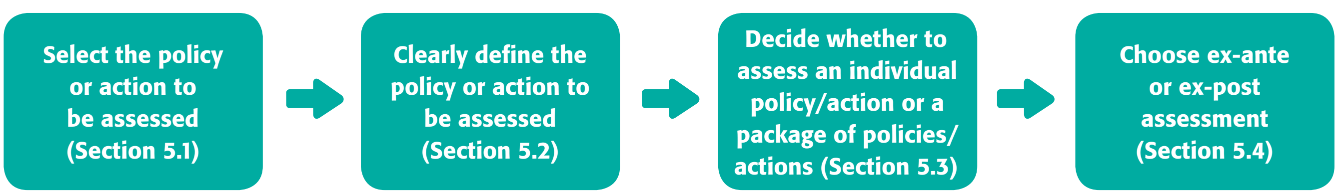
1. For additional guidance on ensuring consistency, see IPCC 2006: Vol. 1, Chap. 5, "Time Series Consistency."

# 5 Defining the Policy or Action



**In order to estimate the GHG effects of a policy or action, users first need to define and provide a detailed description of the policy or action that will be assessed, decide whether to assess an individual policy or action or a package of related policies or actions, and choose whether to carry out an ex-ante or ex-post assessment.**

**Figure 5.1** **Overview of steps in the chapter**




### Checklist of accounting requirements

| Section | Accounting requirements |
|---|---|
| **Define the policy or action to be assessed (Section 5.2)** | • Clearly define the policy or action (or package of policies/actions) that is assessed. |

*Note:* Reporting requirements are listed in Chapter 14.

## 5.1 Select the policy or action to be assessed

Table 5.1 presents general types of policies and actions that may be assessed. Some types of policies and actions are more difficult to assess than others, since the causal relationship between implementation of the policy and its GHG effects may be less direct. For example, information instruments and research, development, and deployment (RD&D) policies may have less direct and measurable effects than regulations and standards. While the standard can be applied to any policy type, subsequent chapters may pose data collection and estimation challenges that hinder a complete and credible assessment.

## 5.2 Define the policy or action to be assessed

A complete and accurate definition and description of the policy or action is necessary to effectively carry out subsequent steps in the assessment process and to transparently report the results.

Users **shall** clearly define the policy or action (or package of policies/actions) that is assessed. Table 5.2 provides a checklist of information that should be provided. At a minimum, users **shall** report the required information in Table 5.2. The optional information in Table 5.2 may be relevant depending on the context.

Users that assess a package of policies/actions should apply Table 5.2 either to the package as a whole or separately to each policy/action within the package. Users that assess a modification of an existing policy or action, rather than a new policy or action, may define the policy to be assessed as either the modification of the policy or the policy as a whole, depending on the objectives.

**Table 5.1 Types of policies and actions**

| Type of policy or action | Description |
|---|---|
| **Regulations and standards** | Regulations or standards that specify abatement technologies (technology standard) or minimum requirements for energy consumption, pollution output, or other activities (performance standard). They typically include penalties for noncompliance. |
| **Taxes and charges** | A levy imposed on each unit of activity by a source, such as a fuel tax, carbon tax, traffic congestion charge, or 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. |
| **Emissions trading programs** | A program that establishes a limit on aggregate emissions from specified sources, requires sources to hold permits, allowances, or other units equal to their actual emissions, and allows permits to be traded among sources. These programs may be referred to as emissions trading systems (ETS) or cap-and-trade programs. |
| **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. Some voluntary agreements include rewards or penalties associated with participating in the agreement or achieving the commitments. |
| **Information instruments** | Requirements for public disclosure of information. These include labeling programs, emissions reporting programs, rating and certification systems, benchmarking, and information or education campaigns aimed at changing behavior by increasing awareness. |
| **Research, development, and deployment (RD&D) 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. |
| **Public procurement policies** | Policies requiring that specific attributes (such as GHG emissions) are considered as part of public procurement processes. |
| **Infrastructure programs** | Provision of (or granting a government permit for) infrastructure, such as roads, water, urban services, and high speed rail. |
| **Implementation of new technologies, processes, or practices** | Implementation of new technologies, processes, or practices at a broad scale (for example, those that reduce emissions compared to existing technologies, processes, or practices). |
| **Financing and investment** | Public or private sector grants or loans (for example, those supporting development strategies or policies). |

*Source:* Adapted from IPCC 2007.

**Table 5.2** **Checklist of information to describe the policy or action assessed**

| Information | Explanation | Example |
|---|---|---|
| **Required information** | | |
| **The title of the policy or action** | Policy or action name | Federal subsidy for home insulation |
| **Type of policy or action** | The type of policy or action, such as those presented in Table 5.1, or other categories of policies or actions that may be more relevant | Subsidy |
| **Description of specific interventions** | The specific intervention(s) carried out as part of the policy or action | Subsidy of $200 per household |
| **The status of the policy or action** | Whether the policy or action is planned, adopted, or implemented | Implemented |
| **Date of implementation** | The date the policy or action comes into effect (not the date that any supporting legislation is enacted) | 2010 |
| **Date of completion (if applicable)** | If applicable, the date the policy or action ceases, such as the date a tax is no longer levied or the end date of an incentive scheme with a limited duration (not the date that the policy/action no longer has an impact on GHG emissions) | 2020 |
| **Implementing entity or entities** | Which entity or entities implement(s) the policy or action, including the role of various local, subnational, national, international, or any other entities | Department of Energy of City X |
| **Objective(s) of the policy or action** | The intended effects(s) or benefit(s) the policy or action intends to achieve (for example, the purpose stated in the legislation or regulation) | Reduction in residential energy use |
| **Geographic coverage** | The jurisdiction or geographic area where the policy or action is implemented or enforced, which may be more limited than all the jurisdictions where the policy or action has an impact | City of X |
| **Primary sectors, subsectors, and emission source/sink categories targeted** | Which sectors, subsectors, and source/sink categories are targeted, using sectors and subsectors from the most recent IPCC *Guidelines for National Greenhouse Gas Inventories* or other sector classifications | Residential energy use (energy sector, IPCC category 1A4b, residential), grid-connected electricity generation (energy sector, IPCC category 1A1ai, electricity generation) |
| **Greenhouse gases targeted (if applicable)** | If applicable, which greenhouse gases the policy or action aims to control, which may be more limited than the set of greenhouse gases that the policy or action affects | $CO_2$, $CH_4$, $N_2O$ |

**Table 5.2 Checklist of information to describe the policy or action assessed (continued)**

| Information | Explanation | Example |
|---|---|---|
| **Other related policies or actions** | Other policies or actions that may interact with the policy or action assessed | Natural gas tax, information campaign to educate residents on the financial benefits of installing insulation |
| **Optional information** | | |
| **Intended level of mitigation to be achieved and/or target level of other indicators (if applicable)** | If relevant and available, the total emissions and removals from the sources and sinks targeted; the target amount of emissions to be reduced or removals to be enhanced as a result of the policy or action, both annually and cumulatively over the life of the policy or action (or by a stated date); and/or the target level of key indicators (such as the number of homes to be insulated) | The residential energy use sector currently emits 1,000,000 t $CO_2e$ annually. The subsidy aims to reduce emissions by 20% to result in annual emissions of 800,000 t $CO_2e$ by 2020. |
| **Title of establishing legislation, regulations, or other founding documents** | The name(s) of legislation or regulations authorizing or establishing the policy or action (or other founding documents if there is no legislative basis) | Energy Policy Act (2005) |
| **Monitoring, reporting, and verification procedures** | References to any monitoring, reporting, and verification procedures associated with implementing the policy or action | Data are collected monthly on number of energy audits carried out, total subsidies provided, and amount of insulation installed; for more information, see website. |
| **Enforcement mechanisms** | Any enforcement or compliance procedures, such as penalties for noncompliance | Audits to ensure installation is installed; for more information, see website |
| **Reference to relevant guidance documents** | Information to allow practitioners and other interested parties to access any guidance documents related to the policy or action (for example, through websites) | N/A |
| **The broader context/ significance of the policy or action** | Broader context for understanding the policy or action, such as other policies or actions that the policy/action replaces, or the political context of the policy/action | See website for a full list of Department of Energy programs and targets to reduce energy use. |
| **Outline of non-GHG effects or co-benefits of the policy or action** | Any anticipated benefits other than GHG mitigation, such as energy security, improved air quality, health benefits, or increased jobs, and any relevant target indicators | Increase in household disposable income resulting from energy savings |
| **Other relevant information** | Any other relevant information | N/A |

## 5.3 Decide whether to assess an individual policy/action or a package of policies/actions

If multiple policies or actions are being developed or implemented in the same timeframe, users may assess the policies or actions either individually or together as a package.[1] When making this decision, users should consider the assessment objectives, feasibility, and the degree of interaction between the policies and actions under consideration.

In subsequent chapters, users follow the same general steps and requirements, whether they choose to assess an individual policy or action or a package of related policies or actions. Depending on the choice, the GHG effect estimated in later chapters will either apply to the individual policy or action assessed or to the package of policies and actions assessed.

Users **shall** report whether the assessment applies to an individual policy/action or a package of related policies/actions. If a package is assessed, users **shall** report which individual policies and actions are included in the package.

### Overview of policy interactions

Multiple policies or actions can either be independent of each other or interact with each other. Policies or actions interact if they produce total effects, when implemented together, that differ from the sum of the individual effects had they been implemented separately. Policies or actions may interact if they affect the same source(s) or sink(s). For example, national and subnational policies in the same sector are likely to interact, since they likely affect the same source(s). Two policies implemented at the same level may also interact—for example, a carbon tax that reduces the GHG intensity of the electricity grid and an energy efficiency policy that reduces demand for electricity. Policies or actions do not interact if they do not affect the same source(s) or sink(s), either directly or indirectly.

Policies or actions that interact with each other can be overlapping, reinforcing, or overlapping and reinforcing. Table 5.3 provides an overview of four possible relationships between policies and actions.

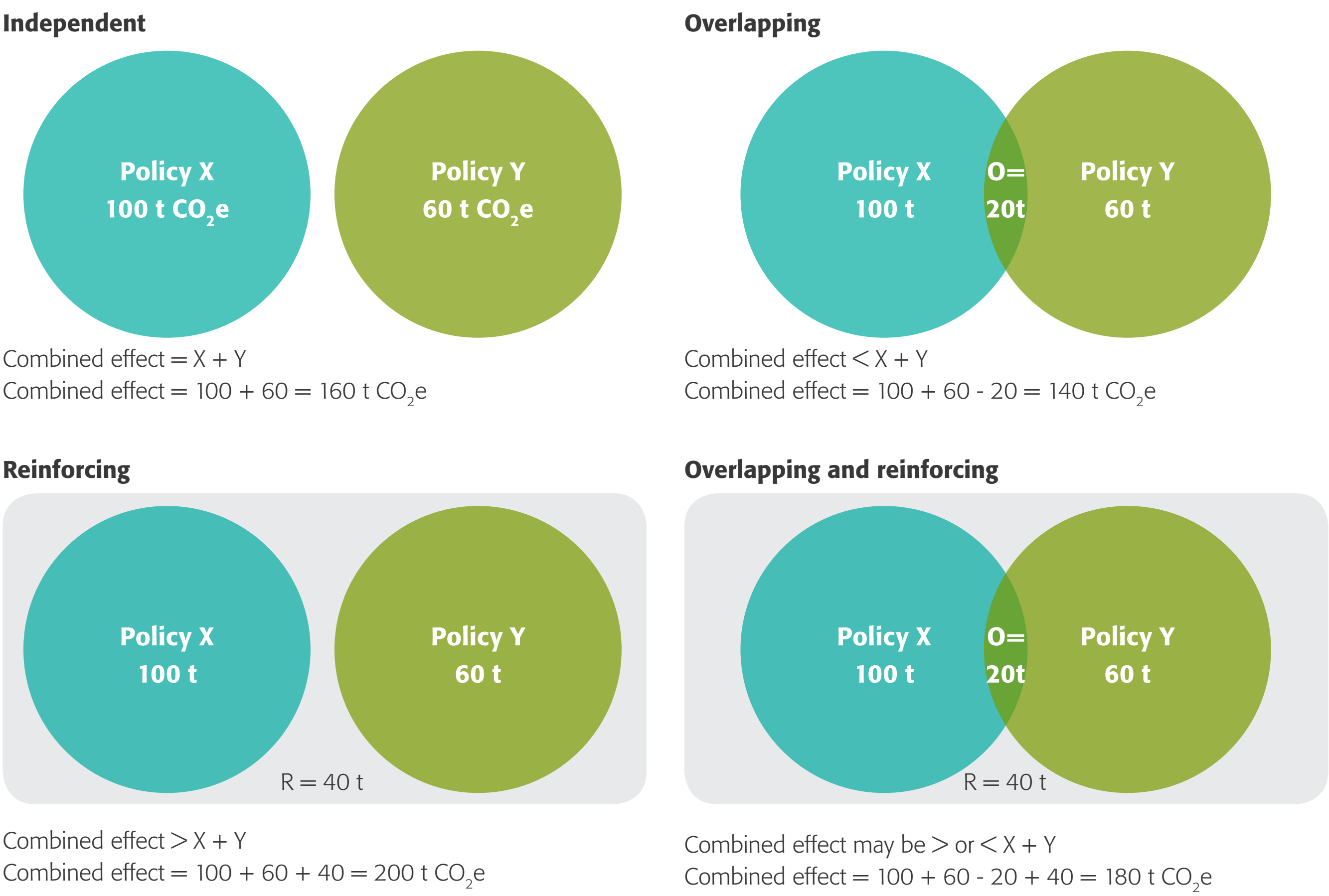
Figure 5.2 illustrates independent, overlapping, and reinforcing policies, as well as policies that may have both overlapping and reinforcing effects. In the figure, Policy X reduces emissions by 100 tonnes $CO_2e$ when implemented on its own and Policy Y reduces emissions by 60 tonnes $CO_2e$ when implemented on its own. Effect O represents an overlapping effect, while Effect R represents a reinforcing effect. See Box 5.1 for an example that illustrates the various possible relationships and the importance of considering interactions when estimating GHG effects.

**Table 5.3** Types of relationships between policies and actions

| Type | Description |
|---|---|
| **Independent** | Multiple policies do not interact with each other. The combined effect of implementing the policies together is equal to the sum of the individual effects of implementing them separately. |
| **Overlapping** | Multiple policies interact, and the combined effect of implementing the policies together is less than the sum of the individual effects of implementing them separately. This includes policies that have the same or complementary goals (such as national and subnational energy efficiency standards), as well as policies that have different or opposing goals (such as a fuel tax and a fuel subsidy). The latter are sometimes referred to as counteracting policies. |
| **Reinforcing** | Multiple policies interact, and the combined effect of implementing the policies together is greater than the sum of the individual effects of implementing them separately. |
| **Overlapping and reinforcing** | Multiple policies interact, and have both overlapping and reinforcing interactions. The combined effect of implementing the policies together may be greater than or less than the sum of the individual effects of implementing them separately. |

*Source:* Adapted from Boonekamp 2006.

**Figure 5.2** Types of relationships between policies and actions




*Note:* Effect O represents an overlapping effect. Effect R represents a reinforcing effect.

**Box 5.1** **Example of interacting policies and actions**

A city government implements a subsidy program for home insulation as well as an information campaign to educate residents on the financial benefits of installing insulation. Both policies are intended to reduce household energy use and emissions. If the subsidy were implemented on its own, 20,000 households would install home insulation, reducing emissions by a total of 40,000 t $CO_2$e/year (see Scenario A). If the information campaign were implemented on its own, 10,000 households would install home insulation, reducing emissions by a total of 20,000 t $CO_2$e/year (see Scenario B).

The two policies would be independent if one set of households responds to the subsidy, while a separate set of households responds to the information campaign. In this case, 30,000 households would install home insulation and the total GHG reduction from both policies being implemented would be 60,000 t $CO_2$e/year (see Scenario C).

However, the policies would overlap if some households would install insulation in either scenario (if *either* the subsidy were in place *or* if the information campaign were in place). Suppose that 5,000 households would install insulation if either one of the policies were in place. In this case, only 25,000 households would install home insulation, resulting in total GHG reductions of 50,000 t $CO_2$e/year, rather than 60,000 t $CO_2$e/year (see Scenario D).

Conversely, the combination of policies may reinforce each other if some households would only install insulation if *both* the subsidy *and* the information campaign were in place (rather than either on its own). Suppose an additional 20,000 households would respond only to the presence of both policies. In this case, 50,000 households would install home insulation (the 20,000 households from Scenario A, the 10,000 households in Scenario B, plus an additional 20,000 households that would only respond to the presence of both policies), resulting in total GHG reductions of 100,000 t $CO_2$e/year (see Scenario E). In practice, there may be both overlapping and reinforcing effects (see Scenario F).

| Scenario | Number of households that install insulation | Total GHG reduction |
|---|---|---|
| A. Subsidy alone is introduced | 20,000 | 40,000 t $CO_2$e/year |
| B. Information campaign alone is introduced | 10,000 | 20,000 t $CO_2$e/year |
| C. Independent case: Both the subsidy and information campaign are introduced. Separate sets of households respond to each policy. | 30,000 | 60,000 t $CO_2$e/year |
| D. Overlapping case: Both the subsidy and information campaign are introduced. Some households would install insulation if *either* policy were in place. | 25,000 | 50,000 t $CO_2$e/year |
| E. Reinforcing case: Both the subsidy and information campaign are introduced. Some households would only install insulation if *both* policies were in place. | 50,000 | 100,000 t $CO_2$e/year |
| F. Overlapping and reinforcing case: Both the subsidy and information campaign are introduced. Some households would install insulation if either policy were in place, while other households would only install insulation if both policies were in place. | 45,000 | 90,000 t $CO_2$e/year |

## 5.3 guidance

To decide whether to assess an individual policy/action or a package of policies/actions, users should:

- Step 1: Characterize the type and degree of interaction between the policies or actions under consideration
- Step 2: Apply criteria to determine whether to assess an individual policy/action or a package of policies/actions

### Step 1: Characterize the type and degree of interaction between the policies or actions under consideration

Potentially interacting policies and actions can be identified by identifying the targeted emission source(s) or sink(s), then identifying other policies and actions that target the same source(s) or sink(s). Once these are identified, users should assess the relationship between the policies/actions (independent, overlapping, or reinforcing) and the degree of interaction (major, moderate, or minor). The assessment of interaction should be based on expert judgment, published studies of similar combinations of policies/actions, or consultations with relevant experts. The assessment should also be qualitative, since a quantitative assessment would require many of the steps needed for a full assessment of both the individual policy/action and the package of policies/actions.

For more guidance on characterizing policy interactions, refer to the policy interaction matrix in Appendix B.

Table 5.4 provides examples of identifying interactions among policies or actions.

### Step 2: Apply criteria to determine whether to assess an individual package/action or a package of policies/actions

If policy interactions exist, there can be advantages and disadvantages to assessing the interacting policies and actions individually or as a package (see Table 5.5). To help decide, users should apply the criteria in Table 5.6.

In some cases, certain criteria may suggest assessing an individual policy/action, while other criteria suggest assessing a package. Users should exercise judgment based on the specific circumstances of the assessment. For example, related policies may have significant interactions (suggesting a package), but it may not be feasible to model the whole package (suggesting an individual assessment). In this case, a user may undertake an assessment of an individual policy (since a package is not feasible), but acknowledge in a disclaimer that any subsequent aggregation of the results from individual assessments would be inaccurate given the interactions between the policies.

**Table 5.4 Examples of identifying policies/actions that target the same emission source and characterizing the type and degree of interaction**

| Policy or action assessed | Targeted emission source(s) or sink(s) | Other policies/actions targeting the same source(s) or sink(s) | Type of interaction | Degree of interaction |
|---|---|---|---|---|
| **Example 1: Subsidy for home insulation** | Household space heating | Energy tax | Overlapping | Moderate |
| | | Information instruments | Reinforcing | Moderate |
| **Example 2: Appliance energy labels** | Energy use in refrigerators | Energy efficiency standards | Overlapping | Moderate |
| | | Subsidies for new appliances | Reinforcing | Moderate |
| **Example 3: Fuel economy regulation** | Emissions of new car fleet | Fuel taxes | Overlapping | Minor |
| | | Biofuel subsidies | Overlapping | Minor |
| | | Rebates for efficient cars | Overlapping | Minor |

**Table 5.5** **Advantages and disadvantages of assessing policies/actions individually or as a package**

| Approach | Advantages | Disadvantages |
|---|---|---|
| **Assessing policies/ actions individually** | • Shows the effectiveness of individual policies/actions, which decision makers may require to make decisions about which individual policies/actions to support<br>• May be simpler than assessing a package in some cases, since the causal chain and range of impacts for a package may be significantly more complex | • The estimated GHG effects from assessments of individual policies cannot be straightforwardly summed to determine total GHG effects, if interactions are not accounted for |
| **Assessing policies/ actions as a package** | • Captures the interactions between policies/actions in the package and better reflects the total GHG effects of the package<br>• May be simpler than undertaking individual assessments in some cases, since it avoids the need to disaggregate the effects of individual policies/actions | • Does not show the effectiveness of individual policies/actions |

**Table 5.6** **Criteria for determining whether to assess policies/actions individually or as a package**

| Criteria | Questions | Guidance |
|---|---|---|
| **Objectives and use of results** | Do the end-users of the assessment results want to know the impact of individual policies/actions, for example, to inform choices on which individual policies/actions to implement or continue supporting? | If "Yes" then undertake an individual assessment |
| **Significant interactions** | Are there significant (major or moderate) interactions between the identified policies/actions, either overlapping or reinforcing, that will be difficult to estimate if policies/actions are assessed individually? | If "Yes" then consider assessing a package of policies/actions |
| **Feasibility** | Will the assessment be manageable if a package of policies/actions is assessed? Is data available for the package of policies/actions? | If "No" then undertake an individual assessment |
| | For ex-post assessments, is it possible to disaggregate the observed impacts of interacting policies/actions? | If "No" then consider assessing a package of policies/actions |

Users may also conduct assessments for both individual policies/actions *and* packages of policies/actions. Doing so will yield more information than conducting only one option or the other. Undertaking both individual assessments and assessments for combinations of policies should be considered if the end-user requires information on both, resources are available to undertake multiple analyses, and undertaking both is practically feasible.

If users choose to assess both an individual policy/action and a package of policies/actions that includes the individual policy/action assessed, users should define each assessment separately and treat each as a discrete application of this standard in order to avoid confusion of the results.

Box 5.2 provides a case study of deciding whether to assess a package of policies.

**Box 5.2 Deciding whether to assess a package of policies for China's industrial energy efficiency policies**

The Institute for Global Environmental Strategies (IGES) carried out an ex-post assessment of China's energy efficiency (EE) policies in the industry sector during the 11th Five-Year Plan (2006–10). The objective was to evaluate to what extent the energy savings achieved by the industry sector during the 11th Five-Year Plan could be attributed to the implementation of EE policies as opposed to other factors.

The first critical step in the assessment was to decide whether to assess policies individually or as a package. IGES initially set out to assess the Top 1000 Enterprises program, which is one of the most significant EE policies in China. The program affects roughly 1,000 of the largest enterprises in nine energy-consuming industries and aimed to achieve energy savings of 100 Mtce (2.9 EJ) during the 11th Five-Year Plan.

However, examining other related EE policies revealed that the enterprises involved in the Top 1000 Enterprises program were also affected by three other policies: (1) the Ten Key Projects energy efficiency program, (2) a value-added tax reduction for utilizing waste heat and pressure, and (3) differentiated electricity pricing. Since all four policies were implemented during the same time period and by the same set of entities, the policies likely interacted with each other. If assessed individually, the sum of energy savings from the policies would likely not accurately represent the total effect on energy conservation. IGES therefore decided to evaluate the four EE policies as a package.

The assessment found that the EE policies collectively achieved energy savings of 316 Mtce (9.2 EJ), accounting for 58 percent of the industry sector's total energy savings from 2006 to 2010. External factors such as economic activity, energy prices, autonomous technology improvements, and structural shifts in the economy accounted for the remainder of the change in sectoral energy use.

## 5.4 Choose ex-ante or ex-post assessment

After defining the policy or action (or package of policies or actions) to be assessed, the next step is to choose whether to carry out an ex-ante assessment, an ex-post assessment, or a combined ex-ante and ex-post assessment. For descriptions of ex-ante and ex-post assessments, see Section 3.2.

Users **shall** report whether the assessment is ex-ante, ex-post, or a combination of ex-ante and ex-post.

### *5.4 guidance*

Choosing between ex-ante or ex-post assessment depends on the status of the policy or action. If the policy or action is planned or adopted, but not yet implemented, then the assessment will be ex-ante by definition. Alternatively, if the policy has been implemented, then the assessment can be ex-ante, ex-post, or a combination of ex-ante and ex-post. In this case, users should carry out an ex-post assessment if the objective is to estimate the effects of the policy or action to date; an ex-ante assessment if the objective is to estimate the expected effects in the future;[2] or a combined ex-ante and ex-post assessment to estimate both the past and future effects of the policy or action.

Box 5.3 provides a case study of carrying out a combined ex-ante and ex-post assessment.

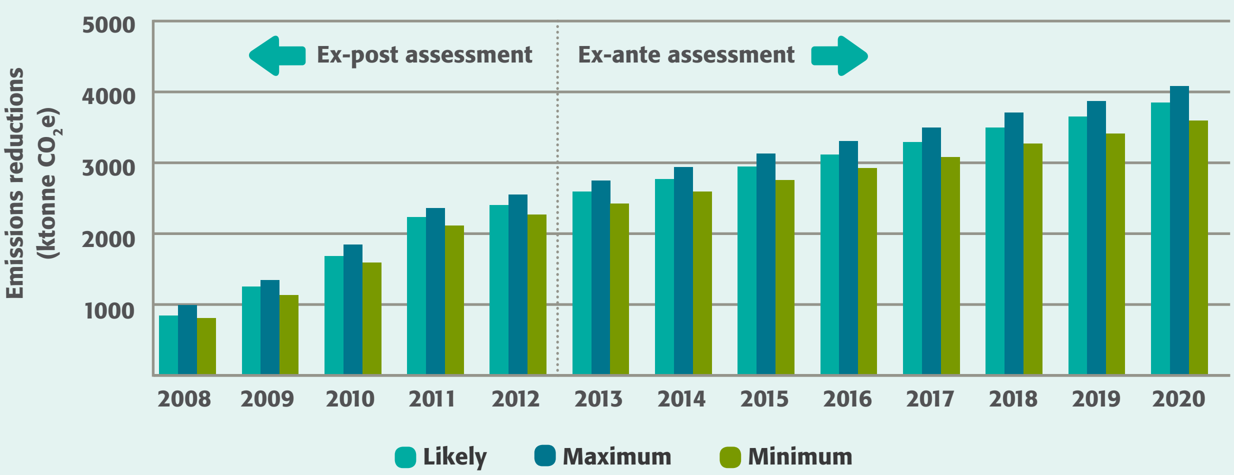
**Box 5.3 Combined ex-ante and ex-post assessment of Belgium's federal tax reduction for roof insulation**

ECONOTEC and VITO, on behalf of the Belgian Federal Public Service, Health, Food Chain Safety, and Environment, carried out a combined ex-ante and an ex-post assessment of the federal tax reduction for roof insulation investments by households in Belgium (ECONOTEC and VITO 2014). The objective was to evaluate the emissions reduction generated as part of a follow-up of the implementation of the Belgian National Climate Plan and the European Union climate policy for 2020.

The assessment was undertaken in 2013. The ex-post assessment covered the Kyoto Protocol first commitment period (2008–12), while the ex-ante assessment covered the years 2013–20. The ex-post assessment shows the contribution to the federal and national commitments in the framework of the Kyoto Protocol, while the latter helps assess to what extent existing policies will be sufficient to meet future targets. In the future, ex-post assessments will also enable the government to evaluate whether implementation is on track.

Figure 5.3 presents the results of the combined ex-post and ex-ante assessment. The assessment includes uncertainty ranges for each year, which were obtained using a Monte Carlo simulation method (further described in Chapter 12).

**Figure 5.3 Ex-post and ex-ante assessment results**



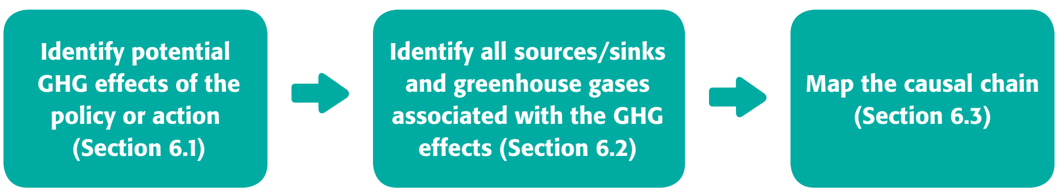

### Endnotes

1. Policies or actions that are implemented earlier in time than the policy or action being assessed should be included in the baseline scenario for the policy or action being assessed. For more information, see Chapter 8.
2. An ex-ante assessment may include historical data if the policy or action is already implemented, but it is still an ex-ante rather than an ex-post assessment if the objective is to estimate future effects of the policy or action.

# 6 Identifying Effects and Mapping the Causal Chain

**In order to estimate GHG effects of the policy or action, users have to first understand what the effects are. This chapter explains how to identify all potential GHG effects of the policy or action and include them in a map of the causal chain. A subset of effects identified in this chapter will then be included in the GHG assessment boundary in Chapter 7.**

**Figure 6.1 Overview of steps in identifying effects and mapping the causal chain**




*Note:* The three steps in this chapter are closely interrelated. Users may carry out the steps in parallel or in any sequence.

### Checklist of accounting requirements

| Section | Accounting requirements |
|---|---|
| **Identify potential GHG effects of the policy or action (Section 6.1)** | • Identify all potential GHG effects of the policy or action.<br>• Separately identify and categorize in-jurisdiction effects and out-of-jurisdiction effects, if relevant and feasible. |
| **Identify all sources/sinks and greenhouse gases associated with the GHG effects (Section 6.2)** | • Identify all source/sink categories and greenhouse gases associated with the GHG effects of the policy or action. |
| **Map the causal chain (Section 6.3)** | • Develop a map of the causal chain. |

*Note:* Reporting requirements are listed in Chapter 14.

## 6.1 Identify potential GHG effects of the policy or action

Users **shall** identify and report all potential GHG effects of the policy or action. GHG effects include both increases and decreases in GHG emissions—as well as increases and decreases in GHG removals—that result from the policy or action. Greenhouse gases include carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2O$), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride ($SF_6$), and nitrogen trifluoride ($NF_3$). Users **shall** separately identify and categorize in-jurisdiction effects and out-of-jurisdiction effects, if relevant and feasible.

### 6.1 guidance

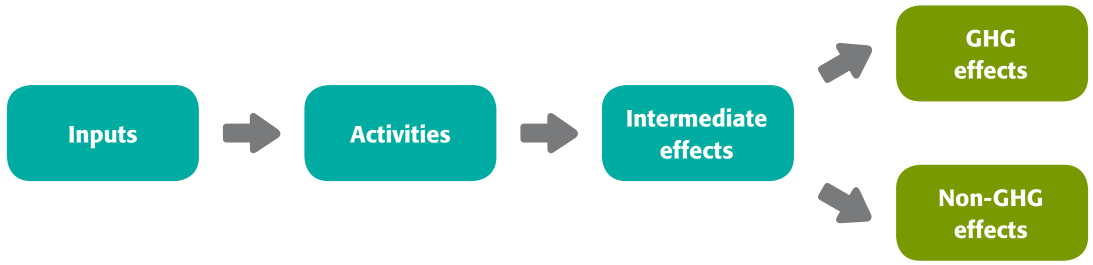
In order to identify the GHG effects of the policy or action, it is useful to first consider how the policy or action is implemented by identifying the relevant *inputs* and *activities* associated with implementing the policy or action. See Table 6.1 for definitions and examples. Understanding inputs and activities is a means to understanding which effects are expected to occur, since inputs are necessary for activities to occur, and activities are necessary for GHG effects to occur (see Figure 6.2). Users should then identify all *intermediate effects* of the policy or action that may lead to GHG effects. Users should ensure that less obvious effects, which may be potentially significant, are not omitted from the assessment. Users may also identify relevant *non-GHG effects* of the policy or action.

**Table 6.1 Summary of inputs, activities, and effects**

| Indicator types | Definitions | Examples for a home insulation subsidy program |
| --- | --- | --- |
| **Inputs** | Resources that go into implementing a policy or action, such as financing | Money needed to implement the subsidy program |
| **Activities** | Administrative activities involved in implementing the policy or action (undertaken by the authority or entity that implements the policy or action), such as permitting, licensing, procurement, or compliance and enforcement | Energy audits, provision of subsidies |
| **Intermediate effects** | Changes in behavior, technology, processes, or practices that result from the policy or action | Consumers purchase and install insulation, home natural gas and electricity use are reduced |
| **GHG effects** | Changes in greenhouse gas emissions by sources or removals by sinks that result from the intermediate effects of the policy or action | Reduced $CO_2$, $CH_4$, and $N_2O$ emissions from reduced natural gas and electricity use |
| **Non-GHG effects** | Changes in relevant environmental, social, or economic conditions other than GHG emissions or climate change mitigation that result from the policy or action | Increase in disposable income due to energy savings |

*Source:* Adapted from W. K. Kellogg Foundation 2004.
*Notes:* In other frameworks, intermediate effects are called "outcomes" and GHG effects and non-GHG effects are called "impacts." In this example (used throughout the standard), homes are heated by natural gas and electricity; in reality, homes may be heated by oil, coal, or other fuels.

**Figure 6.2 Relationship of inputs, activities, intermediate effects, GHG effects, and non-GHG effects**[1]




## Types of effects

To ensure a complete GHG assessment, users should identify as many potential GHG effects as possible. Many effects of the policy or action may not be immediately apparent, and many GHG effects (whether GHG increasing or GHG decreasing) may be far removed from the direct or immediate effects of the policy or action. Policies and actions can lead to effects beyond the sector or country where they are implemented, to a variety of unexpected or unintended consequences, and to long-lasting impacts. For example, RD&D policies may spur technological development over a long time period.

Users should consider the following types of effects:

- **In-jurisdiction and out-of-jurisdiction effects:** Effects that occur inside the geopolitical boundary over which the implementing entity has authority, such as a city boundary or national boundary, as well as effects that occur outside of the geopolitical boundary. Out-of-jurisdiction effects are called *spillover effects* or *multiplier effects* if they reduce emissions outside the jurisdictional boundary, and *leakage* if they increase emissions outside the jurisdictional boundary. Jurisdictional boundaries may not be relevant for all GHG assessments (for example, for private sector actions).
- **Short- 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. Users should define the distinction between "short term" and "long term" based on the individual assessment (for example, 5 years or 10 years). Some effects may also be temporary, while others are permanent.
- **Intended and unintended effects:** Effects that are both intentional and unintentional, based on the original objectives of the policy or action. Unintended effects may include a variety of effects, such as *rebound effects* (marginal increases in energy-using activities or behavior resulting from energy efficiency improvements);[2] effects in sectors other than the targeted sector (such as leakage between sectors); effects on members of society not targeted by the policy or action (sometimes called non-participant spillover effects); effects on behavior once a policy is announced but before it is implemented (such as early action); or lack of compliance or enforcement. Unintended effects may increase or decrease emissions.
- **Likely, possible, and unlikely effects:** All potential effects, regardless of how likely they are to occur.
- **GHG increasing and decreasing effects:** Effects that both increase and decrease GHG emissions from sources and removals of GHGs by sinks.

See Table 6.2 for examples of the various types of effects for an illustrative policy.

**Table 6.2 Illustrative example of various effects for a United States vehicle fuel efficiency standard**

| Type of effect | Examples of effects |
|---|---|
| **Intended effect** | • Fuel consumption and tailpipe emissions per mile driven are reduced. |
| **Unintended effect** | • Some consumers drive further distances, since improved vehicle fuel efficiency decreases the cost of driving per kilometer, thereby reducing some of the emissions benefits. This is called a *rebound effect.*<br>• Emissions from the U.S. electricity generation sector increase as a result of more electric vehicles being sold. |
| **In-jurisdiction effect** | • Automakers in the U.S. produce and sell more efficient cars, which reduces gasoline consumption in the United States. 00 |
| **Out-of-jurisdiction effect** | • Because of the U.S. regulation, Canada adopts a similar vehicle fuel efficiency regulation, leading to reduced emissions from cars in Canada. This is a *spillover effect.*<br>• U.S. automakers might sell old models to countries without similar standards, which could increase emissions in other countries *(leakage).* |
| **Short-term effect** | • U.S. automakers produce more efficient vehicles, using the same basic technology (cars fueled by gasoline and diesel). |
| **Long-term effect** | • U.S. automakers develop new vehicle technologies that reduce emissions even further, such as zero emissions vehicles. |

Users should also consider potential GHG effects in terms of the following:

- **Technology effects:** Design or deployment of new technologies
- **Infrastructure effects:** Development of new infrastructure
- **Consumer behavior and practices:** Changes in purchasing decisions or other practices
- **Business behavior and practices:** Changes in manufacturing decisions or other practices
- **Market effects:** Changes in supply and demand, changes in prices, or changes in market structure or market share resulting from the policy or action
- **Life-cycle effects:** Changes in upstream and downstream activities, such as extraction and production of energy and materials, or effects in sectors not targeted by the policy or action
- **Macroeconomic effects:** Changes in macroeconomic conditions, such as GDP, income, employment, or structural changes in economic sectors
- **Trade effects:** Changes in imports and exports, such as leakage

The above lists of types of effects are intended to guide the development of a comprehensive list of potential effects. They are not intended to be prescriptive or exhaustive. Not all types of effects listed may be relevant to the policy or action under consideration, and not all relevant effects may be listed. The various types of effects are also not mutually exclusive. Each effect will be a combination of the characteristics listed above. For example, a single effect may be out-of-jurisdiction, long-term, unintended, possible, and GHG increasing and may involve market effects, life-cycle effects, and trade effects.

While users should identify a long list of potential effects in this step, not all potential effects need to be included in the GHG assessment boundary in Chapter 7.

## Methods for identifying GHG effects

Various approaches may be used to identify potential effects, such as the following:

- Literature review of prior assessments of similar policies and circumstances

- Consultations, surveys, or panels with relevant experts and stakeholders
- Review of regulations, statutory authorities, development plans, regulatory impact analyses, environmental impact assessments, or economic studies
- Sector-specific guidance or methodologies
- Expert judgment

### Separate tracking of in-jurisdiction and out-of-jurisdiction effects

By separately identifying and categorizing in-jurisdiction and out-of-jurisdiction effects, users can more accurately link the GHG effects of the policy or action to the relevant jurisdiction's GHG inventory and any jurisdiction-level GHG mitigation goals (since out-of-jurisdiction GHG effects do not contribute to GHG mitigation goals that apply only to emission sources within the jurisdictional boundary). Separate categorization also creates transparency around any potential double counting of out-of-jurisdiction effects between jurisdictions.

In certain cases, a single effect may affect both in-jurisdiction and out-of-jurisdiction emissions. In this case, separate tracking may not be feasible. Alternatively, users may choose to apportion the effect between in-jurisdiction emissions and out-of-jurisdiction emissions based on assumptions.

### Identifying non-GHG effects

Users may also identify any non-GHG effects of the policy or action that are relevant to the assessment, which may include the following:

- Environmental effects, such as improved air quality or water quality
- Social effects, such as improved health or quality of life
- Economic effects, such as increased employment, income, or GDP

See Appendix C for additional examples of non-GHG effects.

## 6.2 Identify source/sink categories and greenhouse gases associated with the GHG effects

Users **shall** identify and report a list of all source/sink categories and greenhouse gases associated with the GHG effects of the policy or action. This step is necessary since estimation of baseline emissions and policy scenario emissions (in Chapters 8, 9, and 11) occurs at the level of individual source/sink categories and greenhouse gases.

### 6.2 guidance

Sources are processes or activities that release GHGs into the atmosphere. Sinks are processes or activities that increase storage or removals of GHGs from the atmosphere. The IPCC *Guidelines for National Greenhouse Gas Inventories* provides definitions of source/sink categories that may be used.[3]

In addition to the greenhouse gases covered by the UNFCCC and the Kyoto Protocol ($CO_2$, $CH_4$, $N_2O$, HFCs, PFCs, $SF_6$, and $NF_3$), users may identify additional gases that are identified by the IPCC or covered by the Montreal Protocol.[4] If additional gases are included in the assessment, users should report the results with and without additional gases included.

Table 6.3 provides examples of source/sink categories and greenhouse gases.

### Defining source/sink categories

Users may define sources and sinks either as individual sources and sinks (such as fossil fuel combustion in specific power plants) or as aggregated categories of sources and sinks (such as all fossil fuel combustion in all power plants connected to an electric grid). The decision of whether to identify individual sources/sinks or categories of sources/sinks depends on the policy or action assessed, the types of data collected and monitored, and the estimation methods used. Individual sources correspond to bottom-up data and aggregated sources correspond to top-down data.

When defining affected sources and sinks, users should consider defining the sources and sinks narrowly around the specific processes or activities affected by the policy or action. This helps ensure that processes or activities not affected by the policy or action are not unnecessarily estimated in later steps.

Using the example of a home insulation subsidy, users may define a source as "residential natural gas combustion for space heating" (for the whole residential sector) or may define the source more narrowly as "residential natural gas combustion for space heating in homes that receive the subsidy." Likewise, users may define a source as "fossil fuel

**Table 6.3** Examples of sources/sinks and greenhouse gases

| Source category | Description | Examples of emitting equipment or entity | Relevant greenhouse gases |
|---|---|---|---|
| **Stationary fossil fuel combustion** | Combustion of fuels to generate energy | Power plants, industrial facilities, boilers, furnaces, turbines | $CO_2$, $CH_4$, $N_2O$ |
| **Mobile fossil fuel combustion** | Combustion of fuels | Trucks, trains, airplanes, ships, cars, buses | $CO_2$, $CH_4$, $N_2O$ |
| **Cement manufacture** | Chemical or physical processes | Industrial facilities | $CO_2$ |
| **Aluminum production** | Chemical or physical processes | Industrial facilities | $CO_2$, PFCs |
| **Natural gas systems** | Fugitive emissions from natural gas transmission and distribution systems | Pipelines | $CH_4$, $CO_2$ |
| **Landfills** | Degradation or decomposition of waste | Landfills | $CH_4$ |
| **Electrical transmission and distribution** | Fugitive emissions | Electricity T&D systems | $SF_6$ |
| **Refrigeration and air conditioning equipment** | Fugitive emissions from equipment | Refrigeration and air conditioning equipment | HFCs |
| **Agricultural soil management** | Biological processes, emissions from fertilizer use | Agricultural soils | $CO_2$, $N_2O$ |
| **Forests and other land use** | Forest degradation, deforestation | Forests, vegetation, soils | $CO_2$, $CH_4$, $N_2O$ |

| Sink category | Description | Examples of equipment or entity | Relevant greenhouse gases |
|---|---|---|---|
| **Biological processes** | Removal and storage of $CO_2$ through photosynthesis | Forests, vegetation, soils | $CO_2$ |
| **Carbon capture and storage** | Removal and storage of $CO_2$ | Industrial facilities, power plants, geological formations | $CO_2$ |

combustion in grid-connected power plants" (for the whole electricity generation sector) or may define the source more narrowly as "fossil fuel combustion in grid-connected power plants for supplying electricity to the homes that receive the subsidy." How best to define the source depends on the estimation methods and data that will be used.

## 6.3 Map the causal chain

A causal chain is a conceptual diagram tracing the process by which the policy or action leads to GHG effects through a series of interlinked logical and sequential stages of cause-and-effect relationships. Mapping the causal chain can help identify effects not previously identified. It also helps the user and decision makers understand in visual terms how the policy or action leads to changes in emissions, which can serve as a useful tool to enhance policy design, improve understanding of policy effectiveness, and communicate the effects of the policy to stakeholders.

Users **shall** develop and report a causal chain for the policy or action assessed, based on the effects identified in Section 6.1 and the sources/sinks and greenhouse gases identified in Section 6.2.

Users assessing a package of policies and actions may either (1) develop a single causal chain for the package as a whole or (2) develop separate causal chains for each policy or action included in the package. Either approach is likely to help identify overlaps and interactions between the policies and actions included in the package, which may be useful in subsequent estimation steps.

### 6.3 guidance

### Scope

At a minimum, the causal chain should include all intermediate effects and GHG effects that have been identified. Since the various categories of effects outlined in Section 6.1 are not mutually exclusive, users should be sure not to include the same effect in the causal chain twice.

Figure 6.3 provides a generic example of a causal chain that includes intermediate effects and GHG effects.

**Figure 6.3 Generic example of mapping GHG effects by stage**

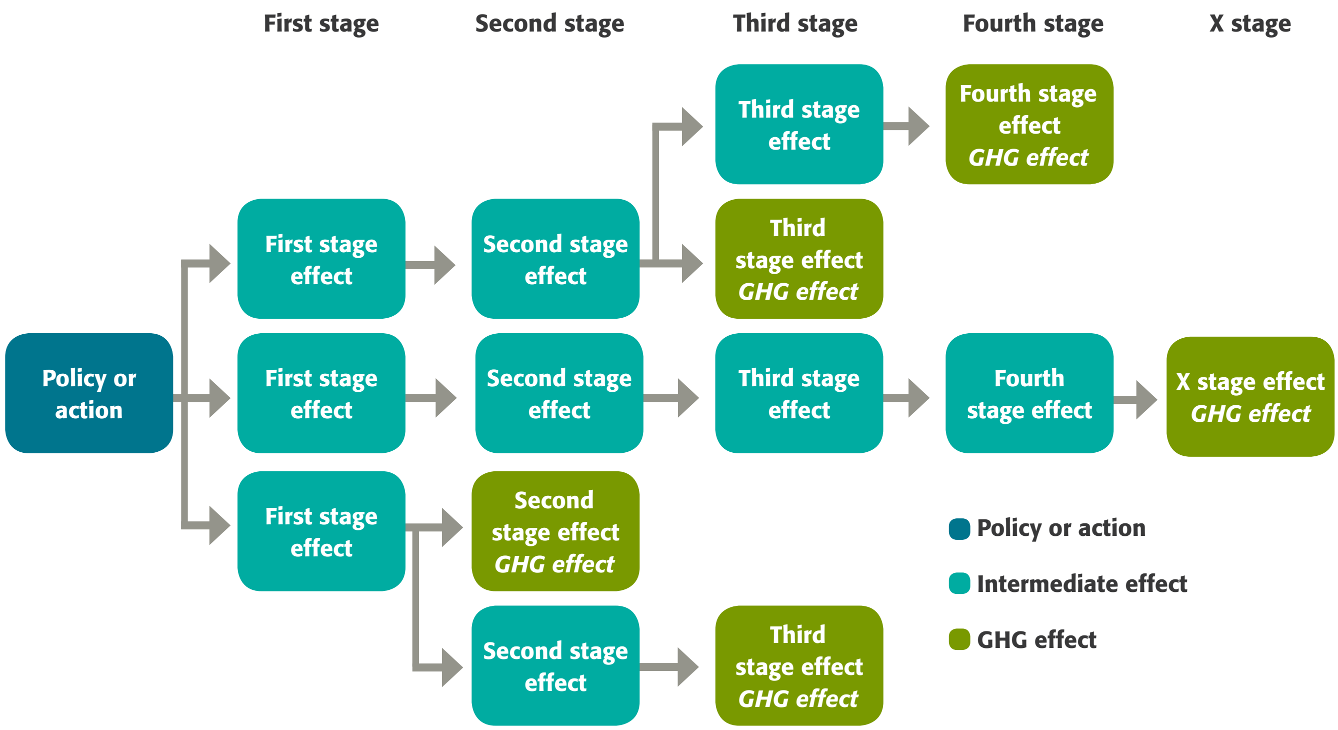
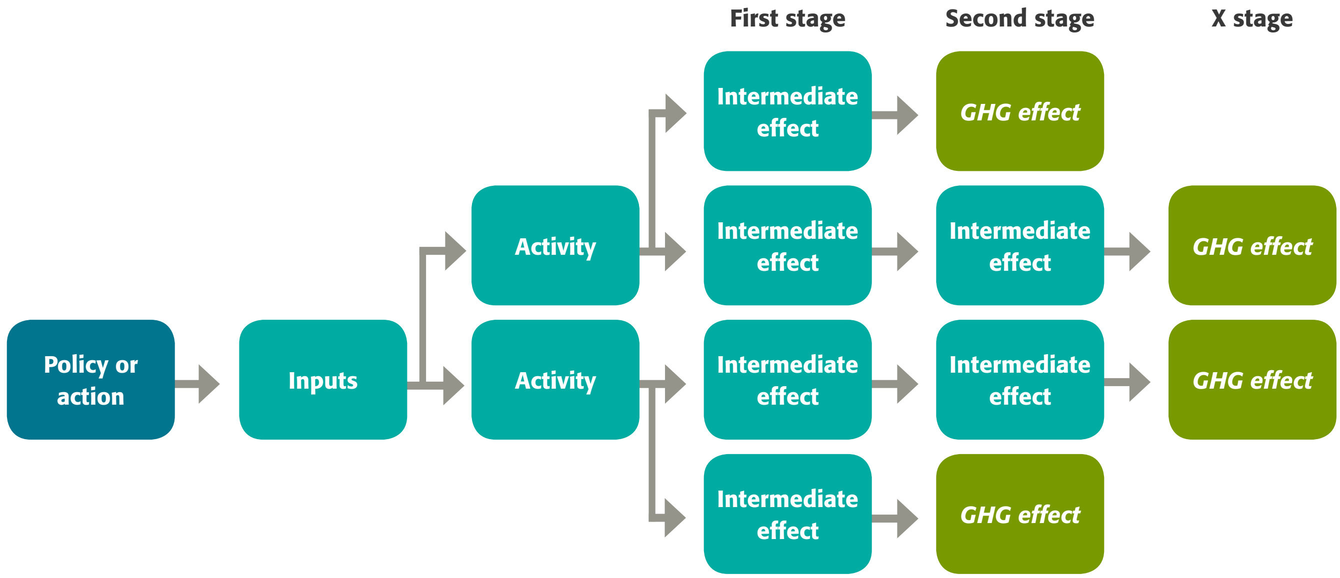


**Figure 6.4** Generic example of mapping inputs, activities, and effects by stage




Users may include inputs and activities in the causal chain as steps toward identification of effects. See Figure 6.4 for a generic example that includes inputs and activities along with intermediate effects and GHG effects. Users should include non-GHG effects along with GHG effects in the causal map, if relevant.

The causal chain represents the changes expected to occur as a result of the policy or action. Implicitly, these changes are relative to a baseline scenario that represents the conditions most likely to occur in the absence of the policy or action. Users may refine the causal chain after more clearly defining the baseline scenario in Chapter 8. Users may also choose to develop two separate causal chains—one representing the baseline scenario and one representing the policy scenario—rather than a single causal chain representing the policy scenario.

Users should separately indicate which GHG effects in the causal chain are in-jurisdiction effects and which are out-of-jurisdiction effects, if relevant and feasible.

## Stages

To develop the causal chain, users should identify the proximate (first stage) effects of the policy or action. Each first stage effect represents a distinct "branch" of the causal chain. Users should then extend each branch of the causal chain through a series of cause-and-effect relationships—that is, a series of intermediate effects—until it leads to a GHG effect—a change in GHG emissions or removals occurring at a source or sink. For example, a change in electricity use (an intermediate effect) should be followed through the causal chain until it reaches a change in fuel combustion to generate grid-connected electricity (a GHG effect occurring at a source).

In some cases, multiple branches of effects lead to distinct sources or sinks. In other cases, two or more branches of effects lead to the same source or sink (if the policy or action has two or more effects on the same source or sink). See Figure 6.5 for an example where two distinct effects (emissions per kilometer traveled decrease and consumers drive more) lead to the same source (tailpipe emissions from cars).

## Completeness

The causal chain should be as comprehensive as possible, rather than limited by geographic or temporal boundaries. To make the mapping step more practical, users should only include those branches of the causal chain that are reasonably expected to lead to changes in GHG emissions or removals. Users do not need to identify effects or branches that are unrelated to changes in GHG emissions or removals. Where feasibility is a concern, users may summarize the GHG effect for each branch without mapping each intermediate effect for each stage separately.

See Figure 6.6 for an illustrative causal chain for a subsidy for home insulation. Table 6.4 provides an example of developing a list of potential GHG effects, affected sources and sinks, and affected greenhouse gases for the same policy example.

See Box 6.1 for a case study of developing a causal chain for Belgium's offshore wind promotion program.

**Figure 6.5 Example of multiple effects leading to the same source (for an illustrative vehicle fuel efficiency regulation)**

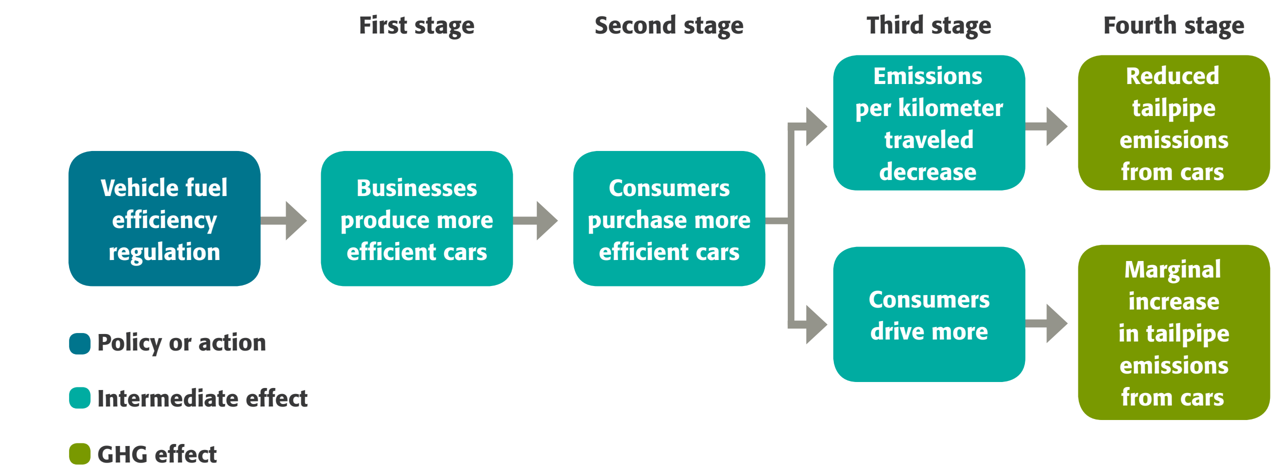



**Figure 6.6 Example of a causal chain for an illustrative subsidy for home insulation**

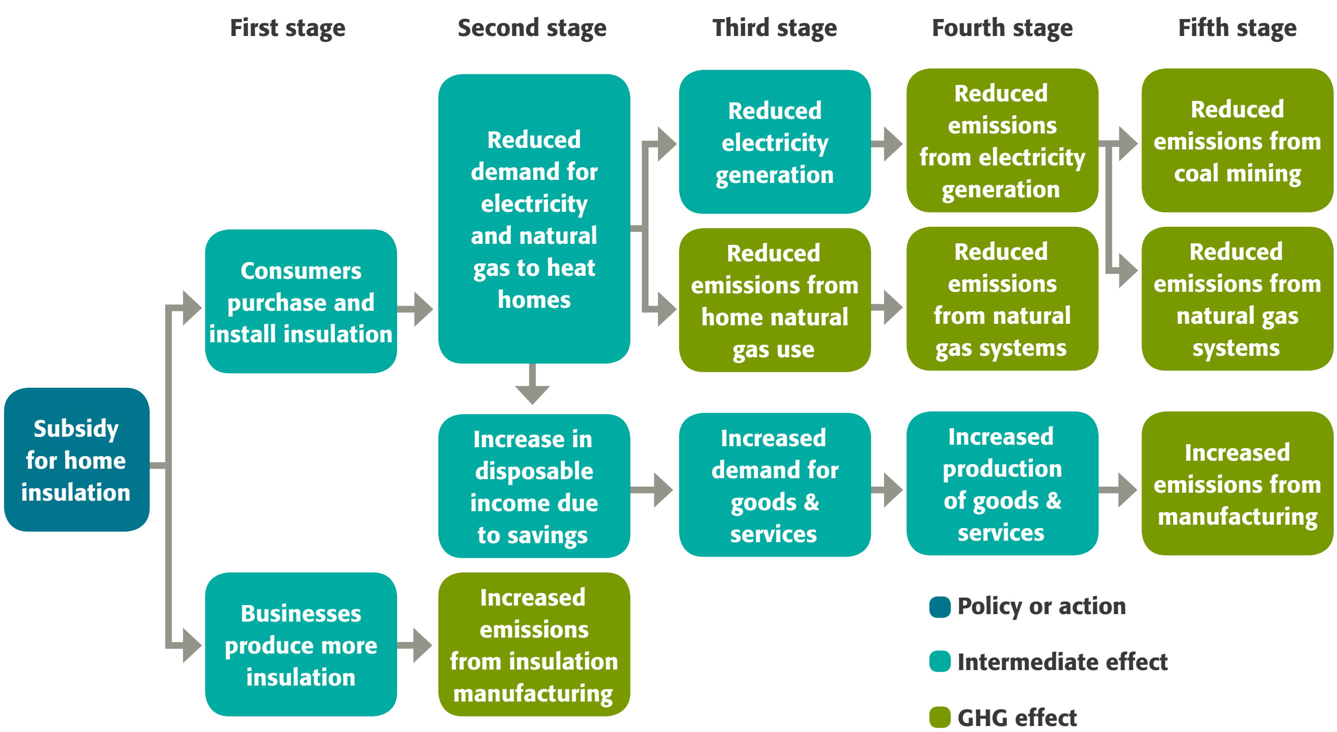


**Table 6.4 Example of developing a list of potential GHG effects, affected sources and sinks, and affected greenhouse gases for a home insulation subsidy program**

| Potential GHG effect | Affected sources | Affected sinks | Affected greenhouse gases |
|---|---|---|---|
| **Reduced emissions from electricity generation** | Combustion of fuels to generate grid-connected electricity for use in homes | N/A | $CO_2$, $CH_4$, $N_2O$ |
| **Reduced emissions from coal mining** | Coal mines | N/A | $CH_4$ |
| **Reduced emissions from natural gas systems (from reduced electricity use)** | Natural gas systems | N/A | $CO_2$, $CH_4$ |
| **Reduced emissions from home natural gas use (space heating)** | Residential natural gas combustion (space heating) | N/A | $CO_2$, $CH_4$, $N_2O$ |
| **Reduced emissions from natural gas systems (from reduced natural gas use)** | Natural gas systems | N/A | $CO_2$, $CH_4$ |
| **Increased emissions from manufacturing** | Manufacturing processes | N/A | $CO_2$, $CH_4$, $N_2O$ |
| **Increased emissions from insulation manufacturing** | Insulation manufacturing processes | N/A | $CO_2$, $CH_4$, $N_2O$, HFCs |

**Box 6.1 Developing a causal chain for Belgium's offshore wind energy promotion program**

VITO, on behalf of the Belgian Federal Public Service, Health, Food Chain Safety, and Environment, carried out a combined ex-post and ex-ante assessment of a package of policies taken by the Belgian federal government to promote the development of offshore wind energy. These policies include a green certificate scheme that offers financial support to offshore wind turbine operators for each megawatt of electricity generated. The objective of the assessment was to estimate the GHG effects (both in-jurisdiction and out-of-jurisdiction) of the program.

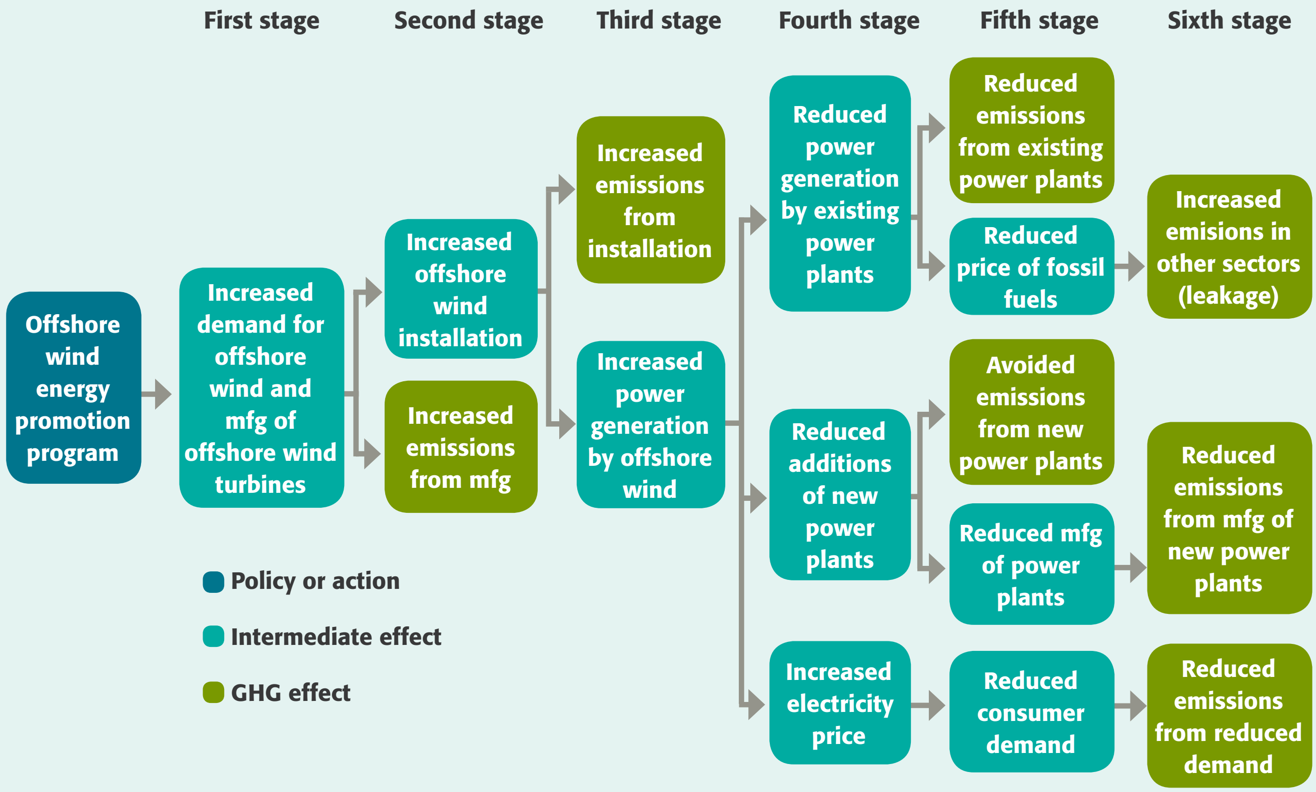
The first step was to identify and map all the sources and sinks affected by the program. Three categories of affected sources and sinks were identified:

1. Increased GHG emissions resulting from the construction, installation, and connection to the grid of the offshore wind turbines.
2. Avoided emissions from electricity generation relative to a baseline scenario without offshore wind energy. It is assumed that without offshore wind, the same amount of electricity would have been generated by a combined cycle gas turbine power station, which could be from an existing power plant or a new installation.
3. Changes in emissions from macroeconomic effects resulting from the green certificate scheme, which will increase electricity prices for industry, the commercial sector, and households and thus affect electricity consumption.

The causal chain (see Figure 6.7) proved to be a useful tool to identify all the sources and sinks affected by the policy, beyond the boundaries normally used in impact assessments. Although not all of the effects were included in the GHG assessment boundary and estimated at a later stage, mapping the causal chain was an insightful way to illustrate that policies can have significant upstream and downstream effects as well as in-jurisdiction and out-of-jurisdiction effects.

**Box 6.1 Developing a causal chain for Belgium's offshore wind energy promotion program (continued)**

**Figure 6.7 Causal chain of Belgium's offshore wind energy promotion program**



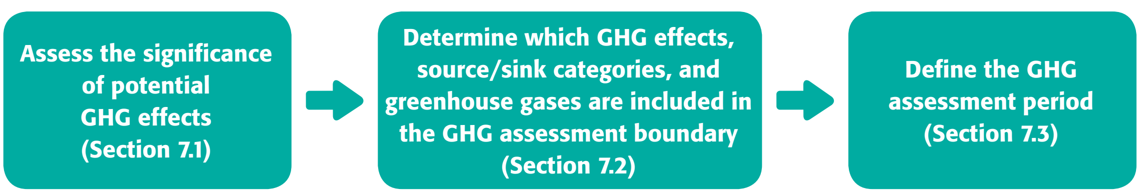

## Endnotes

1. Some non-GHG effects may also lead to GHG effects, such as an increase in disposable income from home insulation leading to more consumption and therefore more emissions (as illustrated in Figure 6.6).
2. For example, households using more space heating in winter as a result of energy efficiency improvements that allow for higher indoor temperatures at lower costs.
3. See IPCC 2006: Vol. 1, Chap. 8, Sec. 8.5, "Classification and Definition of Categories."
4. Additional gases include chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), halogenated ethers, nitrogen oxide ($NO_x$), non-methane volatile organic compounds (NMVOC), carbon monoxide (CO), sulfur dioxide ($SO_2$), and ammonia ($NH_3$). For more information, see IPCC 2006: Vol. 1, Chap. 8, Sec. 8.2.2, "Gases Included." Users may also separately estimate the effects of the policy or action on black carbon as long as the results are not aggregated with other GHGs included in the assessment.

# 7 Defining the GHG Assessment Boundary

**In this chapter, users define the GHG assessment boundary by determining which potential GHG effects identified in Chapter 6 are significant. The GHG assessment boundary defines the scope of the assessment in terms of the range of GHG effects, sources and sinks, and greenhouse gases included in the assessment. This chapter also defines the GHG assessment period—the time period over which GHG effects resulting from the policy or action are assessed.**

**Figure 7.1 Overview of steps for defining the GHG assessment boundary**




### Checklist of accounting requirements

| Section | Accounting requirements |
|---|---|
| **Determine which GHG effects, source/sink categories, and greenhouse gases to include in the GHG assessment boundary (Section 7.2)** | • Include all significant GHG effects, source/sink categories, and greenhouse gases in the GHG assessment boundary. |
| **Define the GHG assessment period (Section 7.3)** | • Define the GHG assessment period based on the GHG effects included in the GHG assessment boundary. |

*Note:* Reporting requirements are listed in Chapter 14.

## 7.1 Assess the significance of potential GHG effects

The primary step in defining the GHG assessment boundary is to assess each of the potential GHG effects identified in the causal chain to determine which are significant and should therefore be included in the GHG assessment boundary. Any type of effect may be significant, including in-jurisdiction and out-of-jurisdiction effects and short-term and long-term effects.

### 7.1 guidance

In order to identify significant effects, users should assess each potential GHG effect in terms of both:

- The likelihood that each GHG effect will occur (Step 1); and
- The relative magnitude of each GHG effect (Step 2).

#### Step 1: Estimate the likelihood that each GHG effect will occur

For each potential effect identified in Chapter 6, users should estimate the likelihood that it will occur by classifying each effect according to the options in Table 7.1. For ex-ante assessments, this involves predicting the likelihood of the effect occurring in the future as a result of the policy or action. For ex-post assessments, this involves assessing the likelihood that the effect occurred in the past as a result of the policy or action. (Certain effects may have occurred during the GHG assessment period for reasons unrelated to the policy or action being assessed.) In cases where the likelihood is unknown or cannot be estimated, the effect should be classified as "possible."

The likelihood should be based on evidence to the extent possible, such as published literature, prior experience, modeling results, risk management methods, consultation with experts and stakeholders, or other methods. If relevant evidence does not exist, expert judgment should be used.

#### Step 2: Estimate the relative magnitude of each GHG effect

Next, users should categorize the relative magnitude of each GHG effect as major, moderate, or minor. This involves approximating the change in GHG emissions and removals resulting from each GHG effect. The relative magnitude of each effect depends on the size of the source/sink category affected and the magnitude of change expected to result from each source/sink category. The size of the source/sink category affected may be estimated based on jurisdictional GHG inventories or other sources.

**Table 7.1 Assessing likelihood of GHG effects**

| Likelihood | Description |
|---|---|
| **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%.) |
| **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%.) |
| **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%.) 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%.) |
| **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%.) |

*Source:* Adapted from IPCC 2010.

Users do not need to accurately calculate GHG effects in this step, but the relative magnitude should be categorized as major, moderate, or minor based on evidence to the extent possible. Evidence may include results from previous studies and literature, prior experience, emission factor databases (national or international), life-cycle databases or studies (for out-of-jurisdiction effects), consultation with experts and stakeholders, or other methods. If evidence does not exist, expert judgment should be used. Users should consider the size of the groups (such as businesses or consumers) expected to take action as a result of the policy, if relevant. Users may estimate changes in relevant activity data (such as changes in vehicle kilometers traveled or electricity consumption), rather than changes in emissions. To follow a more rigorous approach, users may estimate each potential GHG effect by using simplified calculation methods.

The relative magnitude of each GHG effect should be estimated based on the absolute value of the total change in GHG emissions and removals associated with the various effects, taking into account both increases and decreases in GHG emissions and removals. For more information, see Box 7.1.

Table 7.2 provides percentage figures as a rule of thumb to help identify whether an effect is major, moderate, or minor. The percentage figures represent the estimated relative magnitude of the GHG effect being considered (in absolute value terms), relative to the estimated total change in GHG emissions and removals resulting from the policy or action (in absolute value terms). Users may choose to use different percentage thresholds than those presented in Table 7.2.

**Box 7.1 Estimating relative magnitude based on absolute values**

The absolute value of a number is the non-negative value of that number without regard to its sign. For example, the absolute value of 5 is 5, and the absolute value of -5 is also 5. When estimating the relative magnitude of effects, users should compare effects based on their absolute value. For example, assume that one effect increases emissions by 1,000 t $CO_2e$, a second effect reduces emissions by 2,000 t $CO_2e$, and a third effect enhances removals by 3,000 t $CO_2e$. To compare each effect, users should estimate the total change in emissions in absolute value terms, as follows: $|1{,}000 \text{ t } CO_2e| + |-2000 \text{ t } CO_2e| + |-3{,}000 \text{ t } CO_2e| = 6{,}000 \text{ t } CO_2e$. The relative magnitude of each effect should be compared to other effects in relation to the total change in absolute value terms. In this example, the first effect represents one-sixth of the total estimated change, the second effect represents two-sixths (or one-third) of the estimated change, and the third effect represents three-sixths (or one-half) of the total estimated change in emissions in absolute value terms.

**Table 7.2 Assessing relative magnitude of GHG effects**

| Relative magnitude | Description | Approximate relative magnitude (rule of thumb) |
|---|---|---|
| **Major** | The effect significantly influences the effectiveness of the policy or action. The change in GHG emissions or removals is likely to be significant in size. | > 10% |
| **Moderate** | The effect influences the effectiveness of the policy or action. The change in GHG emissions or removals could be significant in size. | 1%–10% |
| **Minor** | The effect is inconsequential to the effectiveness of the policy or action. The change in GHG emissions or removals is insignificant in size. | < 1% |

### Assessing relative magnitude separately by source/sink category

Depending on how a GHG effect is defined, it may affect one source/sink category or multiple source/sink categories. If it affects more than one source/sink category, the relative magnitude of the GHG effect should be assessed separately by source/sink category, since not all sources/sinks affected may be significant and some may therefore be excluded. The relative magnitude depends on both the size of the source/sink category—estimated based on national emission factors, jurisdictional GHG inventories, or other sources—and the magnitude of change expected to result from each source/sink category.

### Assessing relative magnitude separately by gas

If a GHG effect affects more than one greenhouse gas, the relative magnitude of the GHG effect should be assessed separately for each gas. Doing so can enable the exclusion of certain gases, since not all greenhouse gases related to a given effect may be significant. For example, if an insulation subsidy reduces natural gas combustion, the relative magnitude of each affected greenhouse gas ($CO_2$, $CH_4$, and $N_2O$) should be separately assessed. The change in $CO_2$ emissions may be expected to be major, but the change in $N_2O$ emissions may be expected to be minor. In this case, $N_2O$ may be excluded from the assessment. The relative magnitude depends on both the relative contribution of the greenhouse gas—estimated based on national emission factors, jurisdictional GHG inventories, or other sources—as well as the magnitude of change expected to result from each gas. Table 7.3 provides an example of assessing the significance of GHG effects separately by gas.

Assessing the relative magnitude of non-$CO_2$ gases ($CH_4$, $N_2O$, HFCs, PFCs, $SF_6$, and $NF_3$) requires global warming potential (GWP) values. See Box 7.2 for guidance on selecting GWP values when determining significance.

**Box 7.2 Selecting global warming potential (GWP) values**

GWP values convert emissions data for non-$CO_2$ GHGs into units of carbon dioxide equivalent ($CO_2e$). GWP values describe the radiative forcing impact (or degree of harm to the atmosphere) of one unit of a given GHG relative to one unit of carbon dioxide.

The IPCC provides GWP values for 20-year, 100-year, and 500-year time horizons. In most cases, users should use 100-year GWP values to estimate the relative magnitude of GHG effects. Twenty-year GWP values may be used to focus on short-term climate drivers, and should be used if the policy or action assessed is specifically designed to reduce emissions of short-lived greenhouse gases, such as methane. Users should report the GWP values and time horizon used to determine significance. Regardless of whether 20-year GWP values or 100-year GWP values are used to determine significance, users are required to estimate GHG effects using 100-year GWP values in Chapters 8, 9, and 11.

For purposes of determining significance, users should apply the most recent GWP values published by the IPCC. In Chapters 8, 9, and 11, users may either apply (1) the IPCC GWP values agreed to by the UNFCCC, or (2) the most recent GWP values published by the IPCC.

## 7.2 Determine which GHG effects, source/sink categories, and greenhouse gases to include in the GHG assessment boundary

Users **shall** include all significant GHG effects, source/sink categories, and greenhouse gases in the GHG assessment boundary. Users may define significance based on the context and objectives of the assessment. In general, users should consider all GHG effects to be significant (and therefore included in the GHG assessment boundary) unless they are estimated to be either minor in size or expected to be unlikely or very unlikely to occur (see Figure 7.2). Users may consider unlikely effects that

**Figure 7.2 Recommended approach for determining significance based on likelihood and magnitude**

| Likelihood | Magnitude | | |
|---|---|---|---|
| | Minor | Moderate | Major |
| Very likely | May exclude | Should include | Should include |
| Likely | May exclude | Should include | Should include |
| Possible | May exclude | Should include | Should include |
| Unlikely | May exclude | May exclude | May exclude |
| Very unlikely | May exclude | May exclude | May exclude |

*Note:* The area shaded green corresponds to significant GHG effects.

are moderate or major to be significant, depending on the context and objectives.

Users **shall** report the approach used to determine the significance of GHG effects.

## Disclosing and justifying exclusions

Users should strive for completeness, but accounting for all significant effects may not be feasible in all cases. Excluding effects may be necessary in certain cases based on limitations related to:

- Measurability or data availability
- Relevance to policy objectives and context (such as the requirements of the applicable program, project, or agreement)
- User resources and capacity

Users may exclude GHG effects from the assessment, provided that any exclusion is disclosed and justified. Users should follow the principles of relevance, completeness, accuracy, consistency, and transparency when deciding whether to exclude any GHG effects, and should not exclude any GHG effects that would compromise the relevance of the GHG assessment. Users should ensure that the GHG assessment appropriately reflects the changes in GHG emissions resulting from the policy or action and that it serves the decision-making needs of users of the assessment report.

Users should exercise caution in excluding any significant effects from the assessment. Exclusions are likely to lead to misleading and biased results and not accurately represent the change in emissions resulting from the policy or action. Where possible, instead of excluding significant effects altogether, users should:

- Use simplified or less rigorous estimation methods to approximate the magnitude of the effect; or
- Use proxy data to fill data gaps.[1]

Users **shall** disclose and justify any exclusions of GHG effects, source/sink categories, or greenhouse gases from the GHG assessment boundary.

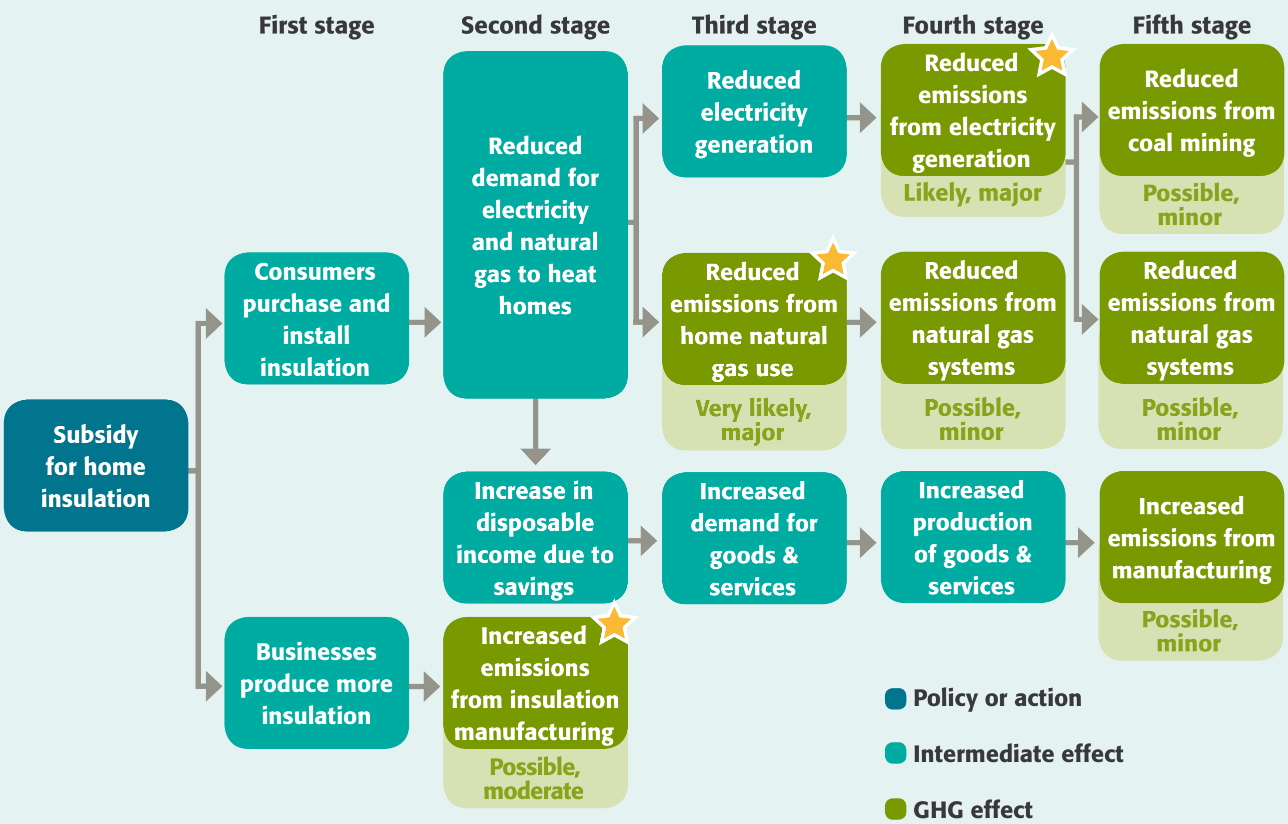
## *7.2 guidance*

Box 7.3 provides an example of selecting GHG effects for inclusion in the GHG assessment boundary based on an estimation of likelihood and relative magnitude.

**Box 7.3** **Illustrative example of defining the GHG assessment boundary for a home insulation subsidy program**

Chapter 6 includes an illustrative example of a causal chain for a home insulation subsidy program (Figure 6.6). Figure 7.3 and Table 7.3 illustrate how to assess each effect in terms of expected likelihood and relative magnitude to determine which effects to include in the GHG assessment boundary. In Figure 7.3, stars indicate GHG effects included in the boundary.

**Figure 7.3** **Example of assessing each GHG effect to determine which effects to include in the GHG assessment boundary**




*Note:* Stars indicate GHG effects included in the boundary.

**Table 7.3** **Example of assessing each GHG effect separately by gas to determine which GHG effects and greenhouse gases to include in the GHG assessment boundary**

| GHG effect | Likelihood | Relative magnitude | Included? |
|---|---|---|---|
| **Reduced emissions from electricity generation** | | | |
| $CO_2$ | Likely | Major | **Included** |
| $CH_4$ | Likely | Minor | Excluded |
| $N_2O$ | Likely | Minor | Excluded |

**Box 7.3 Illustrative example of defining the GHG assessment boundary for a home insulation subsidy program (continued)**

**Table 7.3 Example of assessing each GHG effect separately by gas to determine which GHG effects and greenhouse gases to include in the GHG assessment boundary (continued)**

| GHG effect | Likelihood | Relative magnitude | Included? |
|---|---|---|---|
| **Reduced emissions from coal mining** | | | |
| **$CH_4$** | Possible | Minor | Excluded |
| **Reduced emissions from natural gas systems (from reduced electricity use)** | | | |
| **$CO_2$** | Possible | Minor | Excluded |
| **$CH_4$** | Possible | Minor | Excluded |
| **Reduced emissions from home natural gas use (space heating)** | | | |
| **$CO_2$** | Very likely | Major | **Included** |
| **$CH_4$** | Very likely | Minor | Excluded |
| **$N_2O$** | Very likely | Minor | Excluded |
| **Reduced emissions from natural gas systems (from reduced natural gas use)** | | | |
| **$CO_2$** | Possible | Minor | Excluded |
| **$CH_4$** | Possible | Minor | Excluded |
| **Increased emissions from manufacturing of goods and services** | | | |
| **$CO_2$** | Possible | Minor | Excluded |
| **$CH_4$** | Possible | Minor | Excluded |
| **$N_2O$** | Possible | Minor | Excluded |
| **Increased emissions from insulation manufacturing** | | | |
| **$CO_2$** | Possible | Moderate | **Included** |
| **$CH_4$** | Possible | Minor | Excluded |
| **$N_2O$** | Possible | Minor | Excluded |
| **HFCs** | Possible | Moderate | **Included** |

Finally, the significant GHG effects, source/sink categories, and greenhouse gases are included in the GHG assessment boundary (see Table 7.4).

**Box 7.3 Illustrative example of defining the GHG assessment boundary for a home insulation subsidy program (continued)**

**Table 7.4 Example of developing a list of GHG effects, source/sink categories, and greenhouse gases included in the GHG assessment boundary**

| GHG effect included | Sources | Sinks | Greenhouse gases |
|---|---|---|---|
| **Reduced emissions from electricity generation** | Fossil fuel combustion in grid-connected power plants | N/A | $CO_2$ |
| **Reduced emissions from home natural gas use (space heating)** | Residential natural gas combustion (space heating) | N/A | $CO_2$ |
| **Increased emissions from insulation manufacturing** | Insulation manufacturing processes | N/A | $CO_2$, HFCs |

## Reevaluating significance through an iterative process

The application of the significance criteria may be an iterative process. The estimation of the GHG effects in Chapters 8, 9, and 11 may result in changes to the expected magnitude or likelihood of effects. For example, small or unlikely effects can result in large unforeseen impacts in nonlinear systems. If more accurate estimation leads to significant differences in the estimated magnitude of GHG effects, a reevaluation of significance in this chapter may be necessary.

Box 7.4 provides a case study of defining the GHG assessment boundary.

**Box 7.4 Defining the GHG assessment boundary for the Tunisian NAMA for energy conservation in the building sector**

The National Agency for Energy Conservation (ANME) of Tunisia, Alcor, and Ecofys carried out an ex-ante assessment of the nationally appropriate mitigation action (NAMA) for energy conservation in the building sector in Tunisia. The NAMA includes a solar program for commercial and residential buildings (including solar water heaters and solar photovoltaic energy) and a thermal insulation program for existing and new residential buildings. The objective of the assessment was to estimate and report the expected GHG emission reductions in order to attract and facilitate international support for the NAMA.

To define the GHG assessment boundary for the NAMA, each potential GHG effect (identified in the causal chain) was assessed in terms of both its likelihood of occurring and its estimated emissions impact (using initial calculation methods). Effects were included in the assessment boundary unless they were found to be either minor or very unlikely. Table 7.5 presents the results for the solar water heater program and the thermal insulation program. Defining the boundary around significant effects helped focus efforts on the most significant impacts, while ensuring that no significant effects of the NAMA were excluded.

**Box 7.4 Defining the GHG assessment boundary for the Tunisian NAMA for energy conservation in the building sector (continued)**

**Table 7.5 Example of identifying the GHG effects to include in the GHG assessment boundary for the Tunisian energy conservation NAMA**

| GHG effect | Likelihood | Relative magnitude | Estimated relative magnitude (in absolute value terms) | Included in assessment boundary? |
|---|---|---|---|---|
| **Solar water heater program** | | | | |
| **Reduced GHG emissions as a result of reduced residential LPG use** | Very likely | Major | 70% | **Included** |
| **Reduced GHG emissions as a result of reduced residential natural gas use** | Very likely | Major | 27% | **Included** |
| **Reduced fugitive GHG emissions as a result of reduced gas transport and storage** | Likely | Minor | 0.3% | Excluded (minor) |
| **Increased emissions as a result of increased demand for goods and services** | Very unlikely | Moderate | 2% | Excluded (very unlikely) |
| **Increased emissions as a result of increased transport activity by solar water heater service providers** | Likely | Minor | 1% | Excluded (minor) |
| **Thermal insulation program** | | | | |
| **Reduced GHG emissions as a result of reduced combustion in conventional power plants for a household building** | Very likely | Major | 14% | **Included** |
| **Reduced GHG emissions as a result of reduced residential natural gas use** | Very likely | Major | 84% | **Included** |
| **Reduced fugitive GHG emissions due to reduced gas transport and storage** | Likely | Minor | 1% | Excluded (minor) |
| **Increased GHG emissions due to increased demand for goods and services** | Very unlikely | Minor | 1% | Excluded (very unlikely, minor) |

## 7.3 Define the GHG assessment period

In the steps outlined above, both short-term and long-term effects are included in the GHG assessment boundary if determined to be significant. Users **shall** define and report the GHG assessment period—the time period over which GHG effects resulting from the policy or action are assessed—based on the time horizon of the GHG effects included in the GHG assessment boundary.

### *7.3 guidance*

The ex-ante GHG assessment period (forward-looking) is determined by the longest-term effect included in the GHG assessment boundary. The GHG assessment period may be longer than the policy implementation period—the time period during which the policy or action is in effect—and should be as comprehensive as possible to capture the full range of significant effects based on when they are expected to occur.

The ex-post GHG assessment period (backward-looking) should cover the period between the date the policy or action is implemented and the date of the assessment. The GHG assessment period for a combined ex-ante and ex-post assessment should consist of both an ex-ante GHG assessment period and an ex-post GHG assessment period.

In addition, users may separately estimate and report GHG effects over any other time periods that are relevant. For example, if the GHG assessment period is 2015–40, a user may separately estimate and report GHG effects over the periods 2015–20, 2015–30, and 2015–40.

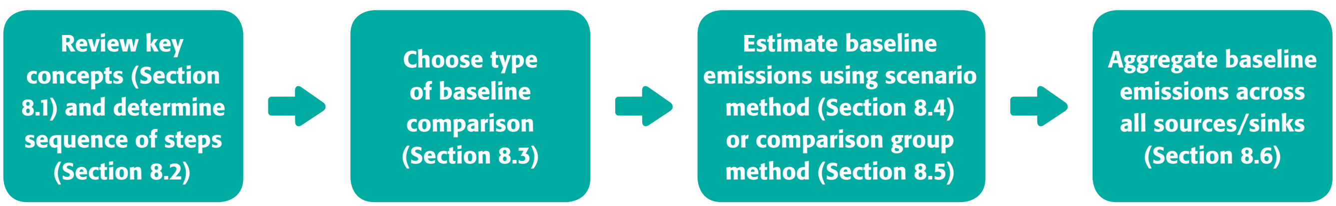
### Endnote

1. For guidance on filling data gaps, see IPCC 2006: Vol. 1, Chap. 2, "Approaches to Data Collection."

# 8 Estimating Baseline Emissions

**Estimating the effect of a policy or action requires a reference case, or baseline scenario, against which GHG effects are estimated. The baseline scenario represents what would have happened in the absence of the policy or action being assessed. Properly estimating baseline emissions is a critical step, since it has a direct and significant impact on the estimated GHG effect of the policy or action. In this chapter, users estimate baseline scenario emissions for the set of sources and sinks included in the GHG assessment boundary.**

**Figure 8.1 Overview of steps for estimating baseline emissions**




## Checklist of accounting requirements

| Section | Accounting requirements |
|---|---|
| **Estimate baseline emissions using the scenario method (Section 8.4)** | For users applying the scenario method:<br>• Define a baseline scenario that represents the conditions most likely to occur in the absence of the policy or action for each source or sink category included in the GHG assessment boundary.<br>• Estimate baseline emissions and removals over the GHG assessment period for each source/sink category and greenhouse gas included in the GHG assessment boundary.<br>• Apply GWP values provided by the IPCC based on a 100-year time horizon. |
| **Estimate baseline emissions using the comparison group method (Section 8.5)** | For users applying the comparison group method:<br>• Identify an equivalent comparison group for each source or sink category included in the GHG assessment boundary.<br>• Estimate emissions and removals from the comparison group and the policy group over the GHG assessment period for each source/sink category and greenhouse gas included in the GHG assessment boundary.<br>• Apply GWP values provided by the IPCC based on a 100-year time horizon. |

*Note:* Reporting requirements are listed in Chapter 14.

## 8.1 Key concepts

To estimate the change in GHG emissions resulting from a given policy or action, users define two scenarios:

- The *baseline scenario*, which represents the events or conditions most likely to occur in the absence of the policy or action (or package of policies and actions) being assessed; and
- The *policy scenario*, which represents the events or conditions most likely to occur in the presence of the policy or action (or package of policies and actions) being assessed.

The baseline scenario depends on assumptions related to key emissions drivers over the GHG assessment period. Drivers include other policies or actions that have been implemented or adopted, as well as non-policy drivers, such as economic conditions, energy prices, and technological development.

When estimating baseline emissions, users should at a minimum estimate all sources and sinks expected to change between the baseline scenario and the policy scenario. Users do not need to calculate emissions from sources and sinks that remain constant between the baseline scenario and the policy scenario, since they do not contribute to the change in emissions resulting from the policy or action.

Baseline scenarios can be determined ex-ante or ex-post. An *ex-ante baseline scenario* is a forward-looking baseline scenario, typically established prior to implementation of the policy or action, which is based on forecasts of emissions drivers (such as projected changes in population, economic activity, or other drivers that affect emissions), in addition to historical data. Ex-ante baseline scenarios are used for ex-ante assessment in Chapter 9.

An *ex-post baseline scenario* is a backward-looking baseline scenario established during or after implementation of the policy or action. Ex-post baseline scenarios should include updates to the ex-ante forecasts of emissions drivers, if an ex-ante assessment was first undertaken. Ex-post baseline scenarios are used for ex-post assessment in Chapter 11.

The methods described in this chapter apply to both ex-ante and ex-post baseline scenarios. See Figure 8.2 for a diagram illustrating both types of baseline scenarios.

This standard is not based on the concept of additionality as commonly defined in project-based accounting. See Box 8.1 for more information.

## 8.2 Determine sequence of steps for estimating the GHG effects of the policy or action

To estimate a change in emissions resulting from a policy or action, users follow four basic steps (see Figure 8.3). These steps cover both Chapters 8 and 9 (for ex-ante assessment) and Chapters 8 and 11 (for ex-post assessment).

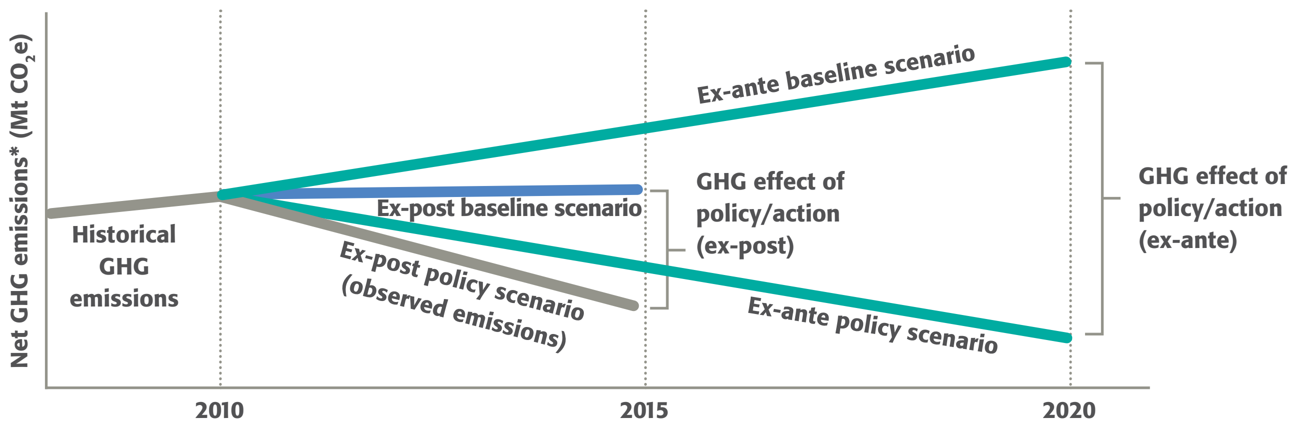
Users may first estimate baseline emissions (described in this chapter) before estimating policy scenario emissions, either ex-ante (Chapter 9) or ex-post (Chapter 11). In this case, users should proceed first with Chapter 8 and then subsequently with Chapter 9 or 11.

Alternatively, users may first estimate policy scenario emissions before estimating baseline scenario emissions, or may implement the two steps in parallel rather than in sequence (for example, if necessitated by certain models), as long as both steps are carried out and separately reported (if feasible based on the method used). In these cases, users should implement Chapters 8 and 9 jointly (for ex-ante assessment) or Chapters 8 and 11 jointly (for ex-post assessment).

In certain cases, users may calculate the GHG effect of the policy or action directly, without explicitly defining separate baseline and policy scenarios. In this case, users should still use the guidance provided in Chapters 8 and 9 (for ex-ante assessment) or Chapters 8 and 11 (for ex-post assessment). For more information, see Box 8.2.

Users may apply different sequences of steps for different categories of sources/sinks and then aggregate the GHG effects across source/sink categories to estimate the total GHG effect of the policy or action.

**Figure 8.2** Ex-ante and ex-post assessment




*Note:* * Net GHG emissions from sources and sinks in the GHG assessment boundary.

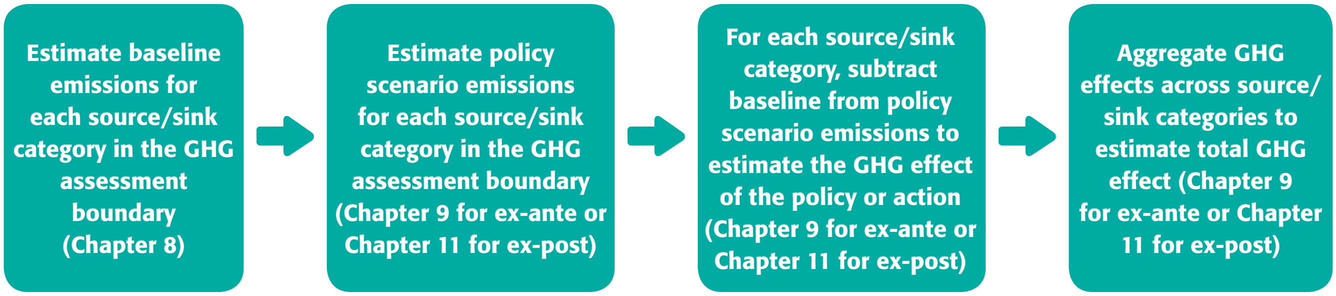
**Box 8.1** Additionality

This standard is designed to determine whether a policy or action results in GHG effects that are additional to what would have happened in the absence of the policy or action, since GHG effects are estimated relative to a baseline scenario that represents what would have most likely happened in the absence of the policy or action. For example, if emissions under the baseline scenario and the policy scenario are the same, the policy does not lead to GHG effects that are additional to what would have happened otherwise.

The concept of additionality in project-based accounting often concerns whether a GHG mitigation project would have been implemented in the absence of financing or incentives generated by an offset crediting program. A project is additional if it would not have been implemented in the absence of such incentives.[1] This standard does not address additionality in this sense, because the objective is not to determine whether a policy or action would have been implemented in the absence of a particular financing or support mechanism.

If GHG reductions achieved by policies or actions are credited by programs, those programs may impose additionality requirements or tests beyond the scope of this standard to determine whether the policy or action would have been implemented without receiving the additional finance or incentives generated by the program.

**Figure 8.3** Typical steps in estimating the GHG effect of the policy or action



### Box 8.2 Calculating the GHG effect directly

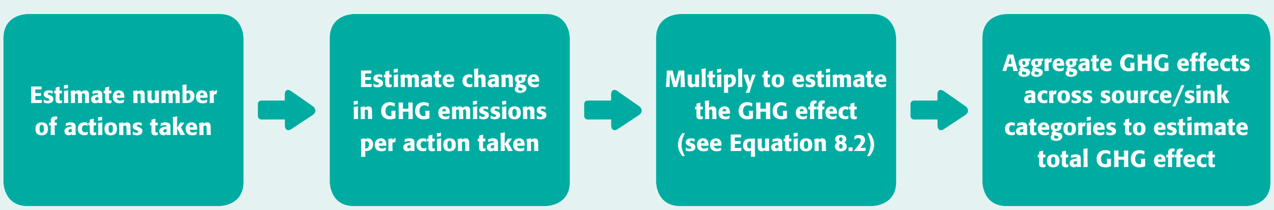
In certain cases, users may apply a simplified method to calculate the GHG effect of the policy or action directly, without separately estimating baseline emissions and policy scenario emissions. One example is the deemed estimates method (also called the “deemed savings” or “unit savings” approach), where the change in emissions is estimated directly by collecting data on the number of actions taken as a result of the policy (such as the number of buildings that install insulation) and applying default values that represent the estimated change in GHG emissions or other relevant parameter per action taken, relative to a baseline (such as the average reduction in energy use per building that installs insulation relative to buildings without insulation or relative to buildings with a different type of insulation). Default values may be derived from previously estimated effects of similar policies or actions. Figure 8.4 outlines the steps involved in carrying out the deemed estimates method.

In order to estimate baseline emissions and removals in Equation 8.2, users should define the most likely baseline scenario by considering various drivers (both existing policies and non-policy drivers) that would affect emissions in the absence of the policy or action being assessed (further described in Section 8.4). Users should also apply conservative assumptions and correct for free rider effects, policy interactions, or other factors not otherwise considered (further described in Section 8.4).

The deemed estimates method may be more practical in certain cases—for example, where it is not feasible to estimate separate scenarios, where a lower level of accuracy and completeness is sufficient to meet stated objectives, or for less significant source/sink categories. Users should exercise caution in using the deemed estimate method, since it involves establishing implicit baseline and policy scenario assumptions, which are reflected in the default “estimated change in GHG emissions per action taken” value. Users should be explicit about baseline scenario and policy scenario assumptions by following all applicable reporting requirements in Chapters 8, 9, and 11. The primary method outlined in Chapters 8, 9, and 11 is the most comprehensive and transparent approach to developing explicit baseline scenario and policy scenario assumptions.

Users may use the deemed estimates method for some source/sink categories affected by the policy or action and use the primary method for other source/sink categories, then aggregate them (in Section 8.6).

**Figure 8.4 Steps in carrying out the deemed estimates method**




**Equation 8.2 Calculating GHG effect using the deemed estimates method**

**Change in emissions and removals =**
number of actions taken as a result of the policy ×
(policy scenario emissions and removals for each affected unit, source, or sink –
baseline emissions and removals for each affected unit, source, or sink)

## 8.3 Choose type of baseline comparison

Estimating the GHG effects of a policy or action ex-post involves a comparison of the outcome of the policy or action with an estimate of what would most likely have happened in the absence of that policy or action. This comparison can be done in one of two ways:

- **Scenario method:** A comparison of a baseline scenario with a policy scenario for the same group or region
- **Comparison group method:** A comparison of one group or region affected by the policy or action with an equivalent group or region not affected by the policy or action

Ex-ante assessments can only use the scenario method. Ex-post assessments can either use the scenario method or the comparison group method. Figure 8.5 provides a decision tree for choosing between the two methods.

*8.3 guidance*

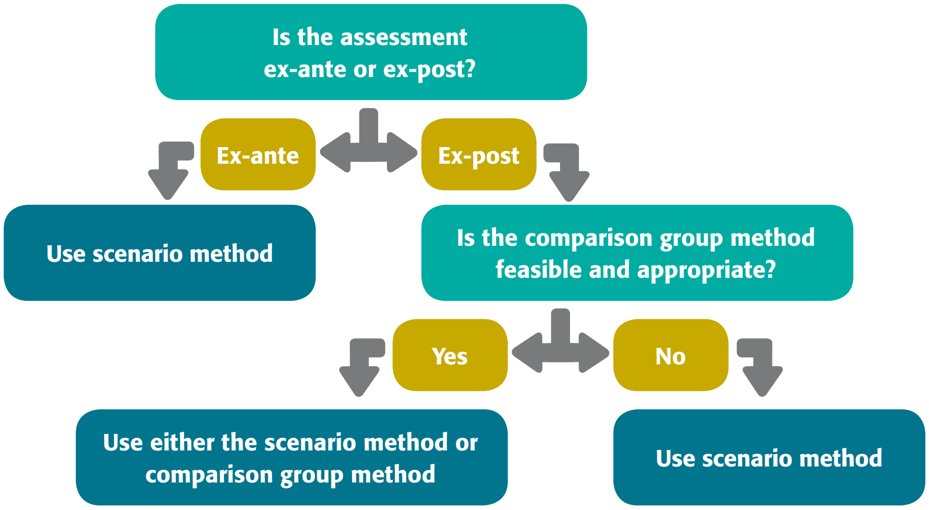
### Determining whether the comparison group method is feasible and appropriate (for ex-post assessment only)

Whether to choose the scenario method or comparison group method for ex-post assessment depends on several factors, including whether an equivalent comparison group exists and the type of policy or action. To reliably and credibly implement a comparison group method, actors affected by the policy (the policy group) and actors not affected by the policy (the comparison group or control group) must be otherwise equivalent. Under ideal experimental conditions, the two groups would be randomly assigned to ensure that any differences between the groups are a result of the policy, rather than any underlying systematic differences or biases. If random assignment is not possible, other methods can be used to avoid "selection bias" and ensure valid comparisons (further described in Section 8.5). If an appropriate comparison group is not available, the scenario method should be used.

The comparison group method may be feasible for policies or actions implemented in one subnational jurisdiction but not in a similar neighboring jurisdiction (assuming that the subnational jurisdictions are otherwise equivalent). The comparison group method may not be feasible for broad policies and actions applied to all relevant actors in a sector or jurisdiction, such as regulations and standards, taxes or charges, or emissions trading programs, since no comparison group would exist.

Users may use a combination of both approaches by using the comparison group method for one subset of source/sink categories and the scenario method for another subset, then aggregating the results (in Section 8.6).

**Figure 8.5 Decision tree for choosing the type of baseline comparison**



Users should only use a combination of methods if it yields more accurate and complete results than would be obtained by using one method consistently for all source/sink categories. In some cases, data obtained from a comparison group can also be used to update or calibrate specific parameters in what is otherwise an ex-post baseline scenario developed using the scenario method.

Users implementing the scenario method should proceed with Section 8.4. Users implementing the comparison group method should proceed to Section 8.5.

## 8.4 Estimating baseline emissions using the scenario method

This section provides guidance on estimating baseline emissions using the scenario method. It is applicable to all ex-ante assessments and to ex-post assessments that use the scenario method. See Figure 8.6 for an overview of steps.

### 8.4.1 Define the most likely baseline scenario

The first step in applying the scenario method is to define the baseline scenario. For each source or sink category included in the GHG assessment boundary, users **shall** define a baseline scenario that represents the conditions most likely to occur in the absence of the policy or action.

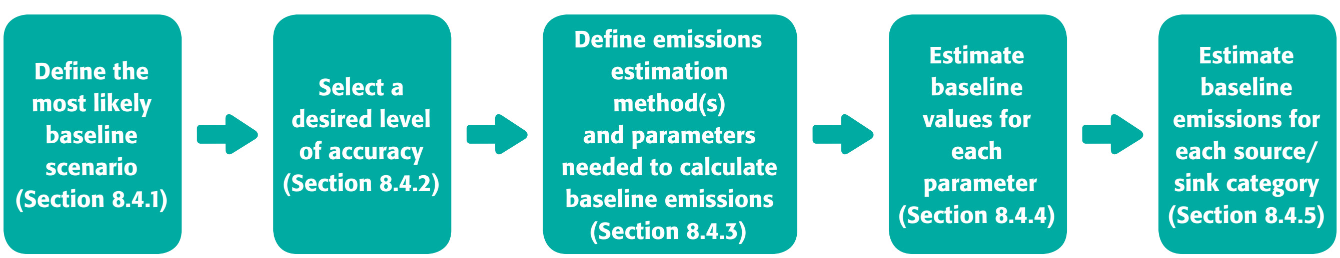
The most likely baseline scenario depends on drivers that would affect emissions in the absence of the policy or action being assessed. Identifying key drivers and determining reasonable assumptions about their "most likely" values in the absence of the policy being assessed have a significant impact on baseline emissions, and consequently on the eventual estimate of the GHG effect of the policy or action.

Drivers that affect emissions are divided into two types:

- **Other policies or actions:** Policies, actions, and projects—other than the policy or action being assessed—that are expected to affect the emissions sources and sinks included in the GHG assessment boundary
- **Non-policy drivers:** Other conditions such as socioeconomic factors and market forces that are expected to affect the emissions sources and sinks included in the GHG assessment boundary

Users **shall** report a description of the baseline scenario—a description of the events or conditions most likely to occur in the absence of the policy or action being assessed—and justification for why it is considered to be the most likely scenario.

**Figure 8.6 Overview of steps for estimating baseline emissions using the scenario method**





Users **shall** report a list of policies, actions, and projects included in the baseline scenario and disclose and justify any implemented or adopted policies, actions, or projects with a potentially significant effect on GHG emissions that are excluded from the baseline scenario. If planned policies are included in the baseline scenario, users **shall** report that the baseline scenario includes planned policies and report which planned policies are included.

Users **shall** report a list of non-policy drivers included in the baseline scenario and disclose and justify any relevant non-policy drivers excluded from the baseline scenario.

## *8.4.1 guidance*

Users should identify plausible baseline options and then choose the option that is considered to be the most likely to occur in the absence of the policy or action. Possible options include:

- The continuation of current technologies, practices, or conditions
- Discrete baseline alternatives, practices, technologies, or scenarios (such as the least-cost alternative practice or technology), identified using environmental, financial, economic, or behavioral analysis or modeling
- A performance standard or benchmark indicative of baseline trends

### Including other policies or actions

In addition to the policy or action being assessed, there are likely to be other policies, actions, or projects that affect the sources and sinks included in the GHG assessment boundary. These may include regulations and standards, taxes and charges, subsidies and incentives, emissions trading programs, voluntary agreements, information instruments, Clean Development Mechanism (CDM) projects, or voluntary market offset projects. (For more examples of policies and actions, see Table 5.1.)

Users should include all other policies, actions, and projects in the baseline scenario 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 during the GHG assessment period (for ex-post assessment).

See Table 8.1 for definitions of implemented, adopted, and planned policies and actions. For ex-ante assessment, adopted policies should be included in the baseline scenario if they are likely to be implemented and if there is enough information to estimate the effects of the policy. Users may optionally include planned policies in the baseline scenario for ex-ante assessment, for example if the objective is to assess the effect of one planned policy relative to other planned policies.

Users should establish a significance threshold (such as the thresholds in Table 7.2) or other criteria to determine which policies, actions, and projects are significant.

For other policies or actions that are included, users should determine whether they are designed to operate indefinitely or are limited in duration. Users should assume that policies or actions will operate indefinitely unless an end date is explicitly stated.

See Table 8.2 for examples of other policies or actions that may be included.

**Table 8.1 Definitions of implemented, adopted, and planned policies and actions**

| Policy or action status | Definition |
|---|---|
| **Implemented** | 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 and are in force; (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 begun to be implemented (for example, a law has been passed, but regulations to implement the law have not yet been established or are not being enforced). |
| **Planned** | Policy/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:* UNFCCC 2000.

**Table 8.2 Examples of other policies or actions that may be included in a baseline scenario**

| Examples of policies or actions being assessed | Examples of other policies or actions that may be included in the baseline scenario |
|---|---|
| **Renewable portfolio standard** | Feed-in tariffs, production tax credits or renewable incentives, renewable energy certificate markets, utility regulations and interconnect fees, rate structures |
| **Subsidies for public transit** | Fuel taxes; tolls on bridges, tunnels, highways |
| **Landfill gas management** | Mandatory landfill diversion rates, regulations covering waste combustion, inclusion of landfill gas management activities as offset mechanisms in voluntary or mandatory carbon markets, regulations for landfill gas management |
| **Sustainable agriculture policy** | National agricultural policies, conservation program subsidies |
| **Afforestation/reforestation policy** | Voluntary/mandatory carbon markets, forest management policies, land-use policies |

### Including non-policy drivers

Non-policy drivers include a wide range of exogenous factors such as socioeconomic factors and market forces that may cause changes in emissions but are not a result of the policy or action assessed. Users should consider the types of non-policy drivers outlined in Table 8.3.

Users should identify non-policy drivers based on literature reviews of similar assessments and policies, consultations with relevant experts and stakeholders, expert judgment, modeling results, or other methods.

Users should include all non-policy drivers in the baseline scenario that are not caused by the policy or action being assessed (i.e., that are exogenous to the assessment), and that are expected to result in a significant change in calculated emissions between the baseline scenario and policy scenario. In ex-ante assessments, users do not need to include drivers that are expected to remain the same under both the policy scenario and baseline scenario. Users should establish a significance threshold (such as the thresholds in Table 7.2) or other criteria to determine which non-policy drivers are significant.

See Table 8.4 for examples of non-policy drivers by policy type.

Users should also identify potential *free rider effects* when identifying the most likely baseline scenario. The free rider effect refers to participants in a policy or program who would have implemented the technologies, practices, or processes associated with the policy or program in the absence of the policy or program.[2] For example, the baseline scenario for an insulation subsidy should consider that a fraction of consumers receiving the subsidy may have installed the same insulation even without the subsidy.

### Defining a range of baseline scenario options

To the extent possible, users should identify the single baseline scenario that is considered most likely. In certain cases, multiple baseline options may seem equally likely. In such cases, users may report a range of results based on multiple alternative baseline scenarios. Users should conduct sensitivity analysis to see how the results vary depending on the selection of baseline options. (For more information on sensitivity analysis, see Chapter 12). See Box 8.3 for a case study of choosing the baseline scenario.

**Table 8.3 Examples of non-policy drivers**

| Examples of non-policy drivers | Specific examples |
|---|---|
| **Economic activity** | GDP, household income |
| **Population** | National population, city population |
| **Energy prices** | Prices of natural gas, petroleum products, coal, biofuels, electricity |
| **Other relevant prices** | Commodity prices |
| **Costs** | Costs of various technologies |
| **Weather** | Heating degree days, cooling degree days |
| **Autonomous technological improvement over time** | Ongoing decarbonization of economic sectors, energy efficiency improvements, long-term trends in the carbon- or energy-intensity of the economy |
| **Structural effects** | Structural changes in economic sectors, shifts from industry to service sector jobs, shifts of industrial production between countries |
| **Consumer preferences** | Changes in preferences for types of vehicles, household size, commuting practices |

**Table 8.4 Examples of non-policy drivers that may be included in a baseline scenario**

| Examples of policies or actions | Examples of non-policy drivers |
|---|---|
| **Renewable portfolio standard** | Load forecast, fuel prices by fuel type, renewable technology prices, transmission and distribution accessibility, grid storage capacity, biomass supply, population, GDP |
| **Subsidies for public transit** | Fuel prices, population, cost of transit alternatives, convenience of transit alternatives, socioeconomic status of commuters, GDP |
| **Landfill gas management** | Landfill tipping fees, value of recycled commodities, waste collection and transport costs, availability of land area for new landfills, population, GDP |
| **Sustainable agriculture policy** | Agricultural productivity, cropland expansion rate, mixed farming and improved agroforestry practices, fertilizer and seed prices, population, GDP |
| **Afforestation/reforestation policy** | Value of forest products (fiber or timber), suitability of lands to support forest growth, demand for production of food, population, GDP |

**Box 8.3 Choosing the baseline scenario for the Keystone XL pipeline**

The Stockholm Environment Institute (SEI) carried out an ex-ante assessment of the proposed Keystone XL pipeline, which would deliver oil from Canada's oil sands to the Gulf of Mexico. In 2013, the U.S. government made its approval of the pipeline contingent in part on whether the pipeline would not result in a net increase in greenhouse gas emissions. The objective of the assessment was to inform that decision by estimating the net global GHG effect of the pipeline, including both in-jurisdiction and out-of-jurisdiction effects.

The most critical step in the assessment was the determination of the most likely baseline scenario: What would most likely happen to the oil from the Canadian oil sands if the pipeline to the Gulf of Mexico were not built?

SEI defined three illustrative baseline scenarios to represent the range of possibilities if the pipeline were not built: (1) none of the oil to be carried by Keystone XL would otherwise make it to global oil markets and be consumed; (2) all of the oil would otherwise make it to market and be consumed; and (3) half of the oil would go to market and be consumed (a middle-ground option). Given lack of better information and the different perspectives in the literature, each was considered to be equally likely.

The assessment found that based on the choice of baseline scenario, the pipeline could either increase global emissions by 93 Mt $CO_2e$ annually, decrease global emissions by 0.3 Mt $CO_2e$, or increase emissions by some amount in between.

The assessment shows the limitations of ex-ante assessment if there is no way to identify the most likely baseline scenario, since the results of the assessment hinge on the selection of the most likely baseline scenario. It also shows the importance of defining and reporting alternative baseline scenarios when uncertainty is high, and conducting sensitivity analyses to understand the range of possible results given the uncertainties. (For more information on uncertainty and sensitivity analysis, see Chapter 12.)

### 8.4.2 Select a desired level of accuracy

A range of methods and data can be used to estimate baseline emissions using the scenario method. Table 8.5 outlines a range of methodological options.

Users 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/resources. In general, users should follow the most accurate approach that is feasible.

More complex methods often yield more accurate results than simpler methods, but not in all cases. Similarly, more source-specific data often yield more accurate results than default data, but not in all cases. Users should choose methods and data that yield the most accurate results within a given context, based on the methodological and data options available.

### 8.4.3 Define the emissions estimation method(s) and parameters needed to calculate baseline emissions

For each source/sink category and greenhouse gas included in the GHG assessment boundary, users should first identify a method (such as an equation, algorithm, or model) for estimating baseline emissions or removals from that source, then identify the parameters (such as activity data and emission factors) needed to estimate emissions using the method.

Users **shall** report the methodology used to estimate baseline emissions, including the emissions estimation method(s) (including any models) used. For models without clear documentation, this may require the user to extract and simplify key sections of model documentation so the methodology is accessible to relevant stakeholders.

**Table 8.5 Range of methodological options for estimating baseline emissions using the scenario method**

| Level of accuracy | Emissions estimation method | Other policies or actions included | Non-policy drivers included | Assumptions about drivers and parameters | Source of data for drivers and parameters |
|---|---|---|---|---|---|
| **Lower** | Lower accuracy methods (such as Tier 1 methods in the IPCC *Guidelines for National GHG 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 (such as Tier 3 methods in the IPCC *Guidelines*) | All significant policies | All significant drivers | Most assumed to be dynamic and estimated based on detailed modeling or equations | Jurisdiction- or source-specific data |

Users **shall** apply GWP values provided by the IPCC based on a 100-year time horizon. Users may use either (1) the IPCC GWP values agreed to by the UNFCCC or (2) the most recent GWP values published by the IPCC. Users **shall** report the GWP values used. Users may separately estimate and report GHG effects using 20-year GWP values, in addition to using 100-year GWP values.

## 8.4.3 guidance

### Defining the emissions estimation method(s)

The typical method of estimating emissions from a source or sink category, whether baseline scenario emissions or policy scenario emissions, is to multiply activity data by an emission factor. Users should refer to the most recent IPCC *Guidelines for National Greenhouse Gas Inventories* for GHG estimation methods and equations for various sectors and sources/sinks. Users should select methods consistent with the desired level of accuracy. The same emissions estimation method(s) should be used to estimate baseline emissions (in this chapter) and policy scenario emissions (either in Chapter 9 or 11).

A variety of equations, algorithms, and models may be used to estimate baseline emissions, including:

- Bottom-up methods (such as engineering models), top-down methods (such as econometric models, regression analysis, or computable general equilibrium models), and hybrid methods that combine elements of bottom-up and top-down methods
- Simple equations (such as simple extrapolation) and complex models (such as simulation models or integrated assessment models)

Top-down methods typically model economic relationships and often rely on more aggregated data sets, whereas bottom-up approaches typically use disaggregated source or sink data. Hybrid models attempt to combine the advantages of top-down and bottom-up modeling by linking the two types of approaches. For more information, see Section 3.2. Users may use existing methods or models that are relevant to the affected sources/sinks or may develop new methods or models (if no relevant and appropriate methods or models exist).

For certain types of policies or actions, simple equations may not be sufficient to represent the complexity necessary to accurately estimate baseline or policy scenario emissions. Detailed modeling approaches may be needed to estimate the effects of certain policies or actions (such as an emissions trading program). Detailed models may also be appropriate when the emissions estimation method includes multiple interacting parameters.

The GHG Protocol website provides a list of calculation tools and resources relevant to estimating the effects of policies and actions (available at www.ghgprotocol.org/policy-and-action-standard).

### Identifying parameters in the emissions estimation method(s)

Users should identify all parameters required to estimate baseline emissions using the emissions estimation method(s) for each source and sink. Parameters are variables such as activity data and emission factors that make up the emissions estimation equations or algorithm. The identified parameters will guide the user in understanding what data needs to be collected to estimate baseline emissions.

#### *Activity data*

Activity data is a quantitative measure of a level of activity that results in GHG emissions. Activity data is multiplied by an emission factor to derive the GHG emissions associated with a process or an operation. Examples of activity data are provided in Table 8.6.

#### *Emission factors*

An emission factor is a factor that converts activity data into GHG emissions data. Emission factors may be expressed in terms of energy output (such as kg $CO_2e$ emitted per liter of diesel consumed) or physical output (such as kg $CO_2e$ emitted per tonne of steel or cement produced). Table 8.6 provides examples of emission factors.

See Box 8.4 for an example of identifying emissions estimation methods and parameters. See Appendix A for guidance on collecting data.

**Table 8.6 Examples of activity data and emission factors**

| Examples of activity data | Examples of emission factors |
|---|---|
| **Liters of fuel consumed** | kg $CO_2$ emitted per liter of fuel consumed |
| **Kilowatt-hours of electricity consumed** | kg $CO_2$ emitted per kWh of electricity consumed |
| **Kilograms of material consumed** | kg PFC emitted per kg of material consumed |
| **Kilometers of distance traveled** | t $CO_2$ emitted per kilometer traveled |
| **Hours of time operated** | kg $SF_6$ emitted per hour of time operated |
| **Square meters of area occupied** | g $N_2O$ emitted per square meter of area |
| **Kilograms of waste generated** | g $CH_4$ emitted per kg of waste generated |

**Box 8.4 Example of identifying emissions estimation methods and parameters for a home insulation subsidy program**

Box 7.3 in Chapter 7 outlines three emission sources that are affected by a home insulation subsidy program and need to be estimated. One of the sources is residential natural gas combustion. The following equation is an example of an emissions estimation method for this source.

**GHG emissions from residential natural gas combustion (t $CO_2$e) =**
[natural gas used for space heating (Btu) + natural gas used for water heating (Btu) +
natural gas used for cooking (Btu)] × natural gas emission factor (t $CO_2$e/Btu)

The parameters in the emissions estimation method are natural gas used for space heating, natural gas used for water heating, natural gas used for cooking, and natural gas emission factor.

Since the policy only affects space heating in particular, users may narrow the equation and parameters to focus only on the specific process or activity affected by the policy, as follows:

**GHG emissions from residential natural gas combustion related to space heating (t $CO_2$e) =**
natural gas used for space heating (Btu) × natural gas emission factor (t $CO_2$e/Btu)

In this case, the parameters in the emissions estimation method are natural gas used for space heating and natural gas emission factor. In practice, the choice between these two emissions estimation methods may depend on data availability.

### 8.4.4 Estimate baseline values for each parameter

Once parameters are identified, the next step is to estimate the values of each parameter under the baseline scenario—that is, the most likely values for each parameter if the policy or action is not implemented—over the GHG assessment period.

Users **shall** report the following:

- The baseline values for key parameters in the baseline emissions estimation method(s)
- The methodology and assumptions used to estimate baseline values for key parameters, including whether each parameter is assumed to be static or dynamic and assumptions regarding other policies/actions and non-policy drivers that affect each parameter
- All sources of data used for key parameters, including activity data, emission factors, and assumptions
- Any potential interactions with other policies and actions and whether and how policy interactions were estimated

Users **shall** justify the choice of whether to develop new baseline data and assumptions or to use published baseline data and assumptions. Users that are not able to document and report a data source **shall** justify why the source is not reported.

Figure 8.7 illustrates the concept of estimating baseline emissions by estimating baseline values for each parameter, based on underlying drivers.

Table 8.7 provides an example of reporting parameter values and assumptions.

#### *8.4.4 guidance*

To estimate baseline values for each parameter, users should first decide whether to develop new baseline values or use baseline values from published data sources. Users should use conservative assumptions to define baseline values when uncertainty is high or a range of possible values exist. Conservative values and assumptions are those more likely to underestimate GHG emissions in the baseline scenario. Conservative values should be used to avoid overestimation of emission reductions.

#### Option 1: Using baseline values from published data sources

In some cases, existing data sources of sufficient quality may be available to determine values for baseline parameters. Potential data sources of historical or projected data include peer-reviewed scientific literature, government statistics, reports published by international institutions (such as the IEA, IPCC, World Bank, FAO, etc.), and economic and engineering analyses and models.

Users should use high-quality, up-to-date, and peer-reviewed data from recognized, credible sources if available. When selecting data sources, users should apply the data quality indicators in Table 8.8 as a guide to obtaining the highest quality data available. Users should select data that is the most representative in terms of technology, time, and geography; most complete; and most reliable.

#### Option 2: Developing new baseline values

In some cases, no published baseline data and assumptions will be available for historical or projected data, or the existing data may be incomplete, of poor quality, or in need of supplementation or further disaggregation. Users should develop new baseline data and assumptions when no relevant data are available that supports the level of accuracy needed to meet the stated objectives.

To develop new baseline values, users should:

1. Collect historical data for the parameter
2. Identify other policies/actions and non-policy drivers that affect each parameter
3. Estimate baseline values for each parameter, based on assumptions for each driver

##### *Collect historical data for the parameters*

For each parameter, users should collect historical data going back to the earliest date for which data of sufficient accuracy, completeness, consistency, and reliability is available. Users should collect data with as high a frequency as is available and relevant, where multiple sources of data exist. For example, monthly data should be preferred over quarterly data, and quarterly data should be preferred over annual data.

**Figure 8.7 Estimating baseline emissions by estimating baseline values for each parameter**

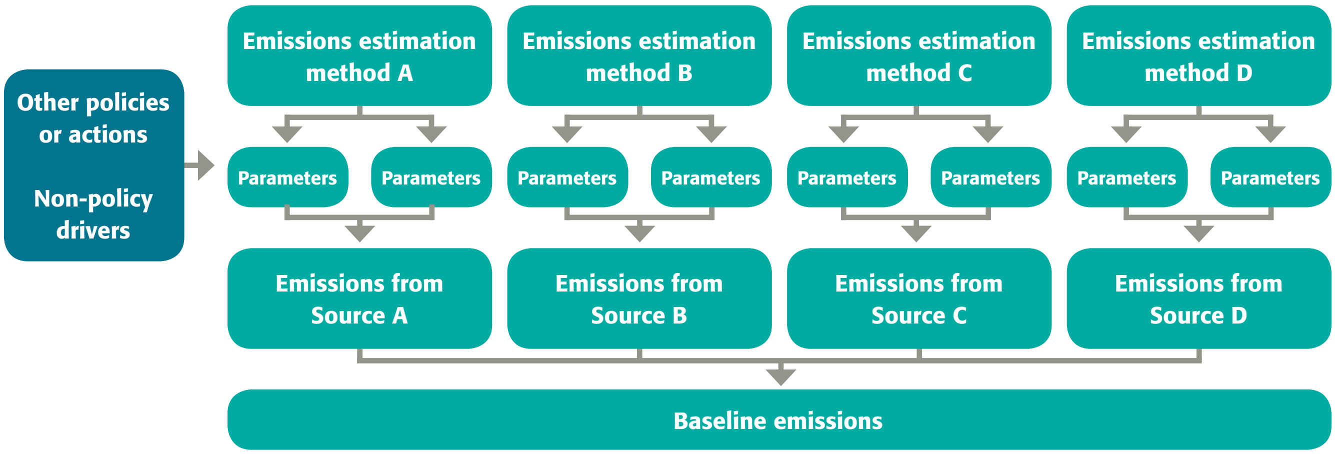



**Table 8.7 Example of reporting parameter values and assumptions used to estimate baseline emissions for a home insulation subsidy**

| Parameter | Baseline value(s) applied over the GHG assessment period | Methodology and assumptions to estimate value(s) | Data sources |
|---|---|---|---|
| **Natural gas used for space heating** | 1,000,000 MMBtu/ year from 2010–25 | Historical data<br>• Average annual natural gas used for space heating over the previous 10 years is 1,250,000 MMBtu/year<br>• The trend over the past 10 years has been constant (after normalization for variation in heating degree days and cooling degree days) rather than increasing or decreasing<br>Implemented and adopted policies included in the baseline scenario:<br>• Federal energy efficiency standards (expected to reduce natural gas use by 10% in the baseline scenario)<br>• Federal energy tax (expected to reduce natural gas use by 7.5% in the baseline scenario, taking into account overlaps with the federal energy efficiency standards)<br>Non-policy drivers included in the baseline scenario:<br>• Natural gas prices are projected to increase by 20% (expected to reduce natural gas use by 2% in the baseline scenario based on price elasticity of natural gas)<br>• Free rider effect: 10% of households that receive the subsidy are expected to install insulation even if they did not receive the subsidy (expected to reduce natural gas use by 3% in the baseline scenario, given 30% expected reduction in energy use per home insulated) | National energy statistical agency; peer-reviewed literature: Author (Year). Title. Publication. |
| **Natural gas emission factor** | 55 kg $CO_2e$/MMBtu from 2010–25 | Expected to remain constant at historical levels since no policies are implemented or adopted to reduce the GHG intensity of natural gas. Non-policy drivers (such as GDP and energy prices) are not expected to affect this parameter. | National energy statistical agency |

**Table 8.8 Data quality indicators**

| Indicator | Description |
|---|---|
| **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 (such as the country, city, or site). |
| **Completeness** | The degree to which the data are statistically representative of the relevant activity. Completeness includes the percentage of locations for which data are 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. |

*Source:* Adapted from Weidema and Wesnaes 1996.

***Identify other policies/actions and non-policy drivers that affect each parameter***

If users choose to develop new baseline values, the second step is to identify key drivers of the emission sources and sinks being estimated. Drivers that affect emissions are divided into two types: (1) other policies or actions, and (2) non-policy drivers. See Section 8.4.1 for guidance on identifying and including other policies/actions and non-policy drivers in the baseline scenario.

***Estimate baseline values for each parameter by making assumptions for each driver***

Once key drivers have been identified, the next step is to develop assumptions regarding the change in each driver over the GHG assessment period under the baseline scenario (assuming the policy or action is not implemented). Assumptions should represent the most likely scenario for each driver, based on evidence, such as peer-reviewed literature, government statistics, or expert judgment. If a variety of assumptions are available from reliable sources, or assumptions are highly uncertain, users should use conservative assumptions that are more likely to underestimate GHG emissions in the baseline scenario.

The baseline value for each parameter depends on the effects of the implemented or adopted policies or actions that are included in the baseline scenario. As described in Chapter 5, policies or actions included in the baseline scenario may interact with each other in overlapping or reinforcing ways—especially if they affect the same parameter(s) in the emissions estimation method(s). If multiple policies included in the baseline scenario are likely to interact, users should estimate the policy interactions when estimating baseline parameter values. Users should estimate the total net effect of all policies included in the baseline scenario on each parameter. Some models used to estimate baseline emissions may automatically calculate interactions between policies. Appendix B provides further guidance on estimating policy interactions.

Users should estimate baseline values for each parameter and specify how each parameter is expected to change over time in the baseline scenario, taking into account the historical data collected for each parameter and the assumptions for each driver over the GHG assessment period. Similar types of estimation equations, algorithms, and models outlined in Step 2 may be used to estimate baseline values of individual parameters. For example, users may apply regression analysis, simple extrapolation, or various models to forecast the baseline value of a parameter in the future based on assumptions for key drivers.

Each parameter in the baseline scenario (such as activity data or an emission factor) may be assumed to be either static or dynamic over the GHG assessment period. Static parameters are those assumed to stay constant over time, while dynamic parameters are assumed to change over time.[3] See Figure 8.8 for an illustration of static and dynamic parameters. Dynamic parameters can be assumed to change at a linear or nonlinear rate over time. See Figure 8.9 for different trends parameters can take over time. Dynamic models that allow for conditions to change throughout the GHG assessment period are typically the most accurate and should be used where relevant and feasible. A linear extrapolation of historical trends may be used if there are justifiable reasons to assume that historical trends would continue in the baseline scenario during the GHG assessment period.

### Sensitivity analysis

For either Option 1 or Option 2, users should conduct sensitivity analysis around key parameters to determine the range of likely values based on upper-bound and lower-bound assumptions. Sensitivity analysis involves varying the parameters (or combinations of parameters) to understand the sensitivity of the overall results to changes in those parameters. Users should prioritize data collection efforts to obtain more accurate assumptions for those parameters that are highly sensitive to changes in assumptions—for example, where a small change in assumptions leads to a large change in estimated GHG effects. (For more information on sensitivity analysis, see Chapter 12.)

**Figure 8.8 Illustration of static and dynamic parameters**

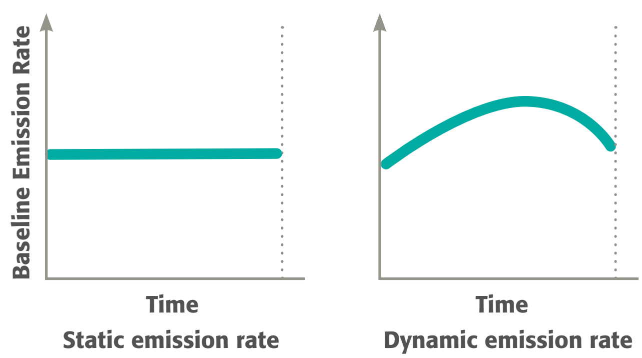
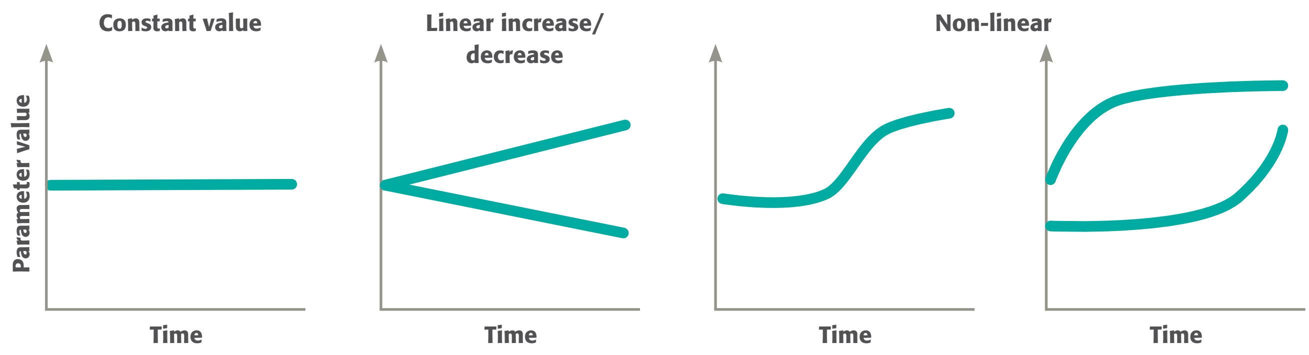



**Figure 8.9 Types of parameter changes over time**



### 8.4.5 Estimate baseline emissions for each source/sink category

The final step is to estimate baseline emissions by using the emissions estimation method identified in Section 8.4.3 and the baseline values for each parameter identified in Section 8.4.4.

Users **shall** estimate baseline emissions and removals over the GHG assessment period for each source/sink category and greenhouse gas included in the GHG assessment boundary. Any sources, sinks, or greenhouse gases in the GHG assessment boundary that have not been estimated **shall** be disclosed, justified, and described qualitatively.

Box 8.5 provides a case study of calculating baseline emissions for a policy.

**Box 8.5 Calculating baseline emissions for Tunisia's PROSOL Elec program**

The National Agency for Energy Conservation (ANME) of Tunisia—together with the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, with support from ALCOR Consulting—carried out a combined ex-post and ex-ante assessment of the PROSOL Elec program in Tunisia. PROSOL Elec is a renewable energy support program, launched by ANME in 2010, that aims to promote and support the installation of photovoltaic (PV) systems in residential and commercial buildings with low-voltage grid connections. The objectives of the assessment were to assess the program's progress to date and to estimate the program's future contribution to mitigation at the national level.

The GHG assessment boundary included three significant effects that needed to be estimated: (1) reduction of GHG emissions resulting from reduced combustion in conventional power plants; (2) reduction of fugitive GHG emissions resulting from reduced gas transport and storage; and (3) increased GHG emissions resulting from increased production of PV systems (an out-of-jurisdiction effect).

For the first effect, the primary source affected by the program is the production of electricity by conventional power plants for consumption in the residential and commercial buildings sector. To calculate baseline emissions for this source, the emissions estimation method and parameters were identified.

Data were needed on: (1) the electricity consumption of residential and commercial buildings; and (2) the electrical mix used in power plants (by power plant type, such as natural gas and coal, taking into account grid losses). Baseline values for each parameter were derived from statistical reports of the National Electricity and Gas Utility and studies on the assessment and development of the energy sector in Tunisia. These data sources took into account the development of key drivers (such as economic activity, population, energy prices, and technical costs) and other implemented policies.

To calculate baseline emissions, the electricity production of the different power plant types was divided by the efficiency of each plant type to calculate the quantity of gas and fuel consumed in each plant. The quantity of consumed gas or fuel was multiplied by national emission factors to calculate the total emissions from combustion. Fugitive emissions from gas transport and storage were calculated by multiplying the quantity of gas consumed with the default emission factor derived from the IPCC. Emissions of methane and nitrous oxide were multiplied by their global warming potential (GWP) values to calculate emissions in units of carbon dioxide equivalent.

The following equation was used to calculate baseline $CO_2$ emissions from natural gas combustion in conventional power plants in 2010:

{Electricity consumption in residential and commercial buildings in 2010 [5,039 GWh] /
(1—transmission and distribution losses factor for 2010 [13.5%] ) x
natural gas share in energy mix for electricity generation in 2010 [99%]} /
(average gas power plants efficiency in 2010 [35%] × conversion factor GWh ->Tj [3.6]) x
national emission factor for natural gas in 2010 [56,000 kg/Tj] =
$CO_2$ emissions from natural gas combustion in 2010 [3,321,895,214 kg = 3,321,895 t]

## 8.5 Estimating baseline emissions and GHG effects using the comparison group method (for ex-post assessment only)

As outlined in Section 8.3, users may use the comparison group method to define the baseline scenario when carrying out an ex-post assessment. The comparison group method cannot be used for ex-ante assessments, since comparative data for the comparison group and policy group during policy implementation cannot be observed prior to policy implementation.

The comparison group method involves comparing one group or region affected by a policy or action with an equivalent group or region that is not affected by that policy or action. Users following the comparison group method **shall** identify an equivalent comparison group for each source or sink category in the GHG assessment boundary.

Users applying the comparison group method **shall** estimate emissions and removals from the comparison group and the policy group over the GHG assessment period for each source/sink category and greenhouse gas included in the GHG assessment boundary. Users **shall** apply GWP values provided by the IPCC based on a 100-year time horizon. Any sources, sinks, or greenhouse gases in the GHG assessment boundary that have not been estimated **shall** be disclosed, justified, and described qualitatively.

### *8.5 guidance*

See Figure 8.10 for an overview of key steps. This section includes a final step of estimating the GHG effect of the policy or action, in addition to estimating baseline emissions.

### Identify the policy group and comparison group

The first step is to identify the policy group (the group or region affected by the policy) and the comparison group or control group (an equivalent group or region not affected by the policy). The policy groups and comparison groups may be groups of people, facilities, companies, jurisdictions, sectors, or other relevant groups.

The policy group and the comparison group should be equivalent in all respects except for the existence of the policy for the policy group and absence of the policy for the comparison group. The most robust way to ensure two groups are equivalent is to implement a randomized experiment—for example, by randomly assigning one subset of entities to participate in a program and randomly assigning the other subset to not participate in the program.

To be equivalent means the comparison group should be the same or similar to the policy group in terms of:

- **Geography:** for example, facilities in the same city, subnational region, or country
- **Time:** for example, facilities built within the same time period
- **Technology:** for example, facilities using the same technology
- **Other policies or actions:** for example, facilities subject to the same set of policies and regulations, except for the policy or action being assessed
- **Non-policy drivers:** for example, facilities subject to the same external trends, such as the same changes in economic activity, population, weather, and energy prices

When identifying a potential comparison group, users should collect data from both the policy group and the comparison group before the policy or action is implemented to determine whether the groups are equivalent. Users

**Figure 8.10 Overview of steps for using the comparison group method**

should ensure that the entities in the comparison group are not directly or indirectly affected by the policy.

If the groups are similar but not equivalent, statistical methods can be used to control for certain factors that differ between the groups (described further below). If the groups are not sufficiently equivalent, the comparison group method will yield misleading results, so users should follow the scenario method instead (see Section 8.4).

### Collect data from the policy group and comparison group

Users should collect data from both the policy group and the comparison group for all the parameters (such as activity data and emission factors) included in the emissions estimation methods. (Section 8.4.3 provides guidance on selecting an emissions estimation method.) Users should collect data from both groups at multiple points in time to account for changes in emissions and various drivers that occur over time. At a minimum, users should collect data from both groups before and after the policy or action is implemented (in the policy group), so that the two groups can be compared during both the pre-policy period and the policy implementation period.

Either top-down or bottom-up data may be used. To collect bottom-up data, representative sampling may be used to collect data from a large number of individual sources or facilities. If so, appropriate statistical sampling procedures should be used, and the sample size should be large enough to draw valid statistical conclusions. Chapter 10 and Appendix A provide additional guidance on collecting data.

### Estimate emissions from both groups and estimate the GHG effect of the policy or action

After data are collected, users should estimate baseline emissions (from the comparison group) and policy scenario emissions (from the policy group). In rare cases where the policy group and comparison group are equivalent, the outcomes of each group in terms of emissions over time can be compared directly. A statistical test (such as a t-test) should be employed to ensure that the difference in values cannot be attributed to chance. If the difference between the two groups is statistically significant, the difference can be attributed to the existence of the policy, rather than to other factors.

In most cases, differences are expected to exist between the groups. If material differences exist that may affect the outcome, users should use statistical methods to control for variables other than the policy that differ between the non-equivalent groups. Such methods are intended to help address the "selection bias" and isolate the effect of the policy being assessed. See Box 8.6 for examples of methods that may be used.

For additional guidance on estimating GHG effects ex-post, refer to Chapter 11.

**Box 8.6 Statistical methods for estimating GHG effects and controlling for factors that differ between groups**

**Regression analysis** involves including data for each relevant driver that may differ between the groups (such as economic activity, population, energy prices, and weather) as explanatory variables in a regression model, as well as proxies for other relevant policies that may differ between the two groups (other than the policy being assessed). If the expanded regression model shows a statistically significant effect of the policy being assessed, then the policy can be assumed to have an effect on the policy group, relative to the comparison group.

**Difference-in-difference methods** compare two groups over two periods of time: a first period in which neither the policy group nor the comparison group implements a given policy and a second period in which the policy group implements the policy and the comparison group does not. This method estimates the difference between the groups prior to policy implementation (A1 - B1 = X); the difference between the two groups after policy implementation (A2 - B2 = Y); and the difference between the two differences (Y - X) as a measure of the change attributable to the policy.

**Matching methods** are statistical approaches for making two groups (a policy group and a comparison group) more equivalent, when random assignment is not possible.

## 8.6 Aggregate baseline emissions across all source/sink categories

The final step is to aggregate estimated baseline emissions across all categories of sources and sinks included in the GHG assessment boundary to estimate total baseline emissions, if feasible based on the method used. This may involve aggregating baseline emissions across sources and sinks calculated using the scenario method and/or the comparison group method. When aggregating across sources and sinks, users should address any possible overlaps or interactions between sources and sinks to avoid over- or underestimation of total baseline emissions.

Users **shall** report total annual and cumulative baseline scenario emissions and removals over the GHG assessment period, if feasible based on the method used. Users should separately estimate in-jurisdiction baseline emissions/removals and out-of-jurisdiction baseline emissions/removals, if relevant and feasible.

See Table 8.9 for an example of calculating and aggregating baseline emissions.

**Table 8.9 Example of calculating and aggregating baseline emissions for a home insulation subsidy**

| GHG effect included in the GHG assessment boundary | Affected sources | Baseline emissions |
|---|---|---|
| **Reduced emissions from electricity use** | Fossil fuel combustion in grid-connected power plants | 50,000 t $CO_2e$ |
| **Reduced emissions from home natural gas use (space heating)** | Residential natural gas combustion | 20,000 t $CO_2e$ |
| **Increased emissions from insulation production** | Insulation manufacturing processes | 5,000 t $CO_2e$ |
| **Total baseline emissions** | | **75,000 t $CO_2e$** |

*Note:* The table provides data for one year in the GHG assessment period.

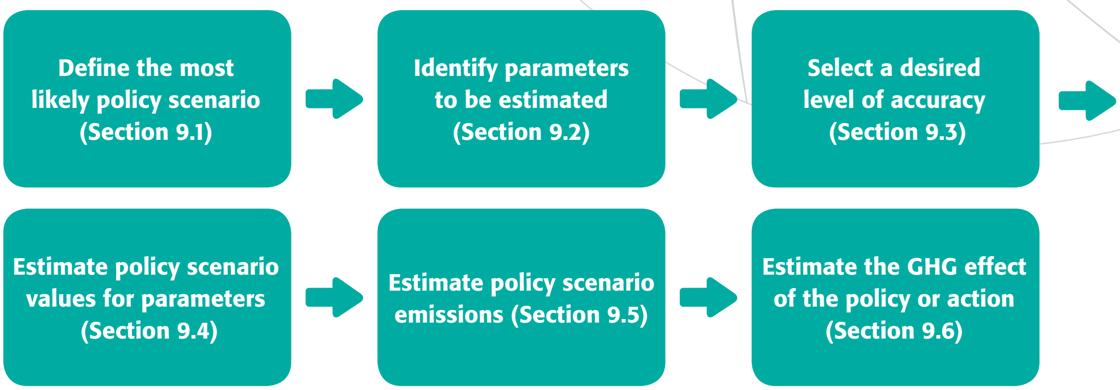
### Endnotes

1. The UNFCCC defines additionality under the Clean Development Mechanism (CDM) as follows: "A CDM project activity is additional if anthropogenic emissions of greenhouse gases by sources are reduced below those that would have occurred in the absence of the registered CDM project activity."
2. Adapted from Kushler, Nowak, and Witte 2014.
3. These terms are sometimes used differently in the context of project-based accounting (such as CDM), where the term "dynamic baseline" refers to a baseline scenario that is changed or updated ex-post during or after the project implementation period. This standard uses the terms to refer not to updating a baseline scenario over time but instead to parameter values that are assumed to change over time.

# 9 Estimating GHG Effects Ex-Ante

**This chapter describes how to estimate the expected future GHG effects of the policy or action (ex-ante assessment). In this chapter, users estimate policy scenario emissions for the sources and sinks included in the GHG assessment boundary. The GHG effect of the policy or action is estimated by subtracting baseline emissions (as determined in Chapter 8) from policy scenario emissions (as determined in this chapter). Users that choose only to estimate GHG effects ex-post may skip this chapter and proceed to Chapter 10.**

**Figure 9.1 Overview of steps for estimating GHG effects ex-ante**




### Checklist of accounting requirements (for users carrying out ex-ante assessment)

| Section | Accounting requirements |
| --- | --- |
| **Define the most likely policy scenario (Section 9.1)** | • Define a policy scenario that represents the conditions most likely to occur in the presence of the policy or action for each source or sink category included in the GHG assessment boundary. |
| **Estimate policy scenario emissions (Section 9.5)** | • Estimate policy scenario emissions and removals over the GHG assessment period for each source/sink category and greenhouse gas included in the GHG assessment boundary, based on the GHG effects included in the boundary.<br>• Apply the same GWP values used to estimate baseline emissions. |
| **Estimate the GHG effect of the policy or action (Section 9.6)** | • Estimate the GHG effect of the policy or action by subtracting baseline emissions from policy scenario emissions for each source/sink category included in the GHG assessment boundary. |

*Note:* Reporting requirements are listed in Chapter 14.

## 9.1 Define the most likely policy scenario

Users carrying out an ex-ante assessment may estimate ex-ante policy scenario emissions either before or after estimating ex-ante baseline emissions. See Section 8.2 in Chapter 8 for more information on the sequence of steps.

Chapter 8 outlines two approaches to defining the baseline scenario: the scenario method and the comparison group method. Only the scenario method is relevant to ex-ante assessment. This chapter assumes the user has estimated baseline emissions using the scenario method.

The *policy scenario* represents the events or conditions most likely to occur in the presence of the policy or action (or package of policies or actions) being assessed. The policy scenario is the same as the baseline scenario except that it includes the policy or action (or package of policies/actions) being assessed. *Policy scenario emissions* are an estimate of GHG emissions and removals associated with the policy scenario. See Figure 9.2 for an illustration of estimating GHG effects ex-ante.

For each source or sink category included in the GHG assessment boundary, users **shall** define a policy scenario that represents the conditions most likely to occur in the presence of the policy or action. Users should identify various policy scenario options and then choose the one considered to be the most likely to occur in the presence of the policy or action. Users **shall** report a description of the policy scenario.

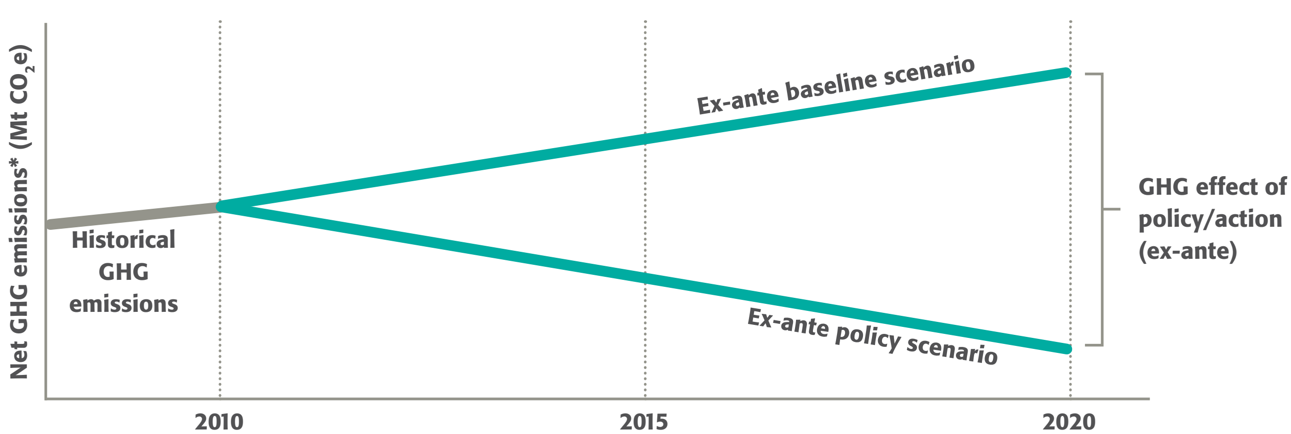
Users do not need to calculate emissions from sources and sinks that remain constant between the baseline scenario and the policy scenario, since they do not contribute to the change in emissions resulting from the policy or action.

## 9.2 Identify parameters to be estimated

The same emissions estimation method(s) used to estimate baseline emissions should also be used to estimate policy scenario emissions from each source or sink. Consistency ensures that the estimated change in emissions reflects underlying differences between the two scenarios, rather than differences in estimation methodology. For more information on emissions estimation methods and parameters, see Chapter 8, Section 8.4.

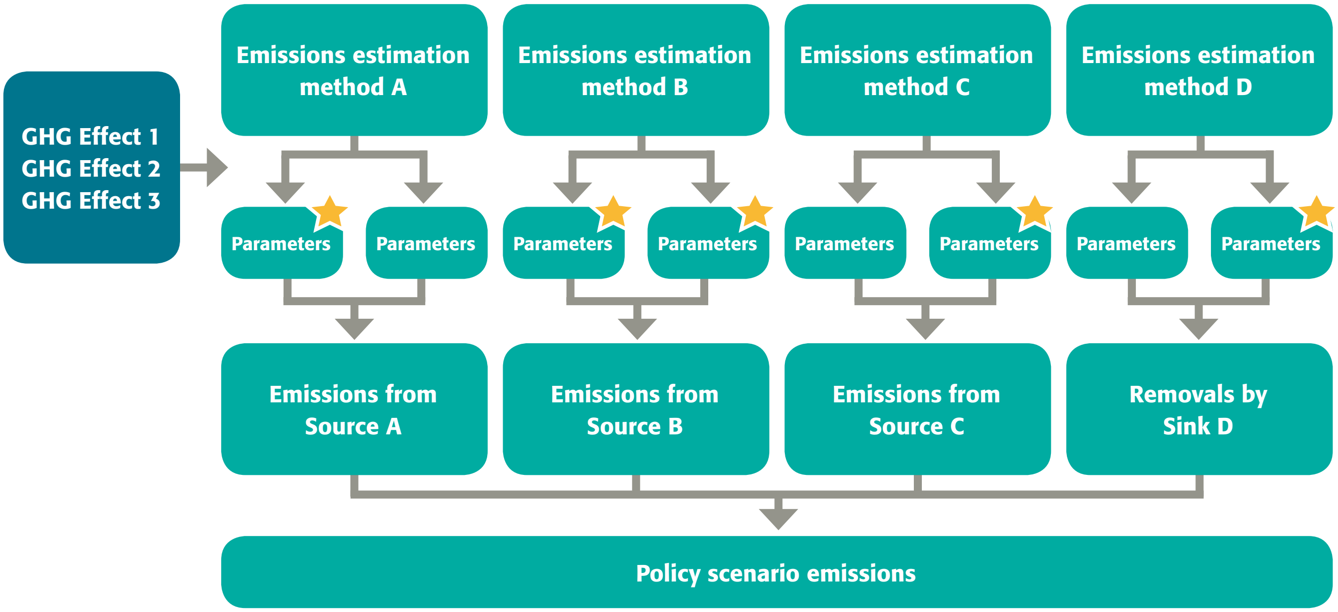
To estimate policy scenario emissions, users should first identify all the parameters (such as activity data and emission factors) in the emissions estimation method(s) that are affected by the policy or action. These parameters need to be estimated in the policy scenario. Parameters that are not affected by the policy or action do not need to be estimated because the values remain constant between the baseline scenario and the policy scenario. To identify affected parameters, users should consider each GHG effect included in the GHG assessment boundary (see Figure 9.3).

**Figure 9.2 Estimating GHG effects ex-ante**




*Note:* * Net GHG emissions from sources and sinks in the GHG assessment boundary.

**Figure 9.3 Identifying parameters affected by the policy or action**




*Note:* Stars indicate parameters affected by the policy or action.

**9.2 guidance**

## Identifying parameters affected by the policy or action

In some cases, it may be straightforward to determine which parameters are affected by the policy or action. See Box 9.1 for an example. In other cases it may be difficult to determine whether a parameter is affected. In such cases users may apply the significance methodology outlined in Chapter 7 to determine the likelihood of each parameter being affected and the relative magnitude of the expected impact. For parameters unlikely or very unlikely to be affected by the policy or action—or where the expected impact is expected to be minor—baseline values may be used in the policy scenario, under the assumption that the parameter remains constant between the baseline scenario and the policy scenario.

**Box 9.1 Example of identifying parameters and determining which are affected by the policy or action assessed (for a home insulation subsidy)**

Box 8.4 in Chapter 8 defines an emissions estimation method and parameters needed to estimate baseline emissions for residential natural gas combustion, one of three sources affected by the subsidy. To estimate policy scenario emissions from this source, the same emissions estimation method and parameters are used to estimate policy scenario emissions, as follows:

**GHG emissions from residential natural gas combustion (t $CO_2$e) =**
**[natural gas used for space heating (Btu) + natural gas used for water heating (Btu) +**
**natural gas used for cooking (Btu)] × natural gas emission factor (t $CO_2$e/Btu)**

The parameters in the emissions estimation method are:

A. natural gas used for space heating
B. natural gas used for water heating
C. natural gas used for cooking
D. natural gas emission factor

The next step is to identify which parameters are affected by the home insulation subsidy and which are not. Parameter A (natural gas used for space heating) is affected by the policy (since insulation reduces energy demand for space heating), so the policy scenario value for this parameter is expected to differ from the baseline scenario value. However, parameters B, C, and D are not affected by the policy (since insulation does not reduce energy demand for water heating or cooking), so the policy scenario values for these parameters are expected to stay the same as in the baseline scenario.

The difference in emissions between the policy scenario and baseline scenario for this source (residential natural gas use) will result from the change in parameter A (natural gas used for space heating).

Alternatively, since the policy only affects space heating in particular, users may narrow the equation and parameters to focus only on the specific process or activity affected by the policy, as follows:

**GHG emissions from residential natural gas combustion related to space heating (t $CO_2$e) =**
**natural gas used for space heating (Btu) × natural gas emission factor (t $CO_2$e/Btu)**

The parameters in the emissions estimation method are:

A. natural gas used for space heating
B. natural gas emission factor

In this case, the difference in emissions between the policy scenario and baseline scenario for this source (residential natural gas use) will also result from the change in parameter A (natural gas used for space heating) only.

## 9.3 Select a desired level of accuracy

Users may use a range of methods and data to estimate policy scenario emissions. Table 9.1 outlines a range of methodological options that may be used. Users 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/resources. In general, users should follow the most accurate approach that is feasible.

Users **shall** report the methodology used to estimate policy scenario emissions, including the emissions estimation method(s) (including any models) used.

## 9.4 Estimate policy scenario values for parameters

The approach to estimating policy scenario values for each parameter depends on whether the parameter is expected to be affected by the policy or action.

- **For parameters not affected by the policy or action:** For these parameters, the parameter value is not expected to differ between the policy scenario and baseline scenario. The baseline value for that parameter (estimated in Chapter 8) should also be used as the policy scenario value for that parameter (in this chapter). All drivers and assumptions estimated in the baseline scenario should be the same in the policy scenario except for those drivers and assumptions that are affected by the policy or action being assessed.
- **For parameters affected by the policy or action:** For these parameters, the parameter value is expected to differ between the policy scenario and baseline scenario. Users should follow the same general steps described in Section 8.4 but should estimate the *policy scenario value* for each parameter rather than the baseline scenario value for each parameter. This requires developing assumptions about how the policy or action is expected to affect each parameter over the GHG assessment period.

**Table 9.1 Range of methodological options for estimating policy scenario emissions**

| Level of accuracy | Emissions estimation method | Interactions with policies included in the baseline scenario | Assumptions about parameters in the policy scenario | Data sources |
|---|---|---|---|---|
| **Lower** | Lower accuracy methods (such as Tier 1 methods in the IPCC *Guidelines for National Greenhouse Gas Inventories*) | Few interacting policies assessed | Most assumed to be static or linear extrapolations of historical trends | International default values |
| | Intermediate accuracy methods | Most interacting policies assessed | Combination | National average values |
| **Higher** | Higher accuracy methods (such as Tier 3 methods in the IPCC *Guidelines*) | All interacting policies assessed | Most assumed to be dynamic and estimated based on detailed modeling or equations | Jurisdiction- or source-specific data |

Users **shall** report the following:

- The policy scenario values for key parameters in the emissions estimation method(s)
- The methodologies and assumptions used to estimate policy scenario values for key parameters, including whether each parameter is assumed to be static or dynamic
- All sources of data for key parameters, including activity data, emission factors, GWP values, and assumptions
- Any potential interactions with other policies and actions and whether and how policy interactions were estimated

If users are not able to report a data source, users **shall** justify why the source is not reported.

## 9.4 guidance

### Estimating policy scenario values for parameters affected by the policy or action

Users should estimate the change in the parameter over time based on what is considered to be the most likely scenario for each parameter, based on evidence, such as peer-reviewed literature, modeling or simulation exercises, government statistics, or expert judgment. Existing literature or methodologies may not be similar enough to use directly. Users may need to make adjustments to results found in literature to adapt to the assumptions made in the baseline scenario and other elements of the assessment. Users may need to apply new methods, models, and assumptions not previously used in the baseline methodology to estimate the expected change in each parameter as a result of the GHG effects of the policy or action.[1]

Each parameter may be assumed to be static or dynamic over the GHG assessment period, and dynamic parameters can change at a linear or nonlinear rate. In many cases, dynamic models that allow for conditions to change throughout the GHG assessment period are expected to be most accurate, so they should be used where relevant and feasible.

To estimate policy scenario values for each parameter affected by the policy or action, users should consider a variety of factors (described in more detail below), such as:

- Historical trends and expected values in the baseline scenario
- Timing of effects
- Barriers to policy implementation or effectiveness
- Policy interactions
- Sensitivity of parameters to assumptions

To the extent relevant, users should also consider the following additional factors:

- Non-policy drivers included in the baseline scenario (see Chapter 8), which should be the same between the policy scenario and baseline scenario if they are not affected by the policy assessed, but should be different between the two scenarios if they are affected by the policy
- Learning curves (economic patterns related to new product development and deployment)
- Economies of scale
- Technology penetration or adoption rates (the pace of adoption by targeted actors, which may be slow initially then accelerate as products become more socially accepted)

Depending on the assessment, users may not need to consider each of these factors. In practice, users may also be limited by the following considerations:

- Type of policy or action (which may require consideration of certain factors but not others)
- Emissions estimation method (for example, simplified approaches may be limited to linear approximations)
- Data availability (which may limit the number of factors that can be considered)
- Objectives of the assessment (which may require a more or less complete and accurate assessment)
- Available resources to conduct the assessment

### Historical trends and expected values in the baseline scenario

Historical data informs the expected future values of each parameter, in both the baseline scenario and the policy scenario. Understanding the historical values of the parameter as well as the expected values in the baseline scenario are both useful when estimating policy scenario values. For more information on historical data, see Section 8.4.4.

### Timing of effects

Policy scenario values over time depend on the timing of expected effects. There may be a delay between when the policy or action is implemented and when effects begin to occur. Effects may also occur before policy implementation begins because of early action taken in anticipation of the policy or action.

Users should consider whether the policy or action is designed to operate indefinitely or is limited in duration (defined in Chapter 5). Users should assume that a policy or action will operate indefinitely unless an end date is explicitly embedded in the design of the policy or action, despite inherent uncertainty over whether it will eventually be discontinued. If the policy or action is limited in duration, the GHG assessment period may include some GHG effects that occur during the policy implementation period and some GHG effects that occur after the policy implementation period.

Users should also consider whether and how the implementation of the policy or action is expected to change over the GHG assessment period. Examples include tax instruments where the tax rate increases over time, performance standards where the level of stringency increases over time, or regulations or emissions trading programs with multiple distinct phases.

In addition to estimating and reporting the full effects of the policy or action over the GHG assessment period, users may separately estimate and report GHG effects over any other time periods that are relevant. For example, if the GHG assessment period is 2015–40, users may separately estimate and report GHG effects over the periods 2015–20, 2015–30, and 2015–40.

### Barriers to policy implementation or effectiveness

The policy scenario values should represent the values most likely to occur in the presence of the policy or action, which depend on assumptions related to policy implementation and effectiveness. Depending on what is considered most likely in an individual context, users should either (1) estimate the maximum effects of the policy or action if full implementation and enforcement is most likely or (2) discount the maximum effects based on expected limitations in policy implementation, enforcement, or effectiveness that would prevent the policy or action from achieving its maximum potential.[2] Users should apply conservative assumptions if there is uncertainty about the extent of policy implementation and effectiveness.

### Policy interactions

The policy or action assessed may interact with implemented or adopted policies and actions included in the baseline scenario. To accurately estimate policy scenario parameter values, policy scenario emissions, and the GHG effects of the policy or action, users should determine whether the policy or action assessed interacts with any policies included in the baseline scenario (either in reinforcing or overlapping ways).

If there are no interactions with other policies or actions included in the baseline scenario, the policy or action assessed will have the full range of effects expected. If the policy or action assessed has a reinforcing effect with policies in the baseline scenario, the policy or action assessed will have a greater range of positive effects than expected. However, if the policy or action overlaps with policies in the baseline scenario, the positive effect of the policy or action will be reduced. In an extreme case where the policy or action assessed overlaps completely with policies included in the baseline scenario, the policy or action would have no GHG effects relative to the baseline scenario.

If interactions with policies included in the baseline scenario exist, users should estimate the magnitude of the policy interactions when estimating policy scenario parameter values and policy scenario emissions. Users should estimate the total net effect of all policies included in the baseline scenario on each parameter in the emissions estimation methods. For guidance on assessing policy interactions, see Appendix B.

### Sensitivity of parameters to assumptions

Users should use sensitivity analysis to understand the range of possible values of various parameters and determine which scenario is most likely. Users should also understand the range of uncertainty associated with various parameters. For more information on assessing uncertainty and sensitivity analysis, see Chapter 12.

See Table 9.2 for an example of reporting parameter values and assumptions.

Users may refer to model documentation that explains the methodologies and algorithms embedded in a model, whether the model was subjected to peer review, and why the selected model was chosen for use in the assessment.

See Box 9.2 for a case study of developing assumptions for a baseline scenario and policy scenario.

**Table 9.2 Example of reporting parameter values and assumptions used to estimate ex-ante policy scenario emissions for a home insulation subsidy**

| Parameter | Policy scenario value(s) applied over the GHG assessment period | Methodology and assumptions to estimate value(s) | Data source(s) |
|---|---|---|---|
| **Natural gas used for space heating** | 1,000,000 MMBtu/year from 2010–14; 910,000 MMBtu/year from 2015–25 | Values calculated based on 30% anticipated uptake of the insulation subsidy starting in 2015 and remaining constant through 2025; and 30% energy use reduction per home with insulation (based on previous studies of similar policies) | Peer-reviewed literature: Author (Year). Title. Publication. |
| **Natural gas emission factor** | 55 kg $CO_2$e/MMBtu (constant) | Same value as in baseline scenario since the policy does not affect this parameter | National energy statistical agency |

**Box 9.2 Developing assumptions for the baseline scenario and policy scenario for the German Renewable Energy Act**

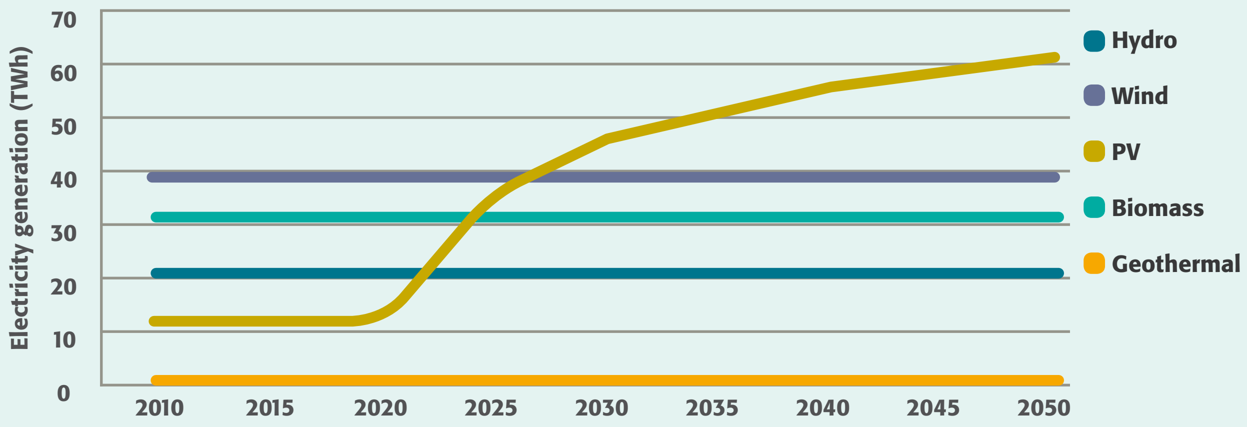
Öko-Institut e.V. carried out an ex-ante assessment of the Renewable Energy Act (EEG) in Germany. The main purpose of the policy is to promote renewable electricity generation. The EEG involves mandatory connection of renewable electricity generators to the power grid, preferential access of renewable electricity (over fossil and nuclear electricity), and feed-in tariffs for renewable electricity generation.

For the baseline scenario, it was assumed there would be no further increase in renewable electricity absent the EEG, except for photovoltaic (PV) electricity. For PV electricity, it was assumed that electricity generation would remain at the 2010 level through 2020. After 2020, it was assumed that world market prices will come down considerably so that PV will be cost-effective and therefore will be installed even without feed-in tariffs. Figure 9.4 presents the baseline scenario assumptions for renewable electricity generation.

The policy scenario represents the development of additional renewable electricity generation under the EEG. The policy scenario was estimated using assumptions from a research study on the long-term development of renewables in Germany (DLR, Fraunhofer IWES, and IFNE 2012). All renewable sources are expected to increase in the policy scenario, with wind power increasing the most dramatically. Figure 9.5 presents the policy scenario assumptions for renewable electricity generation (excluding wind in order to show the same scale as Figure 9.4). Figure 9.6 presents the policy scenario assumptions for renewable electricity generation (including wind), with a different scale.

The difference in electricity generation between the baseline and policy scenarios represents the effect of the policy. The overall annual policy effect amounts to 95 Mt $CO_2$ in 2020 and 138 Mt $CO_2$ in 2050 (see Figure 9.7). To calculate the GHG effect of the policy, it was assumed that in the absence of the EEG, the additional electricity would have been produced by the fossil generation mix. The assumed fossil generation mix (746 g $CO_2$/kWh in 2020 and 519 g $CO_2$/kWh in 2050) was taken from recent modeling exercises for the German Ministry of the Environment, Nature Conservation, and Nuclear Safety.

**Figure 9.4 Baseline scenario assumptions for renewable electricity generation**



**Box 9.2** **Developing assumptions for the baseline scenario and policy scenario for the German Renewable Energy Act (continued)**

**Figure 9.5** **Policy scenario assumptions for renewable electricity generation (excluding wind)**

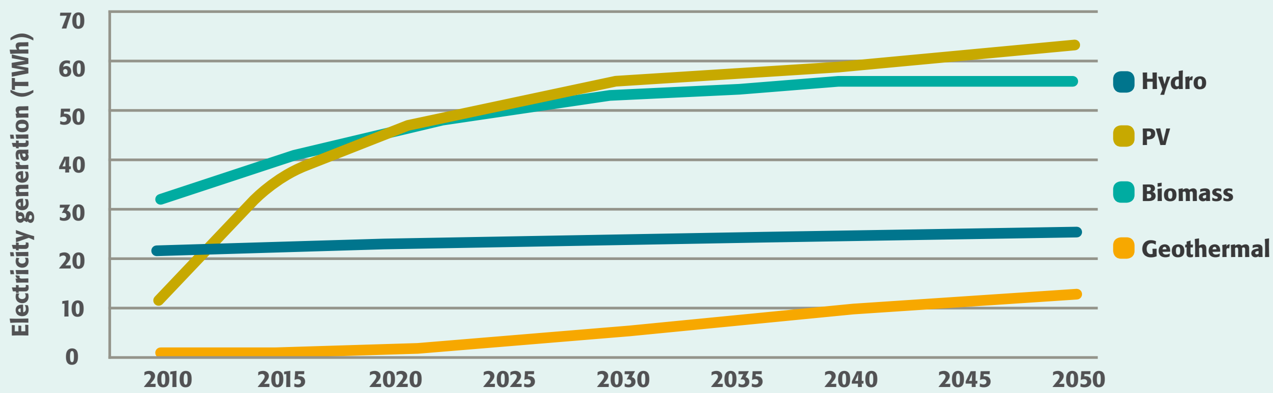



**Figure 9.6** **Policy scenario assumptions for renewable electricity generation (including wind)**

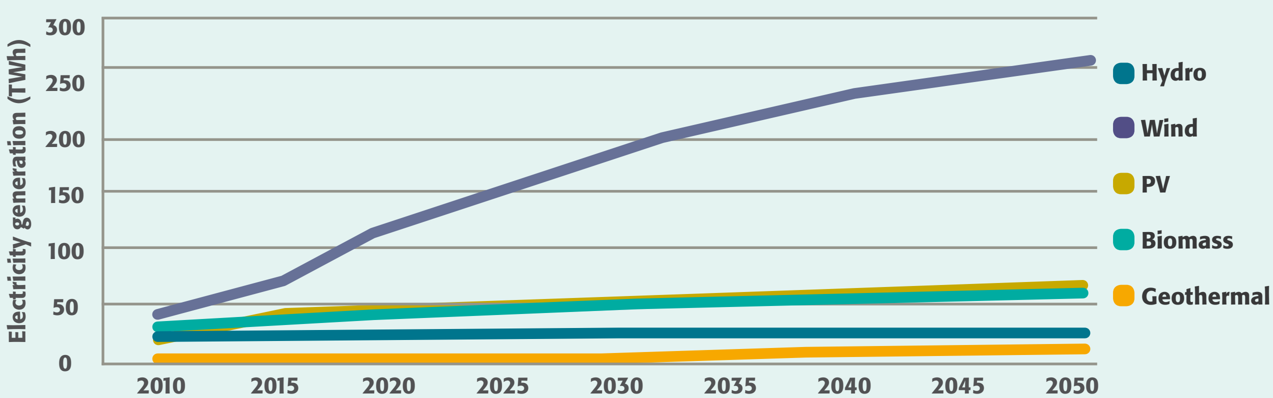
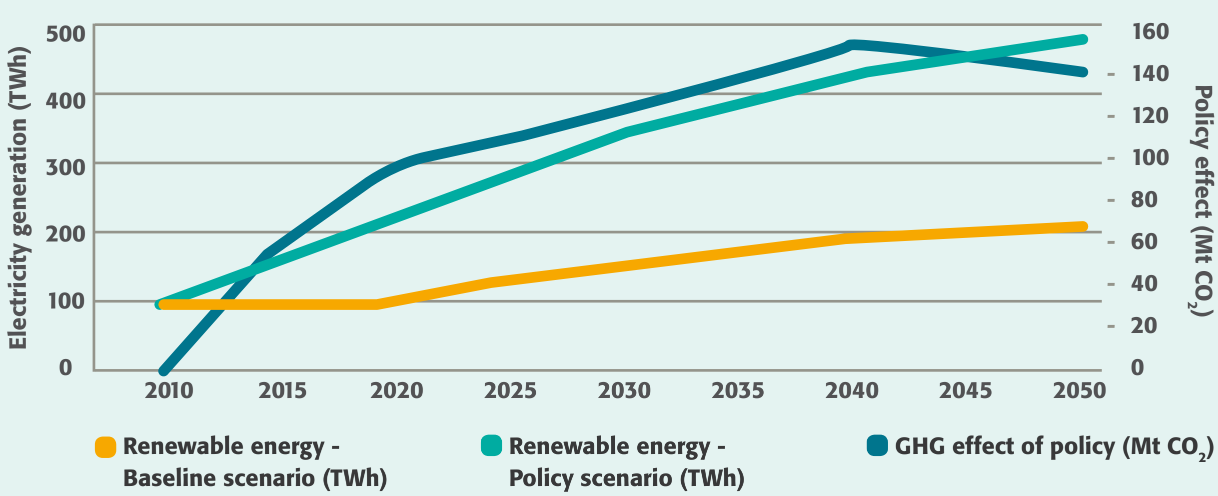



**Figure 9.7** **The estimated GHG effect of the policy, 2010–50**



## 9.5 Estimate policy scenario emissions

Users **shall** estimate policy scenario emissions and removals over the GHG assessment period for each source/sink category and greenhouse gas included in the GHG assessment boundary, based on the GHG effects included in the boundary. Users **shall** apply the same GWP values used to estimate baseline emissions. Any sources, sinks, greenhouse gases, or GHG effects in the GHG assessment boundary that have not been estimated **shall** be disclosed, justified, and described qualitatively.

After estimating policy scenario emissions for each source and sink, users should aggregate policy scenario emissions across all categories of sources and sinks included in the GHG assessment boundary to estimate total policy scenario emissions, if feasible based on the method used. When aggregating across sources and sinks, users should address any possible overlaps or interactions between sources and sinks to avoid over- or underestimation of total policy scenario emissions.

Users **shall** report total annual and cumulative policy scenario emissions and removals over the GHG assessment period, if feasible based on the method used.

## 9.6 Estimate the GHG effect of the policy or action

Finally, users **shall** estimate the GHG effect of the policy or action by subtracting baseline emissions from policy scenario emissions for each source/sink category included in the GHG assessment boundary (see Equation 9.1).

Users should estimate the GHG effect for each source/sink category separately, by following these steps:

1. Estimate baseline emissions from each source/sink category (Chapter 8)
2. Estimate policy scenario emissions for each source/sink category
3. For each source/sink category, subtract baseline emissions from policy scenario emissions to estimate the GHG effect of the policy or action for each source/sink category
4. Aggregate GHG effects across all source/sink categories to estimate total GHG effect of the policy or action

Alternatively, users may follow these steps:

1. Estimate baseline emissions from each source/sink category (Chapter 8)
2. Aggregate baseline emissions across all source/sink categories to estimate total baseline emissions (Chapter 8)
3. Estimate policy scenario emissions for each source/sink category
4. Aggregate policy scenario emissions across all source/sink categories to estimate total policy scenario emissions
5. Subtract total baseline emissions from total policy scenario emissions to estimate the total GHG effect of the policy or action

Both approaches yield the same result. See Table 9.3 for an example. In this example, a user has two options:

- Estimate total policy scenario emissions (70,000 t $CO_2$e) and total baseline emissions (75,000 t $CO_2$e), then subtract the two to estimate the total change (–5,000 t $CO_2$e); or
- Estimate the GHG effect for each source/sink category (–2,000 t $CO_2$e, –4,000 t $CO_2$e, +1,000 t $CO_2$e), then sum across source/sink categories to estimate the total change (–5,000 t $CO_2$e).

**Equation 9.1 Estimating the GHG effect of the policy or action**

**Total net change in GHG emissions resulting from the policy or action (t $CO_2$e) =**

**Total net policy scenario emissions (t $CO_2$e) – Total net baseline scenario emissions (t $CO_2$e)**

*Note:* "Net" refers to the aggregation of emissions and removals. "Total" refers to the aggregation of emissions and removals across all sources and sinks included in the GHG assessment boundary.

**Table 9.3 Example of estimating the GHG effect of a home insulation subsidy**

| GHG effect included | Affected sources | Policy scenario emissions | Baseline emissions | Change |
|---|---|---|---|---|
| **Reduced emissions from electricity use** | Fossil fuel combustion in grid-connected power plants | 48,000 t $CO_2$e | 50,000 t $CO_2$e | **-2,000 t $CO_2$e** |
| **Reduced emissions from home natural gas use** | Residential natural gas combustion | 16,000 t $CO_2$e | 20,000 t $CO_2$e | **-4,000 t $CO_2$e** |
| **Increased emissions from insulation production** | Insulation manufacturing processes | 6,000 t $CO_2$e | 5,000 t $CO_2$e | **+1,000 t $CO_2$e** |
| **Total emissions / Total change in emissions** | | **70,000 t $CO_2$e** | **75,000 t $CO_2$e** | ***-5,000 t $CO_2$e*** |

*Note:* The table provides data for one year in the GHG assessment period.

Users **shall** report the estimated total net change in GHG emissions and removals resulting from the policy/action or package of policies/actions, in tonnes of carbon dioxide equivalent, both annually and cumulatively over the GHG assessment period.

Users **shall** report the total in-jurisdiction GHG effects (the total net change in GHG emissions and removals that occurs within the implementing jurisdiction's geopolitical boundary), separately from total out-of-jurisdiction GHG effects (the net change in GHG emissions and removals that occurs outside of the jurisdiction's geopolitical boundary), if relevant and feasible.

Users should separately estimate and report the change in GHG emissions/removals resulting from each individual GHG effect included in the GHG assessment boundary, where relevant and feasible.[3] Users may also separately report by type of effect, by source or sink, or by category of source or sink.

Users should report the GHG effect of the policy or action as a range of likely values, rather than as a single estimate, when uncertainty is high (for example, because of uncertain baseline assumptions or uncertain policy interactions). See Chapter 12 for guidance on uncertainty and sensitivity analysis.

### 9.6.1 Separate reporting based on likelihood and probability (optional)

Each GHG effect of the policy or action included in the assessment may vary in the likelihood that it will actually occur. In Chapter 7, users categorize potential effects based on whether they are very likely, likely, possible, unlikely, or very unlikely to occur. Depending on how the GHG assessment boundary is defined, the ex-ante assessment may include effects that are possible, unlikely, or very unlikely to occur as a result of the policy or action assessed.

If unlikely or very unlikely effects are included in the assessment, users should report the estimated GHG effects resulting from those effects separately from the results based on very likely, likely, and possible effects. Users should separately report effects by each likelihood category (very likely, likely, possible, unlikely, very unlikely) where relevant and feasible.

Where likelihood is difficult to estimate, users may report a range of values for a given effect based on sensitivity analysis around key parameters (further described in Chapter 12). Users may additionally incorporate probability into the estimation of ex-ante policy scenario emissions, based on the likelihood that each effect will occur. For more information, see Box 9.3.

See Box 9.4 for a case study of calculating the GHG effect of a policy ex-ante.

**Box 9.3 Estimating policy scenario emissions based on likelihood of effects occurring**

In addition to reporting unlikely and very unlikely effects separately, users may choose to estimate policy scenario emissions and GHG effects of the policy or action by estimating a probability-adjusted sum. In this approach, all effects are included and weighted by their probability. Under the most robust approach, users may develop a Monte Carlo simulation in which a range of outcomes is predicted based on the magnitude and probability of the individual effects. As a simpler approach, users may multiply each estimated GHG effect by its expected probability to calculate a probability-adjusted estimate (or expected value) for each effect. If probabilities are unknown, users should use the default probability values in Table 9.4 based on the qualitative likelihood that each effect will occur. For example, if a potential effect is considered “possible” and it would reduce emissions by 10,000 t $CO_2e$, the probability-adjusted estimate (or expected value) for that effect would be 10,000 t $CO_2e$ × 50% = 5,000 t $CO_2e$. Users of this approach should disclose the individual effects and their assumed probabilities.

Users and stakeholders should be aware that this approach may yield a predicted outcome that will not actually happen. In the example above, the estimated probability-adjusted estimate of 5,000 t $CO_2e$ will not actually occur. Instead, the actual outcome will either be 0 t $CO_2e$, or 10,000 t $CO_2e$, depending on whether the possible effect happens or does not happen. Nevertheless, a probability-adjusted estimate is useful to approximate the expected outcome, rather than assuming either 0 t $CO_2e$ or 10,000 t $CO_2e$ when the probability of either outcome is only 50 percent. Users following this approach should clearly disclose that the results represent a probability-adjusted estimate and report the probability values used.

**Table 9.4 Default probability values**

| Likelihood | Default probability value |
|---|---|
| **Very likely** | 100% |
| **Likely** | 75% |
| **Possible** | 50% |
| **Unlikely** | 25% |
| **Very unlikely** | 0% |

**Box 9.4** **Calculating the GHG effect ex-ante of Tunisia's PROSOL Elec program**

PROSOL Elec is a renewable energy support program, launched by the National Agency for Energy Conservation (ANME) of Tunisia in 2010, that aims to promote and support the installation of photovoltaic (PV) systems in residential and commercial buildings with low-voltage grid connections. The objective of the ex-ante assessment was to estimate the program's future contribution to mitigation at the national level.

To estimate ex-ante policy scenario emissions from one of the affected sources—the production of electricity by conventional power plants for consumption in the residential and commercial buildings sector—the same emissions estimation method used to estimate baseline emissions (in Box 8.5) was applied, but one parameter value was changed. The consumption of electricity in buildings was reduced by the amount of electric energy expected to be produced by future photovoltaic systems expected to be installed. The electricity produced by PV systems was calculated by multiplying the amount of kWp installed PV capacity by the specific production of the PV systems in Tunisia.

The number and capacity of PV systems expected to be installed over the period 2014–30 were derived from a strategic study on the development of renewable energies in Tunisia made by ANME. The specific energy production is an empirical value based on annual on-site measurements of 20 percent of all new installed PV systems in Tunisia. This value is not expected to change significantly in the future.

The following equation was used to estimate electricity production from PV systems in 2020. For information on the calculation of baseline emissions, see Box 8.5. The estimated GHG effect is the difference between policy scenario emissions and baseline emissions.

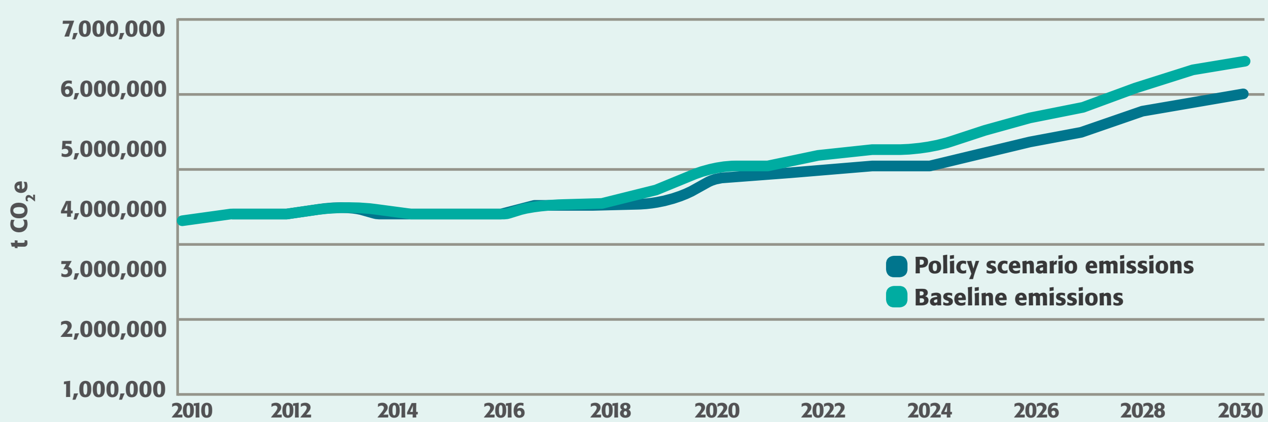
**Installed PV capacity in Tunisia [184,000 kWp] × specific energy production of PV systems in Tunisia [1,600 kWh/kWp] = Electric energy produced by PV systems [294,400,000 kWh = 294 GWh]**

**Baseline electricity consumption in residential and commercial buildings in 2020 = [8,390 GWh]**

**Policy scenario electricity consumption in residential and commercial buildings in 2020 = [8,390 GWh - 294 GWh] = 8,096 GWh**

See Figure 9.8 for a graph of the program's estimated GHG effect.

**Figure 9.8** **Estimated GHG effect of the program, 2010–30**



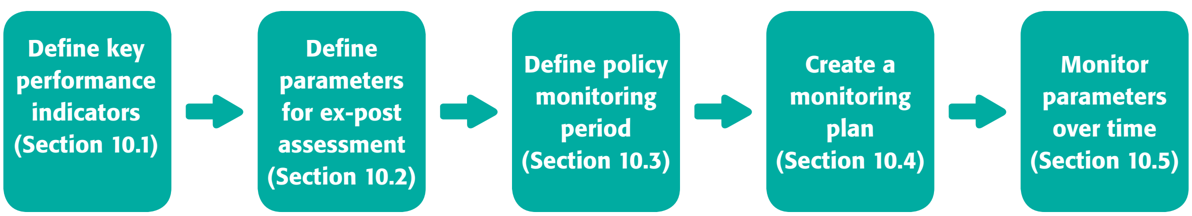
## Endnotes

1. New methods should not be used to estimate total emissions from source/sink categories, since the emissions estimation method used to estimate baseline emissions should also be used to estimate policy scenario emissions.
2. Barua, Fransen, and Wood 2014 provides a framework for considering factors that may influence effective policy implementation in more detail.
3. An individual effect can be separately estimated and reported if it influences distinct sources/sinks within the GHG assessment boundary that are not influenced by the other effects being estimated. In this case, the change in emissions/removals from the source/sink is equal to the change resulting from that GHG effect. If multiple effects influence the same source/sink, the combined effect can be estimated, but not the individual effects.

# 10 Monitoring Performance over Time

**This chapter provides guidance on monitoring the performance of a policy or action during the policy implementation period and on collecting data to estimate GHG effects ex-post. Users that estimate GHG effects ex-ante without monitoring performance may skip this chapter and proceed to Chapter 12.**

**Figure 10.1 Overview of steps for monitoring performance over time**




**Checklist of accounting requirements (for users monitoring performance)**

| Section | Accounting requirements |
|---|---|
| **Define key performance indicators (Section 10.1)** | • Define the key performance indicators that will be used to track performance of the policy or action over time. |
| **Define parameters for ex-post assessment (Section 10.2)** | • For users planning to carry out an ex-post assessment: Define the parameters necessary to estimate ex-post policy scenario emissions and ex-post baseline scenario emissions. |
| **Create a monitoring plan (Section 10.4)** | • Create a plan for monitoring key performance indicators (and parameters for ex-post assessment, if relevant). |
| **Monitor parameters over time (Section 10.5)** | • Monitor each of the parameters over time in accordance with the monitoring plan. |

*Note:* Reporting requirements are listed in Chapter 14.


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

- **To monitor implementation progress:** Monitor trends in key performance indicators to understand whether the policy or action is on track and being implemented as planned
- **To estimate GHG effects:** Collect the data needed for ex-post assessment of GHG effects

Users may monitor data to fulfill one or both functions, depending on objectives. *Key performance indicators* are metrics that indicate the performance of a policy or action, such as tracking changes in targeted outcomes. *Parameter* is a broader term meaning any type of data (such as activity data or emission factors) needed to estimate emissions.

Monitoring key performance indicators is generally less onerous than estimating GHG effects and can provide a low-cost way of understanding policy effectiveness by tracking trends in key indicators. If progress is not on track, monitoring can inform corrective action. However, monitoring indicators is not sufficient to estimate the effect of a policy. To estimate GHG effects ex-post, users need to collect data on a broader range of parameters, which should be monitored during the policy implementation period.

Where possible, users should develop the monitoring plan during the policy design phase (before implementation), rather than after the policy has been designed and implemented. Doing so ensures that the data needed to assess the effectiveness of the policy are collected.

The monitoring plan should be informed by the ex-post estimation method that will be used in order to ensure that the proper data are collected (see Chapter 11).

For additional guidance on collecting data, see Appendix A.

## 10.1 Define key performance indicators

Users that monitor performance **shall** define the key performance indicators that will be used to track performance of the policy or action over time. Where relevant, users should define key performance indicators in terms of the relevant *inputs*, *activities*, and *intermediate effects* associated with the policy or action. Table 10.1 provides definitions and examples of each type of indicator. Inputs and activities are most relevant for monitoring policy or action *implementation*, while intermediate effects and non-GHG effects are most relevant for monitoring policy or action *effects*. Indicators can be either absolute (such as the number of homes insulated) or intensity-based (such as g $CO_2$e/km). Users may also define indicators to track *non-GHG effects*.

Users **shall** report the key performance indicators selected and the rationale for their selection.

The selection of the indicators should be tailored to the policy or action in question, based on the type of policy or action, the requirements of stakeholders, the availability of existing data, and the cost of collecting new data.

Tables 10.2 and 10.3 provide examples of activity and intermediate effect indicators.[1]

**Table 10.1 Types of key performance indicators for monitoring performance**

| Indicator types | Definitions | Examples for a home insulation subsidy program |
|---|---|---|
| **Inputs** | Resources that go into implementing a policy or action, such as financing | Money spent to implement the subsidy program |
| **Activities** | Administrative activities involved in implementing the policy or action (undertaken by the authority or entity that implements the policy or action), such as permitting, licensing, procurement, or compliance and enforcement | Number of energy audits carried out, total subsidies provided |
| **Intermediate effects** | Changes in behavior, technology, processes, or practices that result from the policy or action | Amount of insulation purchased and installed by consumers, fraction of homes that have insulation, amount of natural gas and electricity consumed in homes |
| **GHG effects** | Changes in greenhouse gas emissions by sources or removals by sinks that result from the intermediate effects of the policy or action | Reduced $CO_2$, $CH_4$, and $N_2O$ emissions from reduced natural gas and electricity use |
| **Non-GHG effects** | Changes in relevant environmental, social, or economic conditions other than GHG emissions or climate change mitigation that result from the policy or action (see Appendix C for examples) | Household disposable income from energy savings |

*Source:* Adapted from W. K. Kellogg Foundation 2004.
*Notes:* GHG effects are typically not monitored directly but instead are estimated based on changes in various other parameters. In other frameworks, intermediate effects are called "outcomes" and GHG effects and non-GHG effects are called "impacts."

**Table 10.2 Examples of activity indicators for various policies**

| Examples of policies | Examples of activity indicators |
|---|---|
| **Renewable portfolio standard** | Quantity of long-term contracts with renewable energy power generators established, number of renewable energy certificates (RECs) issued |
| **Fuel economy standard** | Number of emission certificates issued per year, number of vehicle manufacturers from which information on cars sold is collected by the government |
| **Subsidy for home insulation** | Amount of subsidies issued |
| **Energy efficiency standards for appliances** | Number of appliance standards and reporting templates published, number of appliance manufacturers from which information on sold appliances is collected |
| **Government buildings retrofit program** | Number of retrofit projects procured (for example, number of contractors selected for installation through open bidding process) |

*Source:* Adapted from Barua, Fransen, and Wood 2014.

**Table 10.3 Examples of intermediate effect indicators for various policies**

| Examples of policies | Examples of intermediate effect indicators |
|---|---|
| **Renewable portfolio standard** | Total electricity generation by source (such as wind, solar, coal, natural gas) |
| **Public transit policies** | Passenger-kilometers traveled by mode (such as subway, bus, train, private car, taxi, bicycle) |
| **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 replanted 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) |

## 10.2 Define parameters needed for ex-post assessment

Users planning to carry out an ex-post assessment **shall** define the parameters necessary to estimate ex-post policy scenario emissions and ex-post baseline scenario emissions. Users should first define the methods needed for ex-post assessment in order to identify the parameters that should be monitored. See Chapter 11 for a description of various bottom-up and top-down estimation methods. The selection of methods and identification of data sources is an iterative process, since the availability of data informs the selection of methods, and the selection of methods defines the data that need to be collected. There may be overlap between parameters needed for ex-post assessment and intermediate effect indicators used for monitoring performance.

If relevant, users should monitor the parameters in the ex-ante baseline estimation method defined in Chapter 8, including data related to other policies and actions and non-policy drivers, to determine the extent to which the original assumptions in the baseline scenario remain valid or need to be recalculated.

The parameters needed for ex-post assessment vary by type of policy or action and sector. For selected examples, see Table 10.4.

### Bottom-up and top-down data

Both bottom-up and top-down data may be used, and either may be most appropriate depending on the type of policy or action, sector, quantification methods used, and data availability. See Section 3.2 for definitions of bottom-up and top-down data.

Bottom-up data may be most appropriate for sectors with a relatively small, finite set of emitting sources (such as power generation or cement production), where bottom-up data collection at the facility level is feasible. Top-down data may be most appropriate for sectors with a large number of diffuse emitting sources, where bottom-up data collection is not feasible or where top-down data are more accurate and complete.

Table 10.5 provides examples of both types of data.

**Table 10.4 Examples of parameters to be monitored by policy/action type**

| Examples of policies | Selected examples of parameters to be monitored |
|---|---|
| **Energy efficiency program in the commercial buildings sector** | • Electricity use (annual, direct metering)<br>• Emission factor from grid electricity<br>• Gross floor area of building units |
| **Solar power incentives** | • Solar panels produced each year<br>• Capacity of solar power installed<br>• Electricity generated from solar power |
| **Electric vehicle subsidy** | • Number of electric vehicles (quarterly)<br>• Passenger figures (monthly)<br>• Vehicle-kilometers traveled (monthly) |
| **Emissions trading system** | • Facility-level monitoring of emissions data from covered facilities |
| **Information campaign to encourage energy savings in the residential sector** | • Surveys of a representative sample of households to collect data such as: awareness of the campaign, actions taken as a result of the campaign, household size, household income, and household energy use over time |

**Table 10.5 Examples of bottom-up and top-down data by sector**

| Sector | Examples of bottom-up data | Examples of top-down data |
|---|---|---|
| **Transportation** | • Distance traveled (vehicle-kilometers traveled) by transport mode and vehicle type<br>• Percentage of trips taken every year by each mode of transportation, length of each trip by mode, number of trips taken by mode per year<br>• Example data source: annual household surveys and/or transportation models | • Total fuel sold in a city, by fuel type<br>• Example data source: city statistics |
| **Waste** | • Quantity of waste collected by type, quantity of recyclables collected by type, quantity of compost collected, gross quantity of municipal solid waste, waste diversion rate<br>• Example data source: waste management companies (private) or agencies (public) | • Method of disposal (incineration, landfill)<br>• Landfill: tonnage by depths of landfill<br>• Incineration: incineration rate by type of waste<br>• Location of disposal sites<br>• Example data source: city statistics |
| **Residential and commercial buildings** | • Building-level energy use by fuel/energy type<br>• Example data source: annual building surveys or reporting requirements | • Aggregate fuel and electricity consumed by all buildings in a city, by fuel/energy type<br>• Example data source: city statistics from city utilities or energy agencies |

## 10.3 Define the policy monitoring period

The *policy implementation period* is the time period during which the policy or action is in effect (defined in Chapter 5). The *GHG assessment period* is the time period over which GHG effects resulting from the policy or action are assessed (defined in Chapter 7).

The *policy monitoring period* is the time period over which the policy or action is monitored. At a minimum, the policy monitoring period should include the policy implementation period, but where possible it should also include pre-policy monitoring of relevant activities prior to the implementation of the policy and post-policy monitoring of relevant activities after the policy implementation period. In general, the longer the time series of data that is collected, the more robust the assessment will be. See Box 10.1 for an example of a policy monitoring period.

## 10.4 Create a monitoring plan

Users **shall** create a plan for monitoring key performance indicators (and parameters for ex-post assessment, if relevant). A monitoring plan is important to ensure that the necessary data are collected and analyzed. Where possible, users should develop the monitoring plan during the policy design phase (before implementation), rather than after the policy has been designed and implemented.

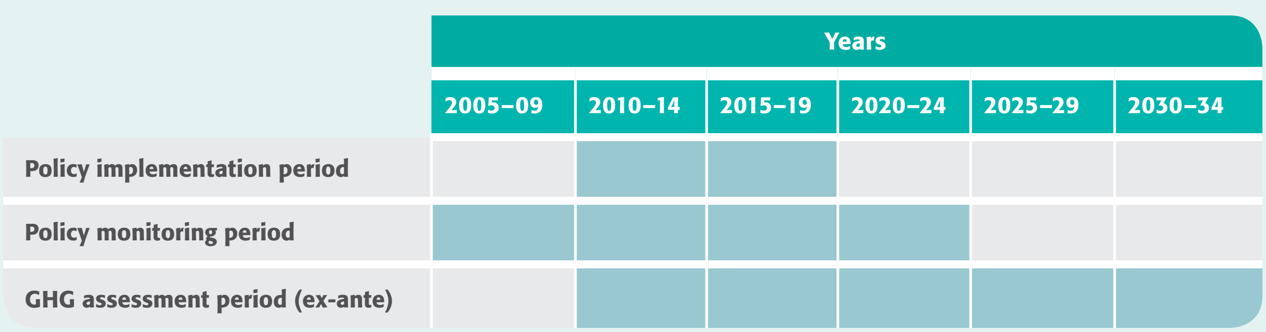
For each of the key performance indicators or parameters, users should describe the following elements in a monitoring plan:

- Measurement or data collection methods
- Sources of data (either existing data sources or additional data collected specifically to monitor indicators)
- Monitoring frequency
- Units of measure
- Whether data are measured, modeled, calculated, or estimated; level of uncertainty in any measurements or estimates; how this uncertainty will be accounted for
- Sampling procedures (if applicable)
- Whether data are verified, and if so, verification procedures used

**Box 10.1 Example of policy monitoring period for a biofuels policy**

A biofuels policy is implemented over the 10-year period 2010–19. The GHG assessment period (ex-ante) continues until 15 years after the policy implementation period ends to account for long-lasting GHG effects resulting from land-use change. The policy monitoring period begins in 2005 to collect baseline data and monitor pre-policy trends prior to 2010. It continues through the policy implementation period and ends in 2024 in order to monitor any post-policy effects between 2020 and 2024. Figure 10.2 illustrates the various periods.

**Figure 10.2 Example of policy implementation period, policy monitoring period, and GHG assessment period**



- 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
- Methods for generating, storing, collating, and reporting data on monitored parameters
- Databases, tools, or software systems to be used for collecting and managing
- Procedures for internal auditing, quality assurance (QA), and quality control (QC)
- Record keeping and internal documentation procedures needed for QA/QC, including length of time data will be archived
- Any other relevant information

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. Users **shall** report the sources of data used. Users should also report any calculation assumptions and uncertainties related to the data. See Appendix A for guidance on data collection and Chapter 12 for guidance on uncertainty.

### Measurement or data collection methods

Data may be measured, modeled, calculated, or estimated. Measured data refers to direct measurement, such as directly measuring emissions from a smokestack. Modeled 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. Estimated data (in the context of monitoring) refers to proxy data or other data sources used to fill data gaps in the absence of more accurate or representative data sources.

Bottom-up monitoring methods may involve collecting data from representative samples of individual facilities or other sources, rather than from all affected facilities or sources.

### Frequency of monitoring

Users may monitor indicators at various frequencies, such as monthly, quarterly, or annually. In general, users should collect data with as high a frequency as is feasible and appropriate in the context of objectives. The appropriate frequency of monitoring should be determined based on the needs of decision makers and stakeholders, following the principle of relevance, and may depend on the type of indicators and data availability. For example, data on inputs are typically available immediately following policy implementation. In contrast, data on the outputs and outcomes of the policy or action may not be realized for some time after implementation. It may therefore be necessary to monitor some indicators over different time periods than for others.

See Box 10.2 for a case study of developing a monitoring plan.

## 10.5 Monitor the parameters over time

Users **shall** monitor each of the parameters over time in accordance with the monitoring plan. Users **shall** report the performance of the policy or action over time, as measured by the key performance indicators, and whether the performance of the policy or action is on track relative to expectations.

If monitoring indicates that the assumptions used in the ex-ante assessment are no longer valid, users should document the differences and take the monitoring results into account when updating the ex-ante estimates or when estimating GHG effects ex-post. Users **shall** report whether the assumptions on key parameters within the ex-ante assessment remain valid.

**Box 10.2 Developing a monitoring plan for the Tunisian NAMA for energy conservation in the building sector**

The National Agency for Energy Conservation (ANME) of Tunisia, Alcor, and Ecofys carried out an ex-ante assessment of the nationally appropriate mitigation action (NAMA) for energy conservation in the building sector in Tunisia. The NAMA includes a solar program for commercial and residential buildings—including solar water heaters (SWH) and solar photovoltaic (PV) energy—and a thermal insulation program for existing and new residential buildings. The objective of the assessment was to estimate and report the expected GHG emission reductions in order to attract and facilitate international support for the NAMA.

A monitoring plan was included as part of the NAMA design. The plan identifies key performance indicators, data sources, monitoring frequency, and the entities responsible for data collection. Table 10.6 provides examples of information contained in the monitoring plan. The plan includes indicators related to both GHG effects and non-GHG effects, since the NAMA is intended to achieve both GHG and various sustainable development benefits, such as creation of skilled jobs and companies in the energy technology sector, reduced household expenditure for energy, and reduced fossil fuel subsidies for the Tunisian government.

Monitoring will be used to track the performance of the NAMA on a regular basis, to inform corrective actions if needed, and to assess the impacts of the NAMA ex-post. The NAMA includes provisions to strengthen monitoring capacity to implement the monitoring plan, such as improving information management systems, establishing new electronic information systems, improving data collection and coordination, and developing procedures for sampled on-site verifications, internal auditing, quality assurance, and quality control.

**Table 10.6 Examples of information contained in the Tunisia energy conservation NAMA monitoring plan**

| Indicator or parameter (and unit) | Source of data | Monitoring frequency | Measured, calculated, or estimated (and uncertainty) | Responsible entity |
|---|---|---|---|---|
| **GHG impact of thermal insulation** | | | | |
| Number of houses insulated and insulated area by type (roof, wall, glazing) and $m^2$ | ANME information system (to be created) | Annual | Measured (Low uncertainty) | ANME |
| For existing dwellings: historical annual electricity and primary thermal energy consumption ($kWh/m^2$) | Energy bills | Annual | Measured (Low uncertainty) | Collected by energy counsellors; feed into ANME information system through electronic application file |
| For new dwellings: annual electricity and primary thermal energy consumption ($kWh/m^2$) of dwellings that do not apply to the program | Sampled metering on 50 new dwellings and survey to assess energy profile (baseline) | Annual verification | Measured for 50 dwellings and estimated for the rest (Medium uncertainty) | Collected by ANME control officers to build a baseline scenario for new dwellings |

**Box 10.2 Developing a monitoring plan for the Tunisian NAMA for energy conservation in the building sector (continued)**

**Table 10.6 Examples of information contained in the Tunisia energy conservation NAMA monitoring plan (continued)**

| Indicator or parameter (and unit) | Source of data | Monitoring frequency | Measured, calculated, or estimated (and uncertainty) | Responsible entity |
|---|---|---|---|---|
| **GHG impact of thermal insulation (continued)** | | | | |
| For new and existing dwellings: final electricity savings and primary thermal energy savings (kWh/$m^2$) | Sampled metering on 100 new and existing dwellings and survey to assess energy profiles' changes (including possible rebound effect) after first year of operation | Annual | Measured for 100 dwellings and estimated for the rest (Medium uncertainty) | Control officers carry out on-site verification; feed information into Promo-isol+ information system |
| Energy intensity of buildings: annual electricity and primary thermal energy consumption (kWh/year) per $m^2$ and per dwellings | ANME information system | Every 5 years | To be determined | ANME |
| **Job creation** | | | | |
| Number of employees in new and existing companies that provide energy services for buildings | ANME accreditation system and human resources department | Annual | Measured (Low uncertainty) | ANME |
| **Creation of new companies** | | | | |
| Number of new companies created to provide energy services for buildings | ANME accreditation system and human resources department | Annual | Measured (Low uncertainty) | ANME |
| **Saved energy costs for end users and saved energy subsidies for the Tunisian government** | | | | |
| (Energy savings by source from GHG ex-post assessment) × (Energy prices for electricity, natural gas, LPG, kerosene, wood, charcoal) | GHG ex-post assessment and ANME sources on energy prices and subsidies | Annual | Measured and calculated (Low uncertainty) | ANME |

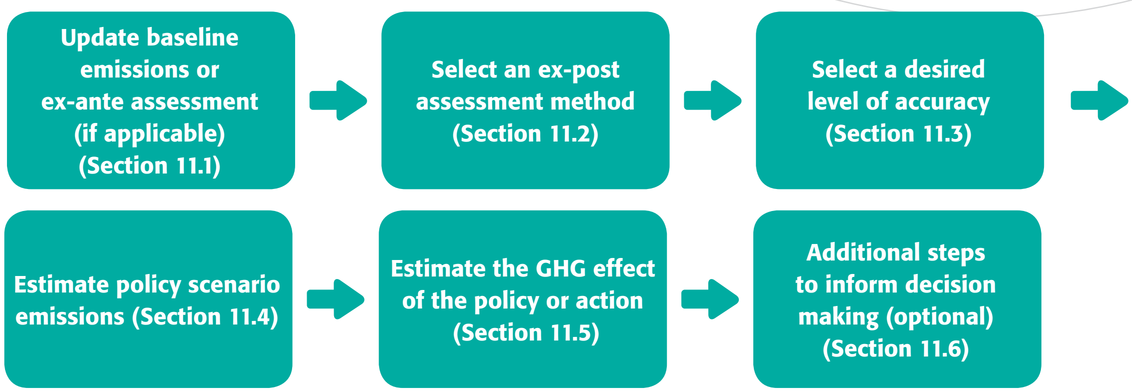
## Endnote

1. Barua, Fransen, and Wood 2014 provides additional guidance on selecting input and activity indicators.

# 11 Estimating GHG Effects Ex-Post

**This chapter describes how to estimate the GHG effects that have occurred as a result of the policy or action (ex-post assessment). In this chapter, users estimate the GHG effect of the policy or action by comparing observed policy scenario emissions (based on monitored data) to ex-post baseline scenario emissions (described in Chapter 8). The GHG effect of the policy or action (ex-post) is estimated by subtracting baseline emissions from policy scenario emissions. Users that choose only to estimate GHG effects ex-ante may skip this chapter and proceed to Chapter 12.**

**Figure 11.1** **Overview of steps for estimating GHG effects ex-post**




### Checklist of accounting requirements (for users carrying out ex-post assessment)

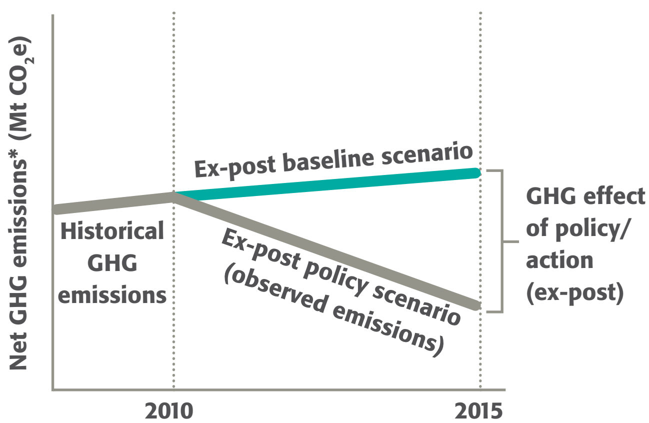
| Section | Accounting requirements |
|---|---|
| **Estimate policy scenario emissions (Section 11.4)** | • Estimate policy scenario emissions and removals over the GHG assessment period for each source/sink category and greenhouse gas included in the GHG assessment boundary.<br>• Apply the same GWP values used to estimate baseline emissions. |
| **Estimate the GHG effect of the policy or action (Section 11.5)** | • Estimate the GHG effect of the policy or action by subtracting baseline emissions from policy scenario emissions for each source/sink category included in the GHG assessment boundary. |

*Note:* Reporting requirements are listed in Chapter 14.

## 11.1 Update baseline emissions or ex-ante assessment (if applicable)

Figure 11.2 provides an illustration of estimating GHG effects ex-post. In contrast to ex-ante policy scenario emissions, which are forecasted based on assumptions, ex-post policy scenario emissions are observed based on data collected during the time the policy or action was implemented. Users carrying out an ex-post assessment may either estimate ex-post policy scenario emissions before or after estimating ex-post baseline emissions. See Section 8.2 in Chapter 8 for more information on the sequence of steps.

**Figure 11.2 Ex-post assessment**




*Note:* * From sources and sinks in the GHG assessment boundary.

Baseline emissions (as described in Chapter 8) should be recalculated every time an ex-post assessment is undertaken. The ex-post baseline scenario should include all other policies or actions with a significant effect on emissions that were implemented both (1) prior to the implementation of the policy or action being assessed and (2) after the implementation of the policy/action being assessed but prior to the ex-post GHG assessment. Any interactions between the policy or action being assessed and the policies or actions included in the baseline scenario should be taken into account. For guidance on assessing policy interactions, see Appendix B. Users **shall** report any potential interactions with other policies and actions and whether and how policy interactions were estimated.

The baseline scenario should also be recalculated to include updates to all non-policy drivers based on their observed values over the GHG assessment period, as well as possible free rider effects. See Table 8.3 for a list of non-policy drivers that should be considered in the baseline scenario if they are exogenous to the assessment—that is, if they are not affected by the policy or action being assessed. Users do not need to calculate emissions from sources and sinks that remain constant between the baseline scenario and the policy scenario, since they do not contribute to the change in emissions resulting from the policy or action.

If an ex-ante assessment for the policy or action was carried out prior to the ex-post assessment, the same method may be used by replacing the forecasted parameter values (ex-ante) with observed parameter values (ex-post) in the ex-post estimation. Alternatively users may apply a different methodology than was used in the ex-ante assessment. Users should choose the approach that yields the most accurate results. If both an ex-ante and ex-post assessment are carried out for the same policy or action at different points in time, each assessment will likely yield different estimates of the GHG effects of the policy, since the observed (ex-post) parameter values will likely differ from assumptions forecasted in the ex-ante scenario.

## 11.2 Select an ex-post assessment method

This section provides a list of ex-post assessment methods that users may use to estimate the GHG effects of a policy or action ex-post. Ex-post estimation methods are classified into two bottom-up methods and top-down methods. For definitions of bottom-up and top-down methods and data, see Section 3.2. Both top-down and bottom-up methods can be carried out under either the scenario method or the comparison group method (described in Chapter 8).

Users should select either top-down, bottom-up, or integrated top-down/bottom-up methods based on a combination of factors, such as:

- Data availability, including the type, quantity, quality, and resolution of data available (which may dictate the use of either bottom-up or top-down data)

- Type of policy and sector (which may determine whether bottom-up or top-down data and methods are more relevant and accurate)
- Number of interacting policies and actions (typically top-down methods are more appropriate when there are a large number of interacting policies)
- Number of actors influenced by the policy (typically top-down methods are more appropriate when there are a large of number of affected actors)
- Capacity, resources, and level of expertise available to carry out the methods

Table 11.1 lists a variety of ex-post assessment methods that may be used. The list is not exhaustive, and users may classify methods differently depending on the individual context. Users may also use a combination of approaches listed in Table 11.1.

In general, the emissions estimation method used to estimate baseline emissions for each source/sink included in the GHG assessment boundary should be used to estimate policy scenario emissions for each source/sink. However, in specific cases highlighted in Table 11.1, this may not be necessary. For example, if direct monitoring of emissions is used to measure GHG emissions in the policy scenario, consistency with the baseline emissions estimation method (based on forecasted activity data) is not necessary.

## 11.3 Select a desired level of accuracy

Table 11.2 outlines a range of methodological options that may be used for ex-post assessment. When selecting methods to estimate GHG effects ex-post, users should consider objectives, the level of accuracy needed to meet stated objectives, the availability and quality of relevant data, the accessibility of methods, and capacity/resources for the assessment.

**Table 11.1 Ex-post assessment methods**

| Method | Description |
|---|---|
| **Bottom-up methods** | |
| **Collection of data from affected participants/ sources/other affected actors** | Parameter values in the policy scenario are determined through data collected from affected participants, sources, or other affected actors. Data collection methods may include direct monitoring of emissions (such as continuous emissions monitoring systems), monitoring of parameters (such as metering of energy consumption), collecting expenditure or billing data (such as purchase records), or sampling methods. Activity data are combined with emission factors to estimate policy scenario emissions. |
| **Engineering estimates** | Parameter values in the policy scenario are estimated using engineering models that represent the emissions or parameter values that would result from the use of a particular equipment, building, vehicle, or other unit, based on assumptions about how the unit is used. Uncertainty may arise if the way a unit is used in practice differs from the manufacturing design specifications. |
| **Deemed estimates** | The *change* in parameter values or emissions (rather than the policy scenario value of parameters or emissions) is estimated using previously estimated effects of similar policies or actions. This involves collecting data on the number of actions taken (such as the number of building that install insulation) and applying default values for the estimated change in GHG emissions or other relevant parameter per action taken (such as the average reduction in energy use per building that installs insulation). The deemed estimate may be based on published studies, equipment specifications, surveys, or other methods. Deemed estimates are used as a lower-cost method for policies or actions that are homogenous across policy contexts, such that deemed estimates from other contexts are representative of the policy or action being assessed. Deemed estimates can be complemented by sampling the affected participants or sources to determine whether the deemed estimates are sufficiently accurate and representative. In this approach, the change is estimated directly, without subtracting baseline scenario emissions from policy scenario emissions. Baseline emissions may be estimated as a subsequent step by adding/subtracting the deemed estimates from observed policy scenario emissions. |
| **Methods that can be bottom-up or top-down depending on the context** | |
| **Stock modeling** | Parameter values in the policy scenario are estimated using stock models, market statistics, and/ or surveys to measure diffusion, uptake, or stock turnover. This is typically used for equipment, vehicles, or other units that are consumed or purchased over time. When conducting a stock modeling analysis, users should consider whether the uptake or purchasing indicators measure replacement of equipment (and the type of equipment that is being replaced) or whether the total usage of units is increasing. |
| **Diffusion indicators** | Parameter values in the policy scenario are estimated using indicators that reflect the share of specific equipment or changes in activities in the market, often for end-use consumption that results in GHG emissions. In contrast to stock modeling, users may have limited data on the stock of new equipment or other units in the asessment boundary, but may have data on indicators of use. If indicators are monitored and there are no other drivers, this method is bottom up. Users may also conduct a regression analysis to identify the effect of the policy, in which case the method is considered top down. |

**Table 11.1 Ex-post assessment methods (continued)**

| Method | Description |
|---|---|
| **Top-down methods** | |
| **Monitoring of indicators** | Parameter values in the policy scenario are estimated using sector or subsector activity changes. In this case, the user may have limited or no information on end use or stock statistics, but may have information on changes in relevant indicators for a sector (such as tranportation or buildings) or subsector (such as space heating in buildings). Policy scenario parameter values should be compared to baseline parameter values to estimate the change. |
| **Economic modeling** | The *change* in parameter values and/or emissions (rather than the policy scenario value of parameters or emissions) is estimated by using econometric models, regression analysis, extended modeling such as input/output analysis with price elasticities, or computable general equilibrium models. These types of models may be most appropriate for fiscal policies, such as taxes or subsidies. Economic models may specify that a dependent variable (GHG emissions or energy use) is a function of various independent variables, such as the policy being assessed, other policies, and various non-policy drivers, such as prices, price elasticities of fuels, economic activity, weather, and population. By doing so, models can control for various factors that affect emissions other than the policy assessed. |

*Source:* Adapted from Eichhammer et al. 2008.

**Table 11.2 Range of methodological options for ex-post assessment**

| Level of accuracy | Emissions estimation method | Interactions with policies included in the baseline scenario | Sources of data |
|---|---|---|---|
| **Lower** | Lower accuracy methods (such as Tier 1 methods in the IPCC *Guidelines for National Greenhouse Gas Inventories*) | Few significant interacting policies assessed | International default values |
| | Intermediate accuracy methods | Most significant interacting policies assessed | National average values |
| **Higher** | Higher accuracy methods (such as Tier 3 methods in the IPCC *Guidelines*) | All significant interacting policies assessed | Jurisdiction- or source-specific data |

*Source:* Adapted from AEA et al. 2009.

## 11.4 Estimate policy scenario emissions

Some ex-post assessment methods outlined in Table 11.1 lead to an estimate of policy scenario emissions, while others lead directly to an estimate of the GHG effect of the policy or action. If feasible based on the method used, users **shall** estimate policy scenario emissions and removals over the GHG assessment period for each source/sink category and greenhouse gas included in the GHG assessment boundary. To do so, users should apply the ex-post assessment method from Section 11.2 with data collected in Chapter 10.

Users should assess whether the effects identified in the causal chain (Chapter 6) actually occurred. This may include assessing the degree of policy implementation to ensure that the policy or action was implemented as planned, including assessing the extent of enforcement and noncompliance, if relevant.

Users should then update the effects identified in the causal chain based on observed data before estimating each GHG effect. To estimate certain effects—such as spillover effects or rebound effects—users may find it useful to conduct surveys with consumers or businesses affected by the policy or action, or use results from similar policy assessments, if the conditions are similar enough for valid comparisons.

Users **shall** apply the same GWP values used to estimate baseline emissions. Any sources, sinks, or greenhouse gases in the GHG assessment boundary that have not been estimated **shall** be disclosed, justified, and described qualitatively.

Users **shall** report the following:

- Total annual and cumulative policy scenario emissions and removals over the GHG assessment period, if feasible based on the method used
- The methodology used to estimate policy scenario emissions, including the emissions estimation method(s) (including any models) used
- All sources of data for key parameters, including activity data, emission factors, GWP values, and assumptions

If users are not able to report a data source, users **shall** justify why the source is not reported.

## 11.5 Estimate the GHG effect of the policy or action

Users **shall** estimate the GHG effect of the policy or action by subtracting baseline emissions from policy scenario emissions for each source/sink category included in the GHG assessment boundary. See Equation 11.1.

Users should estimate the GHG effect for each source/sink category separately, by following these steps:

1. Estimate baseline emissions from each source/sink category (Chapter 8)
2. Estimate policy scenario emissions for each source/sink category
3. For each source/sink category, subtract baseline emissions from policy scenario emissions to estimate the GHG effect of the policy or action for each source/sink category
4. Aggregate GHG effects across all source/sink categories to estimate total GHG effect of the policy or action

Alternatively, users may follow these steps:

1. Estimate baseline emissions from each source/sink category (Chapter 8)
2. Aggregate baseline emissions across all source/sink categories to estimate total baseline emissions (Chapter 8)
3. Estimate policy scenario emissions for each source/sink category
4. Aggregate policy scenario emissions across all source/sink categories to estimate total policy scenario emissions
5. Subtract total baseline emissions from total policy scenario emissions to estimate the total GHG effect of the policy or action

Both approaches yield the same result. See Table 9.3 for an example.

Users **shall** report the estimated total net change in GHG emissions and removals resulting from the policy/action or package of policies/actions, in tonnes of carbon dioxide equivalent, both annually and cumulatively over the GHG assessment period.

Users **shall** report the total in-jurisdiction GHG effects (the total net change in GHG emissions and removals that occurs within the implementing jurisdiction's geopolitical boundary), separately from total out-of-jurisdiction GHG

**Equation 11.1 Estimating the GHG effect of the policy or action**

**Total net change in GHG emissions resulting from the policy or action (t $CO_2$e) =**
Total net policy scenario emissions (t $CO_2$e) – Total net baseline scenario emissions (t $CO_2$e)*

*Notes:* * Taking into account policy interactions. "Net" refers to the aggregation of emissions and removals. "Total" refers to the aggregation of emissions and removals across all sources and sinks included in the GHG assessment boundary.

effects (the net change in GHG emissions and removals that occurs outside of the jurisdiction's geopolitical boundary), if relevant and feasible.

Users should separately estimate and report the change in GHG emissions/removals resulting from each individual GHG effect included in the GHG assessment boundary, where relevant and feasible.[1] Users may also separately report by type of effect, by source or sink, or by category of source or sink.

Users should report the GHG effect of the policy or action as a range of likely values, rather than as a single estimate, when uncertainty is high (for example, because of uncertain baseline assumptions or uncertain policy interactions). See Chapter 12 for guidance on uncertainty and sensitivity analysis.

See Box 11.1 for a case study of calculating the GHG effect of a policy ex-post and Box 11.2 for a case study comparing ex-post and ex-ante results.

**Box 11.1 Calculating the GHG effect ex-post for Tunisia's PROSOL Elec program**

The National Agency for Energy Conservation (ANME) of Tunisia—together with the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, with support from ALCOR Consulting—carried out a combined ex-post and ex-ante assessment of the PROSOL Elec program in Tunisia. PROSOL Elec is a renewable energy support program, launched by ANME in 2010, that aims to promote and support the installation of photovoltaic (PV) systems in residential and commercial buildings with low-voltage grid connections. The objective of the ex-post assessment was to assess the program's progress to date.

Estimating ex-post policy scenario emissions from one of the affected sources—production of electricity by conventional power plants for consumption in the residential and commercial buildings sector—applied the same equation used to estimate baseline emissions (in Box 8.5), except that the consumption of electricity in buildings was reduced by the electric energy produced by photovoltaic systems already installed. The electricity produced by PV systems is calculated by multiplying the amount of kWp-installed PV capacity by the specific production of PV systems in Tunisia.

The number and capacity of PV systems installed and operational were derived from an ANME database. The database is a complete and reliable data source, as every PV installation has to be registered in this database to benefit from the PROSOL Elec program subsidies and interrelated bank credits. The specific energy production is an empirical value based on annual on-site measurements of 20 percent of all new installed PV systems in Tunisia.

The following equation was used to calculate electricity produced by PV systems in 2010. For details on the calculation of baseline emissions, see Box 8.5. The estimated GHG effect is the difference between policy scenario emissions and baseline emissions.

**Installed PV capacity in Tunisia [145 kWp] × specific energy production of PV systems in Tunisia [1,600 kWh/kWp] = electric energy produced by PV systems [232,000 kWh = 0.23 GWh]**

**Baseline electricity consumption in residential and commercial buildings in 2010 = [5,039 GWh]**

**Policy scenario electricity consumption in residential and commercial buildings in 2010 = [5,039 GWh – 0.23 GWh] = 5,039 GWh**

Since the policy was launched in 2010, the impact of the policy to date in 2010 is relatively small, but the impact of the policy is designed to increase each year from 2010 to 2020. See Figure 9.8 for a graph of the estimated GHG effect of the program over the period 2010–30.

### Box 11.2 Comparison of ex-post and ex-ante results for energy efficiency policies in the South African mining sector

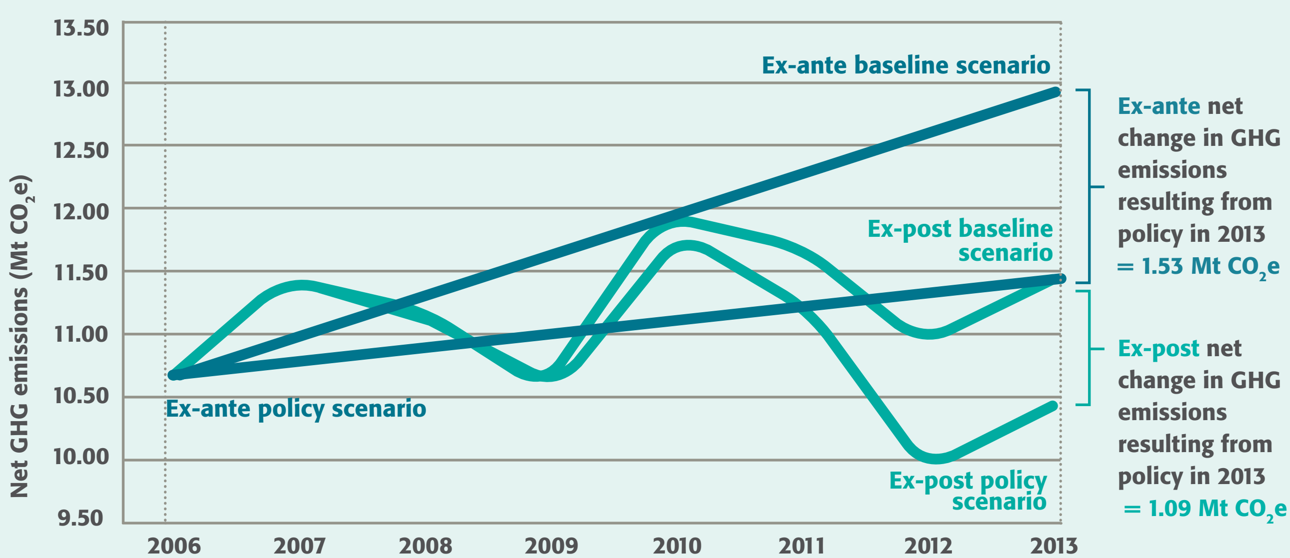
In 2005, the South African government published the Energy Efficiency Accord, which calls for an energy demand reduction of 15 percent in the mining sector by 2015 (relative to the projected mining sector energy use in 2015). Promethium Carbon carried out an ex-post assessment of the energy efficiency policies implemented in the South African mining sector to comply with the Energy Efficiency Accord in order to determine their effectiveness and to estimate the resulting change in GHG emissions and removals. As part of the assessment, the ex-post results from 2013 were compared to the ex-ante estimated reductions from 2006.

The ex-ante baseline scenario was established from government literature, which stated that in 2005, energy demand and resulting GHG emissions in the mining sector were expected to rise at an annual rate of 2.8 percent. However, as seen in the ex-post baseline scenario, energy demand and GHG emissions in the mining sector were extremely variable over the period from 2006 to 2013.

Mining activities (and the resulting emissions) also declined dramatically as a result of the global recession. As a result, ex-post baseline scenario emissions in 2013 were the same as the expected emissions under the ex-ante policy scenario for 2013.

Figure 11.3 highlights the importance of developing a credible ex-post baseline scenario. If the ex-ante baseline scenario had been used instead of developing an ex-post baseline scenario, the ex-post assessment would have shown that initiatives implemented as a result of the accord reduced GHG emissions in the mining sector by 2.62 Mt $CO_2$e (relative to the ex-ante baseline scenario). In fact, these initiatives only reduced emissions by 1.09 Mt $CO_2$e (relative to the ex-post baseline scenario). Without the ex-post baseline scenario, an assessment would have shown that the mining sector was on track to meet the policy without having to implement any GHG reducing initiatives, when in fact additional activities were needed.

**Figure 11.3 Comparison of ex-post and ex-ante results from a policy**



## 11.6 Additional steps to inform decision making (optional)

In addition to estimating the GHG effect of the policy or action, users may take additional steps to help inform decision making. These include:

- Normalizing results
- Harmonizing top-down and bottom-up assessments
- Comparing the GHG effects of policies to the GHG inventory
- Applying decomposition analysis
- Combining ex-ante and ex-post assessments

Each step is explained below.

### 11.6.1 Normalizing results

Users may separately normalize data, depending on the user's objectives. Normalization is a process to make conditions from different time periods comparable. It may be useful if the objective is to compare policy effectiveness by removing fluctuations not influenced by the policy or action, such as weather variations. If data are normalized, users **shall** separately report normalized results from non-normalized results and **shall** report the normalization methods used. Non-normalized results **shall** be reported so that the ex-post GHG assessment reflects actual changes in emissions and removals over the GHG assessment period.

For example, the effectiveness of a building insulation program 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 the policy scenario. Users may normalize the results by estimating the GHG effect that would have been achieved under average weather conditions, rather than actual weather conditions, in order to determine the GHG effect achieved "in principle" as a result of the insulation program, isolated from statistical fluctuations in weather.

In addition to weather conditions, data for a building insulation program could also be normalized for changes in occupancy levels, hours of operation for commercial buildings, or the impacts of economic or business cycles, if such changes occur during the policy implementation period.

See Box 11.3 for an example of normalizing results.

### 11.6.2 Harmonizing top-down and bottom-up assessments

Both top-down methods and bottom-up methods have limitations. Typically, only either a top-down or bottom-up assessment is carried out. However, it is possible to carry out both methods in parallel. If both methods are used, users should harmonize the bottom-up and top-down assessments to the extent possible to compare and control for the differences between the methods. Users **shall** report a description of differences between results from top-down and bottom-up methods (if applicable).

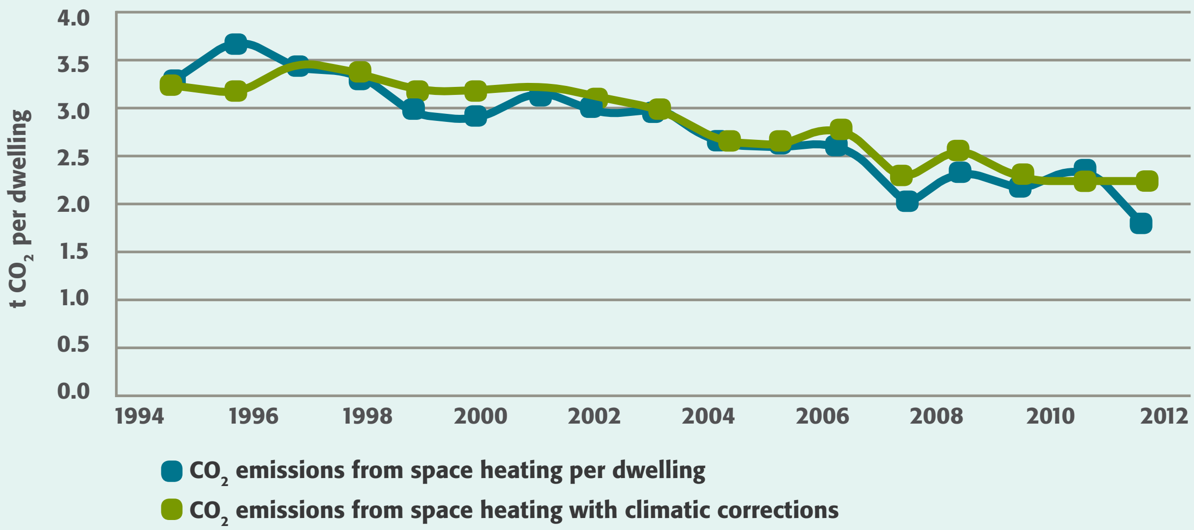
### 11.6.3 Comparing the GHG effects of policies and actions to the GHG inventory

If feasible, users should also compare the results of the ex-post GHG assessment to the annual GHG emissions inventory for the relevant jurisdiction(s) or organization(s) 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 many 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. However, the effect of individual policies and actions may not be visible in the GHG inventory, especially if a policy or action avoids emissions relative to a baseline scenario but does not lead to absolute reductions in emissions. See Section 1.8 for more information on the relationship with GHG inventories.

**Box 11.3 Example of normalizing results for a German space heating policy**

Figure 11.4 shows the impact of normalizing for weather conditions for an example from a German space heating policy. The figure shows that the average decrease in $CO_2$ emissions per dwelling evolves rather uniformly over the time period (see blue line), but in individual years the change in $CO_2$ emissions per dwelling can vary significantly as a result of weather variations (see green line).

**Figure 11.4 Normalization with respect to weather conditions**




*Source:* Odyssee-Mure 2014.

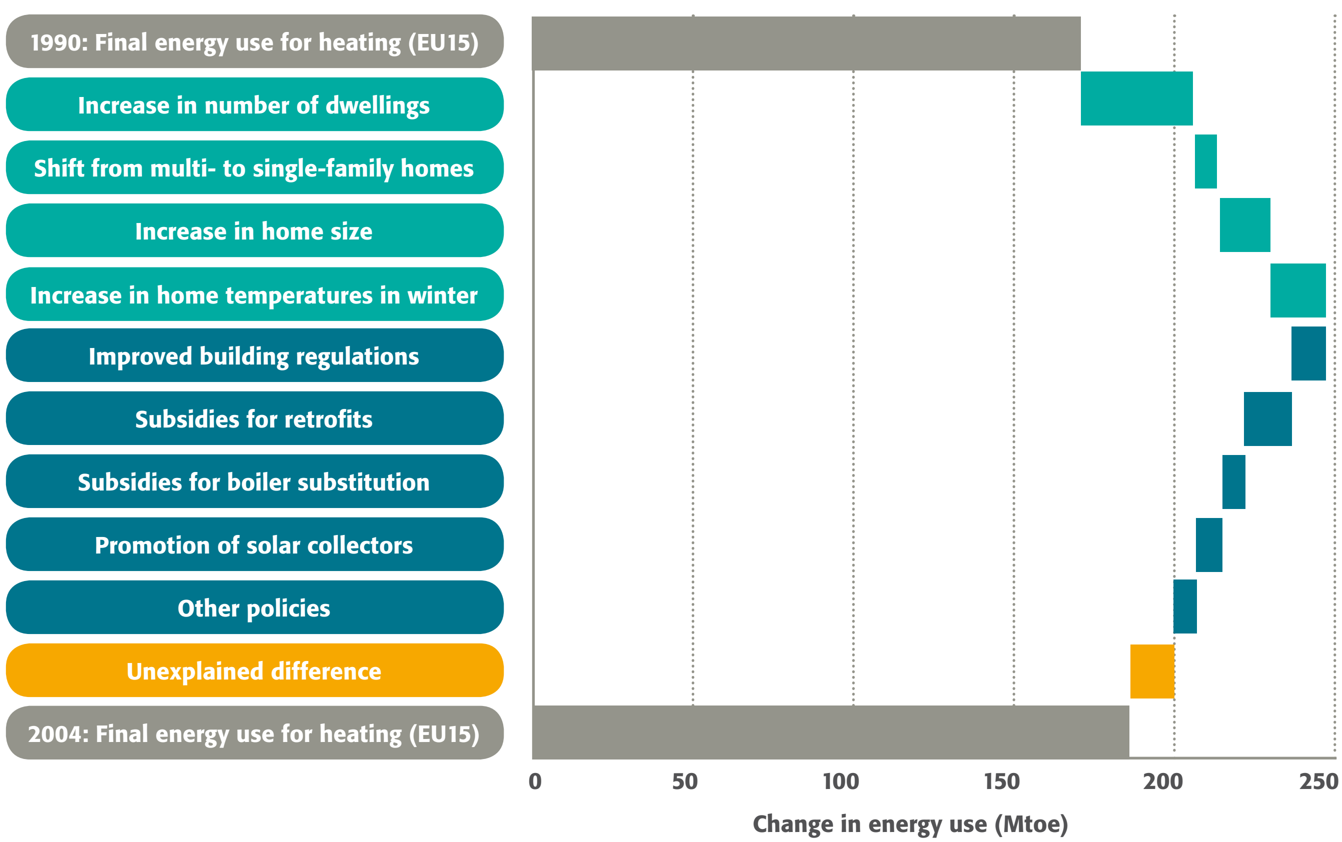
### 11.6.4 Decomposition analysis

Users may apply a decomposition analysis, where relevant, to understand the various factors that lead to changes in overall GHG emissions (as demonstrated in a sectoral or jurisdictional GHG inventory) over time. Through decomposition analysis, a policy assessment can feed into a broader assessment of changes in emissions in a sector or jurisdiction.

Decomposition analysis is a method to subdivide emissions into individual drivers, which can be individually tracked to understand why emissions change over time. For example, residential energy use can be divided into its constituent parameters as follows: Number of houses × average size of houses ($m^2$ per house) × energy efficiency (Btu per $m^2$) × GHG intensity of energy (t $CO_2e$ per Btu). Similarly, transportation emissions can be disaggregated into parameters that can be individually tracked as follows: Distance traveled (km) × fuel efficiency (liters of fuel consumed per km) × GHG intensity of fuels (t $CO_2e$ per liter).

Figure 11.5 provides an example of understanding the changes in residential energy consumption that result from the policies assessed rather than from other factors. Energy use for heating in the European Union increased over the period 1990–2004 (shown in gray), despite the policies implemented during the period (shown in blue). In the baseline scenario, energy use would have increased even more as a result of various non-policy drivers (shown in teal). But the policies reduced energy use (shown in blue) compared to the baseline scenario. The comparison of top-down and bottom-up methods resulted in an unexplained difference (in orange), which may result from uncertainties in some of the assumptions or from data quality limitations.

**Figure 11.5 Example of decomposition analysis for residential energy consumption in the European Union from 1990–2004**




*Source:* Adapted from EMEEES 2009.

### 11.6.5 Combining ex-ante and ex-post assessments

In addition to the monitoring of performance indicators described in Chapter 10, 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. By combining ex-ante and ex-post data, rolling monitoring can demonstrate the GHG reductions that have been initiated up to a certain date (through ex-ante assessment); the GHG reductions that have been achieved up to a certain date (through ex-post assessment); and the GHG reductions that have been achieved (ex-post) compared to the ex-ante estimates.

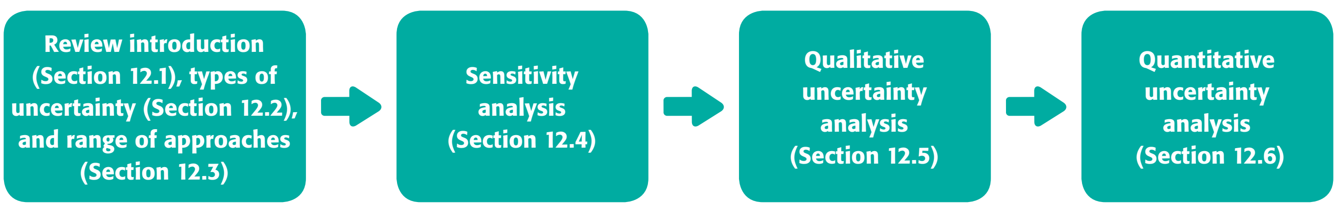
#### Endnote

1. An individual effect can be separately estimated and reported if it influences distinct sources/sinks within the GHG assessment boundary that are not influenced by the other effects being estimated. In this case, the change in emissions/removals from the source/sink is equal to the change resulting from that GHG effect. If multiple effects influence the same source/sink, the combined effect can be estimated but not the individual effects.

# 12 Assessing Uncertainty

**This chapter provides an overview of concepts and procedures for evaluating sources of uncertainty in a GHG assessment, as well as guidance on sensitivity analysis. This chapter is relevant to estimating baseline emissions (Chapter 8), estimating GHG effects ex-ante (Chapter 9), monitoring performance over time (Chapter 10), and estimating GHG effects ex-post (Chapter 11).**

**Figure 12.1 Overview of steps in the chapter**




## Checklist of accounting requirements in this chapter

| Section | Accounting requirements |
|---|---|
| **Introduction to uncertainty assessment (Section 12.1)** | • Assess the uncertainty of the results of the GHG assessment, either quantitatively or qualitatively. |
| **Sensitivity analysis (Section 12.4)** | • Conduct a sensitivity analysis for key parameters and assumptions in the assessment. |

*Note:* Reporting requirements are listed in Chapter 14.

## 12.1 Introduction to uncertainty assessment

Understanding uncertainty can be crucial for properly interpreting GHG assessment results. 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 help users improve assessment quality and increase the level of confidence in the results. Users should identify and track key uncertainty sources throughout the assessment process. Identifying, assessing, and managing uncertainty is most effective when done during, rather than after, the assessment process.

Users **shall** assess the uncertainty of the results of the GHG assessment, either quantitatively or qualitatively. Users may choose a qualitative and/or quantitative approach to uncertainty assessment. Quantitative uncertainty assessment can provide more robust results than qualitative assessment and help users better prioritize data improvement efforts on the sources that contribute most to uncertainty. Reporting quantitative uncertainty estimates also gives greater clarity and transparency to stakeholders.

Understanding uncertainty can help users understand whether to apply conservative assumptions. As explained in Chapter 4, accuracy should be pursued as far as possible, but once uncertainty can no longer be practically reduced, conservative estimates should be used.

### Reporting uncertainty

Reporting information about uncertainty helps users and stakeholders assess the accuracy and uncertainty of the reported results, to inform how the information should be used. Users **shall** report a quantitative estimate or qualitative description of the uncertainty of the results, as well as the range of results from sensitivity analysis for key parameters and assumptions.

Users should report the range of possible outcomes based on different parameter values (representing upper and lower bounds of plausible values) to indicate the level of uncertainty. When uncertainty is high, users should consider reporting a range of values rather than a single value. See Figure 5.3 for an example of reporting a range of values. Users should also use an appropriate number of significant figures depending on the uncertainty of the results, to avoid overstating the precision of the results.

Users should make a thorough yet practical effort to communicate key sources of uncertainty in the results. If feasible, users should present both qualitative and quantitative uncertainty information in the report. Users should also describe their efforts to reduce uncertainty in future revisions of the assessment, if applicable.

Uncertainty can be reported in many ways, including qualitative descriptions of uncertainty sources and quantitative representations, such as error bars, histograms, and probability density functions. Users should provide as complete a disclosure of uncertainty information as possible.

## 12.2 Types of uncertainty

Uncertainty is divided into three categories: parameter uncertainty, scenario uncertainty, and model uncertainty. The categories are not mutually exclusive, but they can be evaluated and reported in different ways. Table 12.1 summarizes each type of uncertainty.

### Parameter uncertainty

Parameter uncertainty may arise from measurement errors, inaccurate approximation, or the way the data was modeled to fit the conditions of the activity. If parameter uncertainty can be determined, it can typically be represented as a probability distribution of possible values that include the chosen value used in the assessment. Individual parameter uncertainties can be combined to provide a quantitative measure of the uncertainty of the assessment results, which may be represented in the form of a probability distribution.

### Scenario uncertainty

Scenario uncertainty is created when multiple methodological choices are available, such as the selection of baseline assumptions. The use of a standard reduces scenario uncertainty by constraining choices users may make in their methodology. To identify the influence of these choices on the results, users should undertake a sensitivity analysis for key parameters (described in Section 12.4).

### Model uncertainty

Simplifying the real world into a numeric model always introduces some inaccuracies. For example, models can introduce uncertainty when used for extrapolation—that is, application of the model beyond the domain for which model predictions are known to be valid. Users should acknowledge model uncertainties and state model limitations qualitatively. If feasible, users may estimate model uncertainty by comparing model results with independent data for purposes of verification; comparing the projections of alternative models; using expert judgment regarding the magnitude of model uncertainty; or other approaches.

## 12.3 Range of approaches

Various approaches are available to assess uncertainty, including qualitative and quantitative approaches. Table 12.2 outlines a range of approaches for assessing uncertainty. Users should select an approach based on the objectives of the assessment, the level of accuracy needed to meet stated objectives, data availability, and capacity/resources.

Depending on the methods used and data availability, users may not be able to quantify the uncertainty of all parameters in the emissions estimation method(s) or quantify the uncertainty of the total estimated change in GHG emissions and removals. Users should quantify the uncertainty for all parameters for which it is feasible. For cases where quantitative uncertainty is

**Table 12.1 Types of uncertainties**

| Types of uncertainty | Description | Possible sources of uncertainty |
|---|---|---|
| **Parameter uncertainty** | Uncertainty regarding whether a parameter value used in the assessment accurately represents the true value of a parameter | • Activity data<br>• Emission factors<br>• Global warming potential (GWP) values |
| **Scenario uncertainty** | Variation in calculated emissions due to methodological choices | • Methodological choices<br>• Selection of baseline scenario and estimation of baseline emissions<br>• Selection of policy scenario and estimation of policy scenario emission |
| **Model uncertainty** | Limitations in the ability of modeling approaches, equations, or algorithms to reflect the real world | • Model limitations |

**Table 12.2 Range of approaches for assessing uncertainty**

| Level of rigor | Extent of sensitivity analysis | Method of assessing uncertainty | Parameters and assumptions assessed for uncertainty |
|---|---|---|---|
| **Lower** | Few key parameters and assumptions analyzed | Qualitative | Few key parameters and assumptions assessed |
| ↓ | Many key parameters and assumptions analyzed | Quantitative: Single parameter uncertainty | Many key parameters and assumptions assessed |
| **Higher** | All key parameters and assumptions analyzed | Quantitative: Propagated parameter uncertainty | All key parameters and assumptions assessed |

not possible to calculate, uncertainty should be assessed and described qualitatively. In addition to estimating or describing uncertainty, users should conduct sensitivity analyses for key parameters, which is less data- and time-intensive than quantitative uncertainty assessment.

Users **shall** report the method or approach used to assess uncertainty.

## 12.4 Sensitivity analysis

Sensitivity analysis is a useful tool to understand differences resulting from methodological choices and assumptions and to explore model sensitivities to inputs. A sensitivity analysis involves varying the parameters (or combinations of parameters) to understand the sensitivity of the overall results to changes in those parameters.

Users **shall** conduct a sensitivity analysis for key parameters and assumptions in the assessment. Key parameters are those that are highly variable or most likely to significantly impact assessment results. Users should identify these parameters in Chapters 8, 9, and 11.

To conduct a sensitivity analysis, users should adjust the value of key parameters to determine the impact of such variations on the overall results. Users should consider reasonable variations in parameter values. Not all parameters need to be subjected to both negative and positive variations of the same magnitude, but they should be varied based on what is considered reasonable. Past trends may be a guide to determine the reasonable range. As a general rule, variations in the sensitivity analysis should at least cover a range of +10 percent and -10 percent (unless this range is not deemed reasonable under the specific circumstances).

See Box 12.1 for a case study of carrying out a sensitivity analysis.

**Box 12.1 Sensitivity analysis for Chile's Program for Minimum Efficiency Performance Standards for residential lighting**

The Climate Change Office of Chile's Ministry of Environment—together with the Energy Efficiency Department of the Ministry of Energy—carried out an ex-ante assessment (according to the *Policy and Action Standard*) of the Program for Minimum Efficiency Performance Standards for residential lighting (MEPS). MEPS is a national policy that intends to gradually eliminate incandescent light bulbs from the market and reduce energy consumption from residential lighting. Through the assessment, the policy was estimated to reduce $CO_2$ emissions by 247,000 t $CO_2e$ per year (on average), or 1,730,000 t $CO_2e$ on a cumulative basis, over the period 2014–20.

One key parameter in the assessment is the estimated replacement rate—the percentage of households that replace incandescent light bulbs with efficient lamps each year. The analysts made assumptions about the replacement rate each year based on a combination of national statistics and expert judgment. Table 12.3 presents the assumed values for the replacement rate over the GHG assessment period.

**Table 12.3 Estimated values for replacement rate used for policy scenario estimation**

| 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|
| 0% | 37% | 64% | 74% | 84% | 94% | 95% |

**Box 12.1 Sensitivity analysis for Chile's Program for Minimum Efficiency Performance Standards for residential lighting (continued)**

The assumed replacement rate was expected to be a high source of uncertainty in the assessment. As a result, conservative assumptions were used and a sensitivity analysis was carried out to define overall sensitivity of estimates of emissions impact to variations in the assumed replacement rate. The analysis also included three other key parameters: number of houses; hours of daily lamp use; and grid emission factors. For each parameter, a range of likely values was defined. For the replacement rate, it was assumed that the value could be as high as 150 percent, or as low as 50 percent of the assumed value in a given year (see Table 12.4).

**Table 12.4 Sensitivity analysis for ex ante results over GHG assessment period (2014–20): Activity data variation considered**

| Sensitivity scenarios | Activity data variation assessed | | | |
|---|---|---|---|---|
| | Replacement rate | Housing units | Hours of lamp use | Grid emission factor |
| **Primary scenario** | 0% | 0% | 0% | 0% |
| **Alternative scenario 1** | +50% | +20% | +50% | +15% |
| **Alternative scenario 2** | -50% | -20% | -50% | -15% |

Table 12.5 shows the sensitivity of the overall results to the variation in each key parameter. In the case of the replacement rate, the variation can lead to estimated GHG reductions as high as 2,037,000 t $CO_2$e or as low as 1,080,000 t $CO_2$e.

**Table 12.5 Sensitivity analysis for ex ante results over the period of assessment (2014–20): Cumulative results for different scenarios**

| Sensitivity scenarios | GHG emission variation (t $CO_2$e) | | | |
|---|---|---|---|---|
| | Replacement rate | Housing units | Hours of lamp use | Grid emission factor |
| **Primary scenario** | -1,730,000 | -1,730,000 | -1,730,000 | -1,730,000 |
| **Alternative scenario 1** | -2,037,000 | -1,823,000 | -2,595,000 | -1,989,000 |
| **Alternative scenario 2** | -1,080,000 | -1,553,000 | -865,000 | -1,470,000 |

The results confirm that the assessment is highly sensitive to assumptions about the replacement rate, and also highly sensitive to assumptions about hours of lamp use. Chile can use these results to prioritize future data collection efforts to reduce uncertainty of future assessments and improve understanding of how consumers are likely to respond to the program.

## 12.5 Qualitative uncertainty analysis[1]

To qualitatively assess uncertainty, users should characterize the level of confidence of the results based on (1) the quantity and quality of evidence and (2) the degree of agreement of the evidence. The level of confidence is a metric that can be expressed qualitatively to express certainty in the validity of a parameter value or result. (The qualitative confidence level described in this section is distinct from statistical confidence and should not be interpreted in statistical terms.)

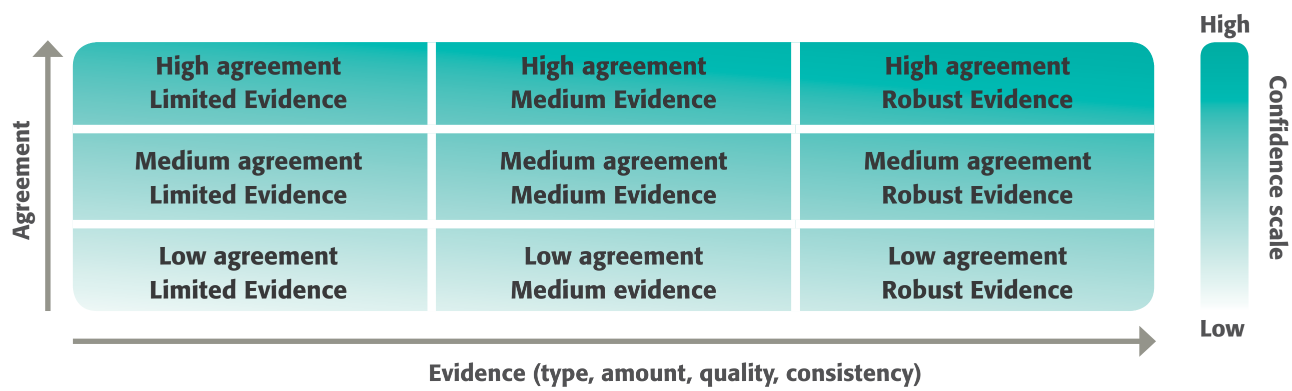
When characterizing parameter uncertainty, evidence refers to the sources available for determining a parameter value. Evidence should be assessed with regard to both the quantity and quality of evidence and can be defined in overall terms of being robust, medium, or limited. Evidence should be considered robust when there is a large quantity of high-quality evidence. Evidence should be considered medium when there is a medium quantity of medium-quality evidence. Evidence should be considered limited when there is a small quantity of low-quality evidence. High-quality evidence adheres to principles of research quality. Low-quality evidence shows deficiencies in adhering to principles of research quality. Medium-quality evidence is a mix of high-quality and low-quality evidence.[2]

The degree of agreement is a measure of the consensus or consistency across available sources for a parameter value or result. The degree of agreement can be defined in terms of high, medium, or low. As a rule of thumb, high agreement means that all sources had the same conclusion; medium agreement means that some sources had the same conclusion; and low agreement means that most of the sources had different conclusions. This step may not be applicable if there is only one source available.

A level of confidence provides a qualitative synthesis of the user's judgment about the result, integrating both the evaluation of evidence and the degree of agreement in one metric. Figure 12.2 depicts summary statements for evidence and agreement and their relationship with confidence, where confidence increases as evidence and agreement increase. The level of confidence can be considered very high, high, medium, low, and very low. In the best case (high confidence), the evidence found should be sourced from multiple credible, independent institutions. Presentation of findings with "low" and "very low" confidence should be reserved for areas of major concern, and the reasons for their presentation should be explained.

The confidence level of individual parameters, models, and scenarios should be aggregated to provide a level of confidence for the overall assessment, if feasible.

**Figure 12.2 Summary statements for evidence and agreement and their relationship with confidence**




*Source:* Adapted from IPCC 2010.

## 12.6 Quantitative uncertainty analysis

Quantitative uncertainty analysis should be undertaken where feasible to characterize the uncertainty of key parameters. Estimates of uncertainty should be made for individual parameters (single parameter uncertainty), then aggregated to source and sink categories as well as to the assessment as a whole (propagated parameter uncertainty). Propagated parameter uncertainty is the combined effect of each parameter's uncertainty on the total result.

Users should collect appropriate information to estimate overall uncertainty as well as source-/sink-specific estimates of uncertainty at a specified confidence level (preferably 95%). Since it may not be practical to measure uncertainty of every source or sink category in a single way, various methods for quantifying uncertainty may be used. Users should use the best available estimates, which may be a combination of measured data, published information, model outputs, and expert judgment.

Approaches of quantifying single parameter uncertainty include the following:

- Measured uncertainty approach (represented by standard deviations)
- Default uncertainty estimates for specific activities or parameters (from IPCC 2006 or other literature)
- Probability distributions from commercial databases
- Uncertainty factors for parameters reported in literature
- Pedigree matrix approach (based on qualitative data quality indicators)
- Survey of experts to generate upper- and lower-bound estimates
- Expert judgment (based on as much data as available)
- Other approaches

Once the uncertainties of single parameters have been estimated, they may be combined to provide uncertainty estimates for the entire assessment. Approaches to combine uncertainties include the following:

- **Error propagation equations:** An analytical method used to combine the uncertainty associated with individual parameters from a single scenario. Equations involve estimates of the mean and standard deviation of each input.
- **Monte Carlo simulation:** A form of random sampling used for uncertainty analysis that shows the range of likely results based on the range of values for each parameter and probabilities associated with each value. In order to perform Monte Carlo simulation, input parameters must be specified as uncertainty distributions. The input parameters are varied at random but restricted by the given uncertainty distribution for each parameter. Repeated calculations produce a distribution of the predicted output values, reflecting the combined uncertainty of the various parameters.

### Further references

For guidance on the methods outlined in this section, see the references below.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- World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD). 2003. *Aggregating Statistical Parameter Uncertainty in GHG Inventories: Calculation Worksheets.* Accessible at http://www.ghgprotocol.org.
- WRI/WBCSD. 2003. "GHG Protocol Guidance on Uncertainty Assessment in GHG Inventories and Calculating Statistical Parameter Uncertainty." Accessible at http://www.ghgprotocol.org.
- WRI/WBCSD. 2011. "Quantitative Inventory Uncertainty." Accessible at http://www.ghgprotocol.org.
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### Endnotes

1. This section is adapted from IPCC 2010.
2. Adapted from DFID 2014.

# 13 Verification

**This chapter provides guidance on verification. While verification is not a requirement of this standard, verifying the results of the GHG assessment is useful for providing the implementing entity and relevant stakeholders with confidence in the results. Users that choose not to verify the results may skip this chapter.**

## 13.1 Introduction

Assurance is the level of confidence that the information reported is relevant, complete, accurate, consistent, transparent, and without material misstatements. Verification is the process for assessing the level of assurance. To provide assurance, verifiers follow a documented rigorous and systematic verification process for the assessment of the reported information against agreed criteria, for example the requirements of a regulation, a standard, a program, or good practice guidance.

The verification process evaluates whether the requirements of the standard have been met, whether the GHG accounting and reporting principles have been followed, and whether reasonable methods and assumptions have been applied. Verification should be a cooperative, iterative process that provides feedback, allowing users to improve accounting practices.

This chapter provides an overview of the process for providing assurance that the reported GHG effect of a policy or action has been estimated and reported according to the requirements of the *Policy and Action Standard*. It is relevant to users planning for verification or considering whether to do so.

Assurance can be provided for both ex-ante and ex-post assessments, by either validating or verifying the change in GHG emissions, respectively. The terminology differs, but the approach in both cases is essentially the same.

- **Validation:** Provides assurance of ex-ante estimates before or during the implementation of a policy or action
- **Verification:** Provides assurance of ex-post estimates during or after the implementation of a policy or action

For the purposes of this standard, the term "verification" is used to include both verification and validation.

Users should decide whether and what type of verification to pursue depending on individual objectives. To meet some objectives (such as external reporting or attracting finance), verification may be required or beneficial, while to


meet other objectives (such as internal decision making) verification may not be necessary.

Users **shall** report whether the GHG assessment results were verified and, if so, the type of verification (first party or third party), the relevant competencies of the verifier(s), and the opinion issued by the verifier.

Verification is related to quality assurance (QA) and quality control (QC). Users should use any combination of verification, QA, and QC, depending on individual objectives and circumstances. For additional guidance on QA/QC and verification, see the IPCC *Guidelines for National Greenhouse Gas Inventories* (2006), Vol. 1, Chap. 6, "Quality Assurance/Quality Control and Verification."

## 13.2 Benefits of verification

Obtaining assurance is valuable for reporting entities and others who make decisions informed by the estimated GHG effects of a policy or action. Users should have the results of the GHG assessment verified where feasible. Verification can provide a variety of benefits, including the following:

- Increased confidence in the reported information as a basis for GHG mitigation strategies before implementation of the policy or action
- Increased confidence in the reported progress of a policy or action in meeting its expected outcome during implementation
- Increased confidence in the reported performance and effectiveness of a policy or action after implementation and in its relative contribution toward meeting a broader GHG reduction goal
- Enhanced internal accounting and reporting practices (such as data collection, estimation methods, and internal reporting systems), and facilitation of learning and knowledge transfer within the organization or jurisdiction
- Improved efficiency in planning or implementing further mitigation policies and actions
- Increased confidence in the results reported by other entities using the *Policy and Action Standard*, promoting a credible representation of the relative efforts undertaken by different entities participating in a collective goal
- Greater stakeholder trust in the reported results

## 13.3 Key concepts

Table 13.1 includes definitions of key concepts related to assurance and verification.

**Table 13.1 Key concepts**

| Concept | Description and examples |
|---|---|
| **Assertion** | A statement by the reporting entity on the results of a policy or action. The assertion is presented to the verifier performing assurance.<br>• Example of an assertion: "The estimated greenhouse gas effect of the policy relative to the most likely baseline scenario is a reduction of 2 million tonnes of $CO_2e$. The change is calculated in conformity with the GHG Protocol *Policy and Action Standard*, supplemented by our entity-specific policies and methodologies described in the policy assessment report." |
| **Assessment report** | An assessment report, completed by the user, documents all required accounting steps and reporting requirements. |
| **Assurance opinion** | The results of the verification of the reporting entity's assertion regarding the estimated change in GHG emissions resulting from the policy or action. If the verifier determines that a conclusion cannot be expressed, the opinion should cite the reason. See Table 13.3 for examples of assurance opinions. |
| **Assurance standards** | Standards or requirements used by verifiers, which determine how the assurance process and the verification steps are performed to be able to formulate an assurance opinion.<br>• Examples: ISO 14064-3 *Specification with Guidance for the Validation and Verification of Greenhouse Gas Assertions*; UNFCCC *Clean Development Mechanism Validation and Verification Standard.* |
| **Evidence** | Data sources, estimation methods and documentation used to calculate changes in emissions and that support the subject matter of the reporting entity's assertion. Evidence should be sufficient in quantity and appropriate in quality.<br>• Examples: Physical observations on the implementation of the policy or action; interview with the planning, implementing, and enforcing authorities; documents prepared by an independent party and/or the reporting entity, such as policy evaluation reports; internal audit reports on the performance of the policy or action. |
| **Materiality** | Central to a verifier's activities is the assessment of the risks of material discrepancies in the change in GHG emissions reported by the user. Discrepancies are differences between reported information by the user and information that could result from the proper application of the *Policy and Action Standard's* requirements and guidance. A material discrepancy, or materiality, occurs when individual or aggregate errors, omissions, and misrepresentations have an impact on the estimated change in GHG emissions significant enough that it could influence the user's decisions. A materiality threshold is the quantitative level of material discrepancy above which an assertion is considered in nonconformity with a standard, regulation, or benchmark. |
| ***Policy and Action Standard* criteria** | Requirements and guidance of the *Policy and Action Standard* against which the reported policy or action results will be evaluated.<br>• Example: Table 3.2 in Chapter 3, which summarizes the requirements of the standard. |
| **Subject matter** | The GHG assessment results and supporting information included in the assessment report. The type of verification performed will determine which subject matter(s) should be assessed. See Section 13.4. |
| **Verification** | The process that results in an assurance opinion on whether an assertion is in conformity with the *Policy and Action Standard's* requirements. |

## 13.4 Subject matter relevant to the *Policy and Action Standard*

The GHG assessment results are the ultimate subject matter assessed in the assurance process. To verify that these results represent a true and fair account of the change in GHG emissions and removals resulting from a policy or action in conformity with the *Policy and Action Standard*, the verifier assesses whether all the requirements of the standard are met. Each step in the standard constitutes a subject matter. The verifier needs to check that the information reported meets the requirements and that the methods and assumptions used are reasonable. A list of the main steps, or subject matters, involved in the estimation of GHG effects required by the standard is included below. See Table 3.2 in Chapter 3 for the full list.

- The causal chain and list of all potential effects considered in the assessment
- The definition of the GHG assessment boundary around significant effects
- The baseline methodology and assumptions
- The ex-ante and/or ex-post assessment methodology and assumptions
- The treatment of policy interactions
- The data collection and monitoring of the policy or action effects over time
- The assessment of uncertainty
- The assessment report

## 13.5 Types of verification

Either first- or third-party verifiers may be used (see Table 13.2). Both first- and third-party verifiers should follow similar procedures and processes. Third-party verification is likely to increase the credibility of the reported policy or action results to external stakeholders. First-party verification can also provide confidence in the reliability of those results, and it can be a worthwhile learning experience prior to commissioning third-party verification. Verification could also be done by a partner organization or by the party receiving the data, rather than by an internal or independent party.

Inherently, third-party verification offers a higher degree of objectivity and independence. Typical threats to independence may include allegiance to an employing entity, pending renewal of funding for a policy or action based on reported performance, promotion of an entity official conditional on performance, or political pressure and other conflicts of interest between the reporting entity and the verifier. These threats should be assessed throughout the verification process. Entities receiving first-party verification should report how potential conflicts of interest were avoided during the verification process.

## 13.6 Levels of assurance

The level of assurance refers to the degree of confidence that stakeholders can have in the reported GHG assessment results. There are two levels of assurance: limited and reasonable. The thoroughness with which the assurance evidence is obtained is less rigorous in limited assurance. Limited assurance provides a "negative opinion" that no

**Table 13.2 Types of verification**

| Type of verification | Description |
|---|---|
| **First-party verification** | Internal verification performed by independent person(s) from within the reporting entity.<br>• Example: person(s) from a different department in an organization not involved in the process of planning, implementing and reporting on a policy or action. |
| **Third-party verification** | Assurance performed by person(s) from an independent entity.<br>• Examples: independent accounting, engineering or policy analysis organization; accredited third-party verification body |

errors were detected. Reasonable assurance provides a "positive opinion" that all assertions are valid. Table 13.3 gives examples of limited and reasonable assurance opinions. The level of assurance requested by the user will determine the rigor of the verification process and the amount of evidence required. The highest level of assurance that can be provided is a reasonable level of assurance. Absolute assurance is typically not provided since it is not feasible to test 100 percent of the inputs to the assessment.

## 13.7 Competencies of verifiers

Selecting a competent verifier is important to give the assurance opinion credibility. A competent verifier has the following characteristics:

- Assurance and verification experience
- Knowledge of, and experience in, GHG assessment for policies and actions, including baseline and policy scenario development
- Knowledge of the reporting entity's activities
- Technical expertise to determine whether any technical or methodological decisions could have a material impact on the estimated effect of the policy or action
- Ability to assess the emission sources and sinks included in the GHG assessment boundary, the selected modeling approach and assumptions, as well as the magnitude of potential errors, omissions, and misrepresentations
- Ability to assess internal information systems for gathering and reporting data, including quality control procedures
- Credibility, independence, and the professional skepticism required to challenge data, methods, and other information

## 13.8 Verification process

Many elements have to be considered as part of the systematic process for providing assurance that an assertion of a reported change in GHG emissions is in conformity with the *Policy and Action Standard*. The following sections describe the main elements of the verification process, assuming that the entity has already selected a suitable type and a level of assurance and identified a competent verifier.

### 13.8.1 Timing of the verification process

The timing of verification depends on the subject matter and needs of the entity. For example, verification can be performed before the implementation of a policy or action when the user, as part of its planning activities, wants to obtain confidence that a policy or action is likely to achieve its expected GHG effect ex-ante. Alternatively, assurance can be performed before an entity's public release of an interim or final report to provide a progress update and inform a potential course adjustment, or it can offer conclusions on the final performance and effectiveness of a policy or action through ex-post assessment. This

**Table 13.3 Levels of assurance**

| Assurance opinion | Nature of opinion |
|---|---|
| **Limited assurance** | **Negative opinion**<br>• Example: "Based on our verification, we are not aware of any material modifications that should be made to the entity's assertion that the policy's change in GHG emissions from the baseline scenario is a reduction of 2 million tonnes of $CO_2$e and is in conformity with the *GHG Protocol Policy and Action Standard.*" |
| **Reasonable assurance** | **Positive opinion**<br>• Example: "In our opinion the reporting entity's assertion that the policy's change in GHG emissions from the baseline scenario is a reduction of 2 million tonnes $CO_2$e is fairly stated, in all material respects, and is in conformity with the *GHG Protocol Policy and Action Standard.*" |

allows for any material issues to be corrected before the release of the assurance opinion (or revised opinion) and the assertion of a change in GHG emissions. The work should be initiated long enough before the planned date of implementation of the policy or action, or the release date of the assessment report, so that the verification is useful in improving the estimation of the change in GHG emissions, when necessary. The time required for verification depends on the nature and complexity of the subject matter and the level of assurance selected.

### 13.8.2 Preparing for verification

Preparing for verification is a matter of ensuring that the evidence the verifier needs is easily accessible. The type of evidence and documentation requested by the verifier depends on the subject matter, the type of policy or action considered, and the type and level of assurance being sought. Maintaining documentation of the GHG assessment process through the use of a data management plan is helpful for ensuring that the assurance evidence is available.

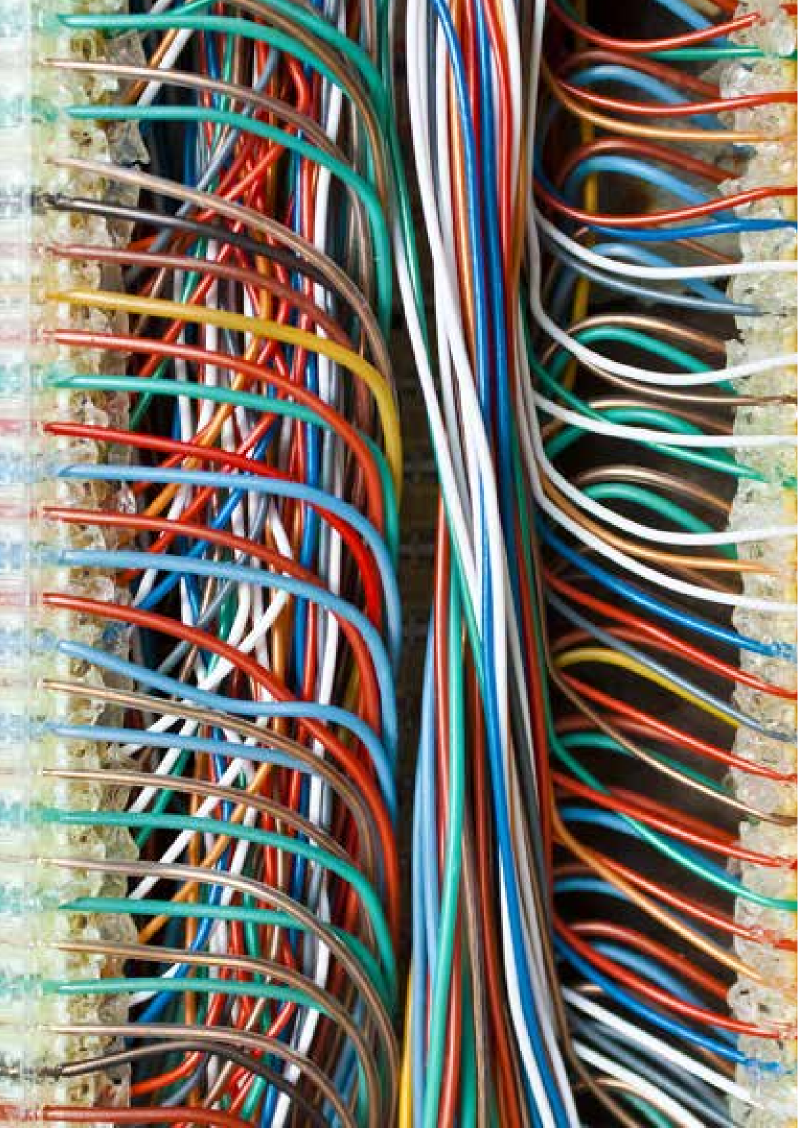
Prior to initiating verification, the reporting entity should ensure that the following are prepared and made available to the verifier:

- The entity's written assertion on the estimated change in GHG emissions and removals resulting from the policy or action
- The completed assessment report and a referenced description of the tools and methods used
- Access to sufficient and appropriate evidence (such as baseline data, decisions and supporting rationales, interim reports, internal evaluations and performance reports, and peer reviews).

### 13.8.3 Steps of verification

The systematic process of verification, whether performed by a first- or third-party verifier who provides limited or reasonable assurance, features several steps that are common to all approaches.

1. **Planning and scoping**: Planning involves the prioritization of effort by the verifier toward the data, methods, and information most likely to affect the reported change in GHG emissions from a policy or action. In practice the verifier assesses the risks and magnitude of potential errors, omissions, and misrepresentations in the GHG assertion. The assurance plan is structured around the assurance standards. It identifies the level and objectives of the assurance, the criteria and scope (subject matter and materials to be verified), the materiality threshold, and the activities and schedule the verifier plans to implement to assess the GHG assertion against the standard's principles and requirements.
2. **Identifying data, methods, and assumptions**: This step requires identifying GHG emissions from the sources and sinks included in the baseline and policy scenario, as well as the assumptions and methods used for estimating the change in GHG emissions. If applicable, the internal controls and systems of the entity relevant to the policy or action are also identified, such as quality control and quality assurance activities and internal audits.
3. **Verification**: This step requires carrying out the verification activities as planned in the schedule. The main steps in a schedule include the collection and analysis of evidence as well as the appraisal of the evidence against the standard's criteria. The verification process generally includes the following steps:
    - Determining whether the requirements in the standard are correctly interpreted by the user and whether the assessment is in conformance with the requirements
    - Assessing the relevance, completeness, consistency, transparency, and accuracy of the data/information provided, as well as the reliability and credibility of data sources
    - Where multiple methodological choices, equations, or parameters are available to the user, determining whether adequate justification for the selected choice has been provided
    - Checking whether all the assumptions and data used are clearly disclosed along with references and sources as well as whether justifications are provided (where required) that are reasonable and supported by evidence
    - Identifying issues that require further elaboration, research, or analysis



To complete these steps, verifications should consider the following activities:

- Interviewing relevant stakeholders and experts
- Reviewing relevant documents, including available assessment reports or studies of other similar policies or actions
- Cross-checking information provided by the assessment entity with independent sources other than those used (for example, through independent research)
- Site visits to observe monitoring systems and take sample measurements (if applicable), preferably focusing on issues deemed material
- Other standard auditing techniques and procedures

4. **Assessing materiality**: This consists in determining if the verification findings support the entity's assertion on the change in GHG emissions from its policy or action. Depending on the level of assurance and materiality threshold agreed, the verifier assesses if the information reported by the entity is in conformity with the standard's criteria or if there is any material discrepancy in the information reported.

5. **Forming and reporting an assurance opinion**: The verifier next forms an assurance opinion, the nature of which depends on the level of assurance agreed (see Table 13.3). As part of their opinion, verifiers should report the following:
   - A description of the studied policy or action
   - A reference to the reporting entity's assertion included in the GHG assessment report
   - A description of the assurance process
   - A list of the *Policy and Action Standard's* principles and requirements
   - A description of the reporting entity's and verifier's responsibilities
   - Whether the verification was performed by a first or third party
   - The verification standard used to perform the verification, for example ISO 14064–3: *Specification with Guidance for the Validation and Verification of Greenhouse Gas Assertions*
   - How any potential conflicts of interest were avoided in the case of first-party assurance
   - A summary of the work performed
   - The level of assurance achieved (limited or reasonable) or a statement as to why an opinion cannot be expressed
   - The materiality threshold, if set
   - Any additional details regarding the verifier's conclusion, including details on any discrepancies noted or issues encountered in performing the verification
   - Practical modifications to help rectify any discrepancies

# 14 Reporting

**This chapter provides reporting requirements explaining what information shall be publicly reported in order for a GHG assessment report to be in conformance with the GHG Protocol *Policy and Action Standard*. This chapter also lists optional reporting information that users should report, if relevant. A sample reporting template is available at www.ghgprotocol.org/policy-and-action-standard.**

## 14.1 Required information

Users **shall** report the following information about the GHG assessment and the estimated change in GHG emissions and removals resulting from the policy or action:

- The title of the policy or action (or package of policies/actions) assessed
- Whether the assessment applies to an individual policy/action or a package of policies/actions, and if a package, which individual policies and actions are included in the package
- The objective(s) and the intended audience of the GHG assessment
- The year the assessment was developed
- Whether the reported assessment is an update of a previous assessment, and if so, links to any previous assessments
- Whether the GHG assessment is an ex-ante assessment, an ex-post assessment, or a combined ex-ante and ex-post assessment
- The GHG assessment period
- The estimated total net change in GHG emissions and removals resulting from the policy/action or package of policies/actions (i.e., the difference between the baseline scenario and the policy scenario), in tonnes of carbon dioxide equivalent, both annually and cumulatively over the GHG assessment period
- Total in-jurisdiction GHG effects (the total net change in GHG emissions and removals that occurs within the implementing jurisdiction's geopolitical boundary), separately from total out-of-jurisdiction GHG effects (the net change in GHG emissions and removals that occurs outside of the jurisdiction's geopolitical boundary), if relevant and feasible

Users **shall** report the following information about the policy or action assessed and the methodology used to estimate changes in GHG emissions and removals resulting from the policy or action:

### Defining the Policy or Action (Chapter 5)

- The status of the policy or action (planned, adopted, or implemented), the date of implementation, and the date of completion (if applicable)
- The implementing entity or entities
- The objective(s) of the policy or action
- The type of policy or action
- A description of the specific interventions included in the policy or action
- The geographic coverage; the primary sectors, subsectors, and emission source/sink categories targeted; and the greenhouse gases targeted (if applicable)
- Other related policies or actions that may interact with the policy or action assessed

### Identifying Effects and Mapping the Causal Chain (Chapter 6)

- A list of all potential GHG effects of the policy/action that were considered in the assessment
- A list of all source/sink categories and greenhouse gases associated with the GHG effects of the policy or action
- A causal chain

### Defining the GHG Assessment Boundary (Chapter 7)

- Any potential GHG effects, source/sink categories, or greenhouse gases excluded from the GHG assessment boundary, with justification for their exclusion
- The approach used to determine the significance of GHG effects

### Estimating Baseline Emissions (Chapter 8)

- A description of the baseline scenario (i.e., a description of the events or conditions most likely to occur in the absence of the policy or action) and justification for why it is considered the most likely scenario
- Total annual and cumulative baseline scenario emissions and removals over the GHG assessment period, if feasible based on the method used
- The methodology and assumptions used to estimate baseline emissions, including the emissions estimation method(s) (including any models) used
- Justification for the choice of whether to develop new baseline assumptions and data or to use published baseline assumptions and data
- A list of policies, actions, and projects included in the baseline scenario
- Any implemented or adopted policies, actions, or projects excluded from the baseline scenario, with justification for their exclusion
- Whether the baseline scenario includes any planned policies and if so, which planned policies are included
- A list of non-policy drivers included in the baseline scenario
- Any relevant non-policy drivers excluded from the baseline scenario, with justification for their exclusion
- The baseline values for key parameters (such as activity data, emission factors, and GWP values) in the baseline emissions estimation method(s)
- The methodology and assumptions used to estimate baseline values for key parameters, including whether each parameter is assumed to be static or dynamic, and assumptions regarding other policies/actions and non-policy drivers that affect each parameter
- All sources of data used for key parameters, including activity data, emission factors, GWP values, and assumptions
- Any potential interactions with other policies and actions and whether and how policy interactions were estimated
- Any sources, sinks, or greenhouse gases in the GHG assessment boundary that have not been estimated in the baseline scenario, with justification, and a qualitative description of those sources, sinks, or gases

### Estimating GHG Effects Ex-Ante (Chapter 9)

- A description of the policy scenario (i.e., a description of the events or conditions most likely to occur in the presence of the policy or action)
- Total annual and cumulative policy scenario emissions and removals over the GHG assessment period, if feasible based on the method used
- The methodology and assumptions used to estimate policy scenario emissions, including the emissions estimation method(s) (including any models) used
- The policy scenario values for key parameters (such as activity data, emission factors, and GWP values) in the emissions estimation method(s)
- The methodology and assumptions used to estimate policy scenario values for key parameters, including whether each parameter is assumed to be static or dynamic
- All sources of data used for key parameters, including activity data, emission factors, GWP values, and assumptions
- Any potential interactions with other policies and actions and whether and how policy interactions were estimated
- Any sources, sinks, greenhouse gases, or GHG effects in the GHG assessment boundary that have not been estimated in the policy scenario, with justification, and a qualitative description of the change to those sources, sinks, or gases

### Monitoring Performance over Time (Chapter 10)

- The key performance indicators selected and the rationale for their selection
- The sources of indicator data
- The performance of the policy or action over time, as measured by the key performance indicators, and whether the performance of the policy or action is on track relative to expectations
- Whether the assumptions on key parameters within the ex-ante assessment remain valid

### Estimating GHG Effects Ex-Post (Chapter 11)

- Total annual and cumulative policy scenario emissions and removals over the GHG assessment period, if feasible based on the method used
- The methodology and assumptions used to estimate policy scenario emissions, including the emissions estimation method(s) (including any models) used
- All sources of data for key parameters, including activity data, emission factors, GWP values, and assumptions
- Any potential interactions with other policies and actions and whether and how policy interactions were estimated
- If data are normalized, the normalized results separately reported from the non-normalized results, and the normalization methods used
- Description of differences between results from top-down and bottom-up methods (if applicable)
- Any sources, sinks, or greenhouse gases in the GHG assessment boundary that have not been estimated in the policy scenario, with justification, and a qualitative description of the change to those sources, sinks, or gases

### Assessing Uncertainty (Chapter 12)

- A quantitative estimate or qualitative description of the uncertainty of the results
- The range of results from sensitivity analysis for key parameters and assumptions
- The method or approach used to assess uncertainty

### Verification (Chapter 13)

- Whether the GHG assessment results were verified, and if so, the type of verification (first party or third party), the relevant competencies of the verifier(s), and the opinion issued by the verifier

## 14.2 Optional information

Users should report, where relevant:

- The net change in GHG emissions and the net change in GHG removals, separately reported in tonnes of carbon dioxide equivalent
- Net changes in GHG emissions and removals, reported separately by individual greenhouse gas
- Net changes in GHG emissions and removals, reported separately by individual effect, by type of effect (i.e., intended effects, unintended effects, in-jurisdiction effects, out-of-jurisdiction effects, short-term effects, and long-term effects), or by source or sink category
- A probability-adjusted estimate (or expected value) of the net changes in GHG emissions and removals resulting from the policy or action, with disclosure that the results represent a probability-adjusted estimate
- A range of likely values for the net change in GHG emissions and removals, rather than a single estimate, when uncertainty is high (for example, because of uncertain baseline assumptions or uncertain policy interactions)
- Net changes in GHG emissions and removals resulting from likely effects, separately reported from net changes in GHG emissions and removals resulting from unlikely effects
- Net changes in GHG emissions and removals, separately reported by likelihood category (very likely, likely, possible, unlikely, very unlikely)
- Annual or cumulative GHG effects over time periods other than the GHG assessment period
- Trends in key performance indicators used to monitor performance, such as the change in key performance indicators since the last reporting period
- The GHG inventory of the jurisdiction or organization implementing the policy or action
- Historical GHG emissions of the jurisdiction or organization implementing the policy or action
- GHG mitigation goal(s) of the jurisdiction or organization implementing the policy or action
- The contribution of the assessed policy or action toward the jurisdiction's or organization's GHG mitigation goal
- Any potential overlaps with other policies and actions
- Any possible double counting of GHG reductions by other parties that may claim GHG reductions from the same policies or actions, and any practices or precautions used to avoid double counting
- A description of non-GHG effects of the policy or action, estimates of non-GHG effects of the policy or action, and the methodologies used to estimate non-GHG effects
- Cost and/or cost-effectiveness of the policy or action and the methodologies used to quantify costs
- Any limitations in the assessment not described elsewhere
- Other relevant information

# Appendices

# Appendix A
# Guidance on Collecting Data

**This appendix provides general guidance on data collection and is relevant to Chapters 8, 9, 10, and 11. More specific information on the data required for specific steps in the GHG assessment is provided in Chapters 8, 9, 10, and 11.**

Developing a GHG assessment of a policy or action is typically a data-intensive process. The quality of the GHG assessment depends on the quality of the data used to develop it. Users should collect data of sufficient quality to ensure that the GHG assessment appropriately reflects actual changes in GHG emissions and removals resulting from the policy or action and serves the decision-making needs of users, both internal and external to the reporting entity. See Figure A.1 for an overview of the process for collecting data.

## A.1 Prioritize data collection efforts

Users should prioritize data collection efforts on the GHG effects expected to have the most significant impact on total results. In general, users should collect higher quality data for those effects determined to be most significant when defining the GHG assessment boundary (see Chapter 7).

## A.2 Select data

After prioritizing GHG effects, users should select data based on the objectives of the assessment and the level of accuracy needed to meet those objectives, data availability, and the quality of available data.

GHG emissions calculation methods require a variety of parameters, including activity data and emission factors (see Chapters 8–11). For each parameter needed to estimate effects of policies or actions, users may use either primary data or secondary data. See Table A.1 for descriptions of each data type.

**Figure A.1** Iterative process for collecting data

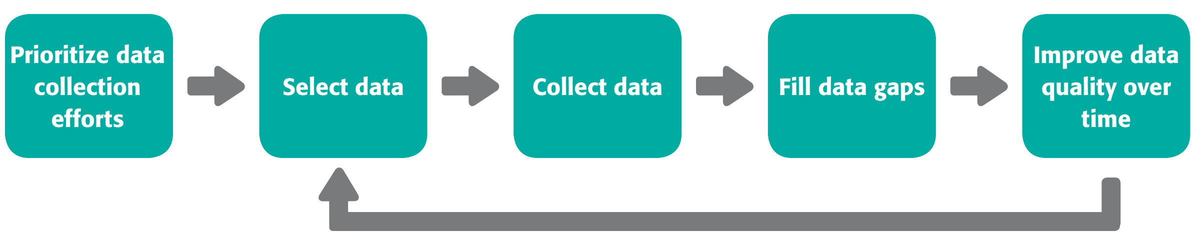



**Table A.1** Primary and secondary data

| Type of data | Description |
|---|---|
| **Primary data** | Data collected from specific sources or sinks affected by the policy or action (for example, fuel use measured at a specific facility) |
| **Secondary data** | Data that is not collected from specific sources or sinks affected by the policy or action (for example, data from published databases, government statistics, literature studies, and industry associations) |

For example, if a user is carrying out an ex-post assessment of a home insulation subsidy using the deemed estimate approach, the user may collect data on the number of homes insulated (primary data) and multiply that number by energy savings per home to determine total energy savings. The estimated savings per home can be based on either primary data (measured changes in energy use for each home or a representative sample of homes) or secondary data (average estimates of energy savings based on similar, previous studies).

Primary data is most relevant to monitoring performance during policy implementation (Chapter 10) and ex-post assessment (Chapter 11), but may also be relevant when developing baseline scenarios and ex-ante policy scenarios derived based on historical data, which may be primary or secondary.

Primary data may be obtained through meter readings, purchase records, utility bills, engineering models, direct monitoring, mass balance, stoichiometry, or other methods for obtaining data from specific sources and sinks affected by the policy or action.

When using secondary data sources, users should prioritize databases and publications that are internationally recognized, provided by national governments, or peer-reviewed. Any secondary data used should be representative of the policy or action being assessed. For the example described above, the representativeness of secondary data can be determined by sampling a subset of homes affected by the program to verify whether the actual energy savings are similar to the estimated savings based on secondary data. If sampling is not possible, users should select secondary data based on data quality indicators (see Table 8.8).

Users may use any combination of primary and secondary data. In general, users should collect high-quality primary data for high-priority effects. In some cases, primary data may not be available or may be of lower quality than the available secondary data for a given activity (for example, if data are collected using unreliable measurement methods). In some cases, top-down secondary data may be more reliable, accurate, and complete than bottom-up primary data (for example, for policies and actions with national scope where national statistics are accurate and complete). Both types of data have advantages and disadvantages (see Table A.2).

Users should select data that are the most representative in terms of technology, time, and geography; most complete; and most reliable (see Table 8.8). When uncertainty exists, users should choose conservative values. Users are required to document and report all sources of data used, including activity data, emission factors, GWP values, and assumptions (see Chapter 14).

**Table A.2 Advantages and disadvantages of primary data and secondary data**

| Type of data | Advantages | Disadvantages |
|---|---|---|
| **Primary data** | • Provides better representation of the policy's specific effects<br>• Enables more accurate assessment of policy effectiveness | • May be costly<br>• May be difficult to verify the quality of primary data |
| **Secondary data** | • Enables estimation when primary data is unavailable or of insufficient quality<br>• Can be useful for estimating GHG effects for minor sources or effects<br>• Can be more cost-effective and easier to collect<br>• Can be used to estimate the relative magnitude of various effects (for example, when defining the GHG assessment boundary in Chapter 7) and prioritize efforts in primary data collection | • Data may not be representative of the policy or action's specific effects<br>• May limit the ability to accurately quantify and assess policy effectiveness |

## A.3 Collect data

Data collection should be viewed in the context of the overall policy assessment process. Data may be collected before a policy or action is implemented, during implementation, and after implementation (if applicable). See Table A.3 for an example for a hypothetical insulation subsidy program.

The precise data that will need to be collected depends on the policy in question, the stage in the process (such as defining the baseline or estimating GHG effects ex-post), and the method being followed. It is also useful to consider the data required across all steps in the standard. By understanding the data required for each step, users can best ensure a consistent approach to data collection and make the best use of existing data sources and data collection mechanisms.

See Table A.4 for a description of various data collection procedures.

### Collecting data on emission factors

Emission factors can be global, national, subnational, or source-specific. Users should choose emission factors that are the most geographically, temporally, and technologically representative of the activity being estimated.

Users may use either marginal emission factors or average emission factors. Users should choose emission factors that are most appropriate and representative for the individual context. When estimating the GHG effect resulting from a change in electricity consumption or generation, users should apply marginal emission factors, which are generally more accurate than average emission factors. Unlike

**Table A.3 Examples of data to be collected by stage**

| Stage | Purpose | Examples of data to be collected |
|---|---|---|
| **Pre-policy** | Informs the baseline scenario | Amount and type of insulation installed prior to the policy |
| **Policy implementation** | Indicates ongoing performance of policy | Amount and type of insulation installed during each year of policy implementation |
| **Post-policy** | Informs the estimate of the policy impact ex-post | Amount and type of insulation installed over lifetime of the policy |

**Table A.4 Data collection procedures**

| Procedures | Description |
|---|---|
| **Data compilation** | The processes that have been followed to compile the data should be clearly described. This may include a description of how the data is compiled, who has compiled the data, and where the data is stored. |
| **Data processing** | The steps taken to further process the data should be clearly described. This should include details of any modifications or corrections that have been made to the data, including the cleaning of data sets, the removal of outliers and any other adjustments. These changes should be documented, along with a brief justification for any key decisions. |
| **Quality assurance / quality control** | For key data sources or data sets, users should provide a judgment on the overall quality of the analysis. This may require a subjective assessment, but the aim is to provide an indication of the overall quality of the data and the main uncertainties. Established QA/QC procedures should be clearly followed. |

average emission factors (which represent aggregated total emissions associated with producing electricity from all sources of supply divided by the total amount of electricity), marginal emission factors reflect the emissions profile of a select subset of electricity generation facilities based on their role in the dispatch order of the system. If appropriate marginal emission factors are not available in a given region, average emission factors should be used.

Sources of emission factors include the following:

- IPCC, *Guidelines for National Greenhouse Gas Inventories* (2006)
- IPCC, Emission Factor Database[1]
- Country-specific emission factors from national inventories, reports, and guidelines
- Emission factors contained in the GHG Protocol calculation tools and guidance[2]
- *The GHG Protocol for Project Accounting* and the related GHG Protocol *Guidelines for Quantifying GHG Reductions from Grid-Connected Electricity Projects* (if applicable)
- CDM databases and the CDM "Tool to Calculate the Emission Factor for an Electricity System"[3] (if applicable)

## A.4 Fill data gaps

If data of sufficient quality are not available, proxy data may be used to fill data gaps. Proxy data are 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 (see Chapter 14). For additional guidance on filling data gaps, see IPCC 2006: Volume 1, Chapter 2, "Approaches to Data Collection."

## A.5 Improve data quality over time

Collecting data, assessing data quality, and improving data quality is an iterative process. Over time, users should replace lower quality data with higher quality data as it becomes available.

### Endnotes

1. Available at www.ipcc-nggip.iges.or.jp/EFDB/.
2. Available at www.ghgprotocol.org.
3. Available at http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool–07-v2.pdf/.

# Appendix B
# Guidance on Assessing Policy Interactions

**This appendix provides guidance on assessing policy interactions when estimating the GHG effects of policies and actions. This appendix is relevant to multiple chapters in the standard where policy interactions may arise, including Chapters 5, 8, 9, and 11.**

An individual policy or action may interact with other policies and actions to produce total effects that differ from the sum of the individual effects of each individual policy. Policies and actions can interact in either overlapping or reinforcing ways or can be independent of each other. For more background information and examples of policy interactions, see Chapter 5, Section 5.3.

Interactions can occur between policies included in the baseline scenario, between policies included in the baseline scenario and the policy or action being assessed, or within a set of policies or actions that is assessed as a package. Understanding policy interactions is an important step toward accurately estimating the GHG effects of a policy or action.

Policies may interact with each other if they affect the same parameter(s) in the emissions estimation method(s) for a source or sink in the GHG assessment boundary. For example, for the source "residential natural gas emissions," the emissions estimation method may be: "GHG emissions (t $CO_2e$) = natural gas use (MMBtu) × emission factor (t $CO_2e$/MMBtu)." In this case, "natural gas use" is a parameter. (For more information on emissions estimation methods and parameters, see Chapter 8, Section 8.4.) Multiple policies may affect the same parameter either directly (such as a natural gas tax and a natural gas subsidy that both affect natural gas use) or indirectly (such as two policies that have systemic effects on a broader economic, environmental, or social system).

Policy interactions should be considered or addressed in the following cases:

1. **Chapter 5:** Deciding whether to assess an individual package/action or a package of policies/actions
2. **Chapter 8:** Estimating baseline emissions when the baseline scenario consists of multiple interacting policies
3. **Chapter 9:** Estimating ex-ante policy scenario emissions when the policy or action assessed interacts with policies included in the baseline scenario
4. **Chapter 11:** Estimating GHG effects ex-post when the policy or action assessed interacts with policies included in the baseline scenario
5. **Optional step:** Allocating GHG effects to individual policies within a policy package, when policies within the package interact (ex-ante or ex-post)
6. **Optional step:** Aggregating GHG effects across multiple policies or packages of policies (ex-ante or ex-post)

Guidance on each case is provided below.

### Case 1: Deciding whether to assess an individual or package of policies/actions

See Chapter 5, Section 5.3.

### Case 2: Estimating baseline emissions when the baseline scenario consists of interacting policies

As described in Chapter 8, Section 8.4, the baseline scenario should include all currently implemented or adopted policies and actions that have a significant effect on GHG emissions. The policies and actions included in the baseline scenario may interact with each other. If the policies are likely to interact with each other, users should estimate the policy interactions when estimating baseline emissions, by taking into account the net impact of all the policies included in the baseline scenario on all the emissions sources/sinks included in the GHG assessment boundary.

To do this, users should follow three steps for each source/sink in the GHG assessment boundary:

1. **Develop a list of policies influencing parameter values:** First, identify all parameters in the emissions estimation method(s) for each source/sink (see Section 8.4). For each parameter, develop a list of policies included in the baseline scenario that may influence the parameter value.

2. **Develop a policy interaction matrix**: Next, develop a policy interaction matrix for each parameter influenced by multiple policies. A policy interaction matrix is a visual way to understand the interactions between combinations of policies identified in Step 1. See Figure B.1 for a generic example of a policy interaction matrix and Figure B.2 for an illustrative example for a specific parameter. A separate matrix should be developed for each relevant parameter. For each matrix, each axis of the matrix should contain all policies in the list of policies (identified in Step 1), such that each cell in the matrix represents a pair of potentially interacting policies.

   For each combination of policies in the matrix, users should make a qualitative determination of whether the net interaction of policies is likely to be independent, overlapping, or reinforcing with respect to the parameter. (For descriptions and examples of each type of interaction, see Section 5.3). Any combination of policies can have both overlapping and reinforcing effects, and determining whether the net effect is overlapping or reinforcing may require detailed analysis (see Box 5.1 in Chapter 5).

   For each combination of policies in the matrix, users should also categorize the general magnitude of interaction into three categories: major, moderate, or minor. The assessment should be based on expert judgment, published studies of similar combinations of policies/actions, or consultations with relevant experts. If users cannot determine the type and/or magnitude of the interaction, the interaction should be categorized as "uncertain."

   Based on the combination of interaction type (independent, overlapping, reinforcing) and magnitude estimate (major, moderate, minor), users should fill out the matrix using the symbols in the key in Figure B.1.

   Finally, users should narrow the list of interactions to those that are either overlapping or reinforcing and either moderate or major. Uncertain interactions should also be retained in the list. This set represents (potentially) significant interactions that should be estimated in Step 3.

**Figure B.1 Generic example of a policy interaction matrix for one parameter**

| Policies | Policy 1 | Policy 2 | Policy 3 | Policy N |
|---|---|---|---|---|
| Policy 1 | N/A | | | |
| Policy 2 | ++ | N/A | | |
| Policy 3 | - | +++ | N/A | |
| Policy N | --- | 0 | U | N/A |

*Source:* Adapted from Boonekamp and Faberi 2012.

**Key:**

| | |
|---|---|
| Independent | 0 |
| Overlapping | --- major/-- moderate/- minor interaction |
| Reinforcing | +++ major/++ moderate/+ minor interaction |
| Uncertain | U |

Significant interactions to be estimated (highlighted in teal)

3. **Estimate the combined effects of interacting policies on each parameter:** Users should estimate the collective, combined effect of all significant interacting policies (that are either moderate or major and either reinforcing or overlapping) on each parameter in the emissions estimation method for the source/sink. Some models selected to estimate emissions in Chapters 8, 9, or 11 may automatically calculate interactions between policies. If using simpler models where interaction effects are not calculated automatically, users should manually estimate and incorporate the interaction effects between policies on the various parameters. Users may also need to carry out surveys of affected actors, such as consumers or businesses, to understand whether the actors made a decision to implement a particular action based on one policy, another policy, the combination of both policies,

**Figure B.2 Illustrative example of a policy interaction matrix for a specific parameter: natural gas used in space heating**

| Policies | Insulation subsidy | Natural gas tax | Energy labeling | Energy efficiency standards |
|---|---|---|---|---|
| Insulation subsidy | N/A | | | |
| Natural gas tax | -- | N/A | | |
| Energy labeling | ++ | - | N/A | |
| Energy efficiency standards | --- | - | -- | N/A |

**Key:**

| | |
|---|---|
| Independent | 0 |
| Overlapping | --- major/-- moderate/- minor interaction |
| Reinforcing | +++ major/++ moderate/+ minor interaction |
| Uncertain | U |

Significant interactions to be estimated (highlighted in teal)

or neither policy. In some cases the necessary data may not be available and expert judgment may be necessary.

### Case 3: Estimating ex-ante policy scenario emissions when the policy or action assessed interacts with policies included in the baseline scenario

As described in Chapter 9, Section 9.4, the policy or action assessed may interact with the policies included in the baseline scenario. Users should estimate policy scenario emissions taking into account the net impact of any significant interactions between the policy/action assessed (or package of policies/actions assessed) and the various policies included in the baseline scenario. To do so, users should follow the same three steps outlined for Case 2 above, with the addition of including the policy/action (or package of policies/actions) being assessed in the list of policies in the policy interaction matrix.

The incremental effect of the policy/action being assessed relative to other policies/actions included in the baseline scenario is attributed to the policy/action being assessed. If the interaction between the policy/action being assessed and the policies included in the baseline scenario is net overlapping, then the net GHG effect of the policy/action will be less than if it were assessed without considering interactions with baseline policies. Conversely, if the interaction effect between the policy/action being assessed and the policies included in the baseline scenario is net reinforcing, then the net GHG effect of the policy/action will be more than if it were assessed without considering interactions with baseline policies.

See Box B.1 for a case study of assessing policy interactions.

### Case 4: Estimating GHG effects ex-post when the policy or action assessed interacts with policies included in the baseline scenario

As mentioned in Chapter 11, the policy or action (or package of policies/actions) being assessed ex-post may interact with policies included in the baseline scenario. Any interaction effects (either reinforcing or overlapping effects) between policies included in the baseline scenario and the policy or action being assessed are attributed to the policy or action being assessed. This results from the methodology itself because the baseline scenario includes other implemented policies but not the policy or action assessed (and hence does not include any interactions between other

### **Box B.1** Assessing policy interactions for an air quality management plan in Colombia

The Clean Air Institute (CAI) carried out an ex-ante assessment of the Air Quality Management Plan of the Area Metropolitana del Valle de Aburra (AMVA) in Antioquia, Colombia. The objectives were to evaluate the GHG impact of the transportation measures in the plan and inform the development of an integrated environmental strategy for sustainable urban mobility in the AMVA. The assessment was performed with the Long-Range Energy Alternatives Planning System (LEAP), an energy model, using information from the latest emissions inventory developed locally.

The plan consists of two transportation policies: (1) regulations to improve vehicle technologies; and (2) incentives to reduce trips from private cars and motorcycles and increase trips by bicycle, walking, and public transportation. Both policies affect emissions from urban transport—the first by improving vehicle technology and the second by shifting toward less-emitting modes of transport. As a result, interactions between the two policies were considered likely.

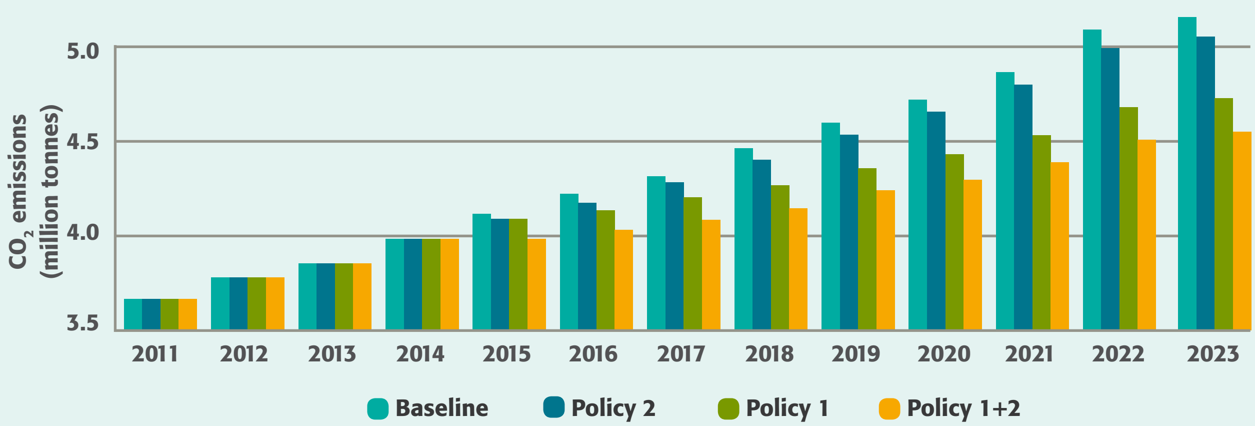
CAI assessed the policies both individually and as a package. The metropolitan authority was interested in the individual impact of each policy in order to understand whether each was effective and should continue to be supported and implemented. The authority was also interested in the total impact of both policies when implemented together to understand how effective the policies would be when implemented together. Assessing policy interactions was necessary to accomplish these objectives.

To help understand the interactions, CAI developed a table (Table B.1) to identify the types of vehicles affected by each policy. The policies affected two common sources: cars and motorcycles. The assessment of the interaction focused on these two common sources. CAI then estimated emissions under four scenarios: the baseline scenario where neither policy is implemented, a policy scenario where only Policy 1 is implemented, a policy scenario where only Policy 2 is implemented, and a policy scenario where both policies are implemented together. See Figure B.3. CAI found that the combined effect of the two policies together was similar to the sum of the individual effects of the two policies had they been implemented on their own.

**Table B.1** Types of vehicles affected by each policy

| Policies | Cars | Taxis | Buses | Bus rapid transit | Trucks | Motorcycles |
|---|---|---|---|---|---|---|
| Policy 1: Improve vehicle technology | X | | X | | X | X |
| Policy 2: Incentives to reduce trips | X | | | X | | X |

**Figure B.3** Estimating emissions and policy interactions for the Air Quality Management Plan



implemented policies and the policy or action assessed). In contrast, the (observed) policy scenario includes other implemented policies as well as the policy or action assessed (and hence includes interactions between other implemented policies and the policy or action assessed). When baseline emissions are subtracted from policy scenario emissions, the interaction effects are automatically attributed to the policy or action assessed. For an example of estimating policy interactions ex-post, see Box B.2.

Attributing interaction effects to the policy or action assessed yields an accurate estimate of the effects of the policy in the specific context and policy environment in which it was implemented. Users should exercise caution in generalizing the results to other jurisdictions, since the results will be misleading if applied to another jurisdiction with a different combination of policies in effect. The results will only be meaningful in the jurisdiction where the policy was implemented.

### Case 5: Allocating GHG effects between individual policies within a policy package, when policies within the package interact (ex-ante or ex-post)

Users that assess a package of policies/actions may want to determine the individual effects of each policy or action within that package. If any overlapping or reinforcing interactions may exist between those policies and actions, users should not allocate the total GHG effect among the various policies in the package. Instead, to determine the relative effect of each policy with respect to the others, users should carry out new assessments of each policy individually, rather than as a package, by estimating the GHG effects of each policy or action separately, assuming the other policies were not implemented. To estimate the relative effect of each policy, assuming all the policies will be implemented, users should carry out new assessments of each policy individually and include all other policies in the baseline scenario. If the policies are completely independent of each other, the sum of the GHG effects of the policies within the package individually would be the same as the GHG effects from the combination of policies.

**Box B.2 Example of estimating policy interactions ex-post**

Two policies are in effect: (1) an energy labeling program for appliances and (2) an information campaign that makes the labels known to users. The policy being assessed is the information campaign. The energy labeling program is included in the baseline scenario. The (observed) policy scenario emissions reflect the combined effect of both policies—that is, what types of appliances consumers actually purchased—but do not reveal whether the purchases were a result of the labeling program, the information campaign, both policies taken together, or neither policy.

In the observed policy scenario (with both policies in effect), appliance-related emissions decreased by 2,000 t $CO_2e$. To estimate the effect of the information campaign, users should estimate baseline emissions based on the scenario in which the labeling program existed but the information campaign did not. The relative effect of each policy can be estimated through survey methods in which a sample of consumers is asked whether their appliance purchasing decisions were influenced by the labeling program, the information campaign, both policies together, or neither policy.

Assume that the survey finds that the labeling program alone would have reduced emissions by 1,500 t $CO_2e$ and the information campaign alone would have reduced emissions by 200 t $CO_2e$. Therefore, in the baseline scenario, a GHG reduction of 1,500 t $CO_2e$ would have occurred as a result of the implementation of the labeling program alone. The GHG effect of the information campaign is the difference between policy scenario emissions and baseline emissions (500 t $CO_2e$). The estimated GHG effect of 500 t $CO_2e$ is greater than the 200 t $CO_2e$ that the policy would have achieved on its own, because the interaction effect (a reinforcing effect of 300 t $CO_2e$) is attributed to the information campaign.

### Case 6: Aggregating GHG effects across policies or actions

GHG effects should not be directly aggregated across policies or actions if any overlapping or reinforcing interactions between the policies being aggregated have not been accounted for. In this case, the sum would either overestimate or underestimate the GHG effects resulting from the combination of policies.

In general, GHG effects may be directly aggregated across policies or actions if:

- They are independent of each other (for example, because they do not affect the same sources or sinks) or the interactions between them have been accounted for;
- The methods, assumptions, and data sources are otherwise comparable; and
- The baseline scenario for each policy being aggregated includes only policies implemented before that policy was implemented.

To aggregate GHG effects across two or more interacting policies, users should consider assessing the policies as a package to estimate the total net effect of all of the policies, rather than assessing them individually and then summing the results. For ex-post assessments, if assessing a policy package is not possible, users should estimate the GHG effects of each policy using a different approach than the approach explained in Chapter 11. This alternative approach is explained in Box B.3. Users not aggregating results ex-post should follow the guidance in Chapter 11 rather than following the approach in Box B.3.

**Box B.3** **Approach for estimating GHG effects ex-post to enable aggregation across policies**

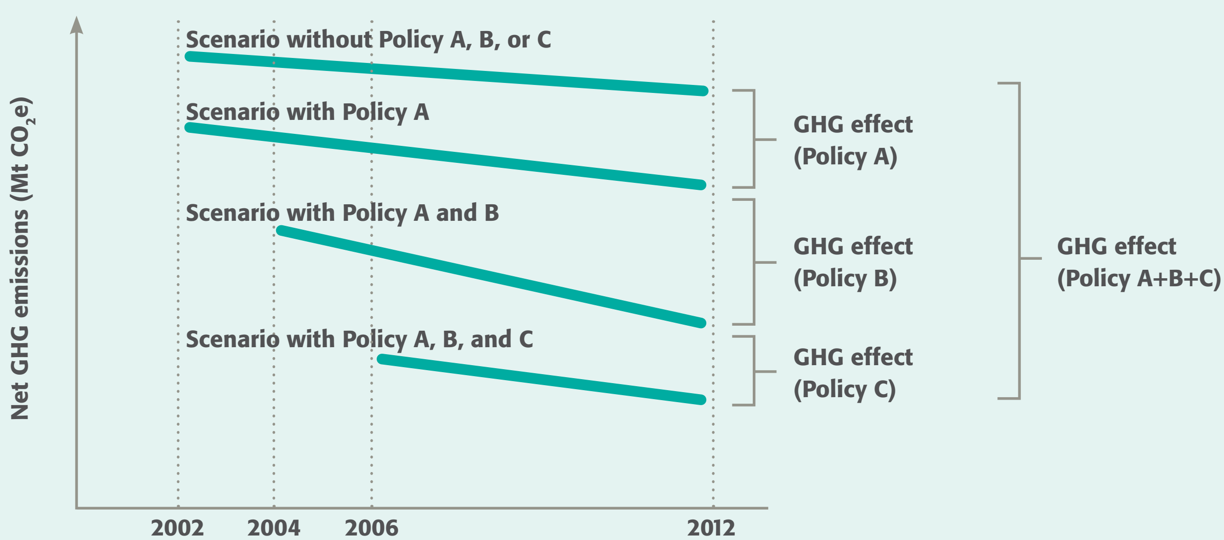
The approach in Chapter 11 does not enable valid aggregation across policies ex-post because the baseline scenario for each policy includes all other policies that are implemented during the GHG assessment period. If each policy includes all the other policies in its baseline scenario, aggregation of results would lead to double counting of interactions between the policies, and total estimated results would be different from the actual combined effect of all policies being implemented together.

To aggregate results ex-post, the baseline scenario for each policy being aggregated should include only policies implemented before that policy was implemented (rather than including all policies that were implemented at the time the assessment was carried out). The baseline scenario for each policy being aggregated should exclude other policies being aggregated that were introduced later in time. If this approach is applied consistently to all policies being aggregated, ex-post assessments of multiple policies may be aggregated to estimate the total GHG effects (assuming the methodologies are comparable).

Figure B.4 illustrates a situation in which aggregation of GHG effects across policies may be valid. Policy A, Policy B, and Policy C are three policies implemented sequentially: Policy A is implemented in 2002, Policy B is implemented in 2004, and Policy C is implemented in 2006. All three policies affect the same set of sources. In any monitoring period, the sum of individual GHG effects from A, B, and C will equal the combined GHG effects from A, B, and C if:

- The baseline scenario for Policy A includes neither Policy B nor Policy C;
- The baseline scenario for Policy B includes Policy A but not Policy C;
- The baseline scenario for Policy C includes both Policy A and Policy B; and
- The emissions estimation method used for each scenario is the same.

**Figure B.4** **Aggregating GHG effects across policies**



# *Appendix C*
# *Examples of Non-GHG Effects*

**This standard is designed to inform policy development through estimation of GHG effects. In practice, policymakers will decide which policies to implement and how to evaluate their effectiveness within a broader context that also takes into account various impacts in addition to greenhouse gas emissions.**

Non-GHG effects are any effects of a policy or action other than changes in GHG emissions and may include a wide range of social, economic, and environmental impacts. Table C.1 provides a list of non-GHG effects that may be relevant depending on the objectives of a given assessment.

Any non-GHG effects may be identified alongside GHG effects while developing the causal chain (Chapter 6) and included in the GHG assessment boundary (Chapter 7). The non-GHG effects of policies and actions may be estimated by subtracting baseline values for the non-GHG effect (in Chapter 8) from policy scenario values for the non-GHG effect (in Chapters 9 or 11). Indicators related to non-GHG effects may be monitored over time (Chapter 10), as illustrated in Box 10.2. Quantification methods and data sources will vary by type of non-GHG effect. For example, to estimate macroeconomic effects such as effects on GDP, employment, or trade, users should use computable general equilibrium or other economic models. Users may choose to identify and qualitatively describe the non-GHG effects of a policy or action, rather than quantitatively estimating them.

**Table C.1 Examples of non-GHG effects**

| Category | Examples of non-GHG effects | |
|---|---|---|
| **Environmental effects** | • Air quality and air pollution (such as particular matter, ozone, carbon monoxide (CO), sulfur dioxide ($SO_2$), nitrogen oxides ($NO_x$), lead, and mercury)<br>• Water quality, water pollution, and water scarcity<br>• Ozone depletion<br>• Waste | • Toxic chemical/pollutants<br>• Biodiversity/wildlife loss<br>• Loss or degradation of ecosystem services<br>• Deforestation and forest degradation<br>• Loss of top soil<br>• Loss or degradation of natural resources<br>• Energy use |
| **Social effects** | • Public health<br>• Quality of life<br>• Gender equality<br>• Traffic congestion | • Road safety<br>• Walkability<br>• Access to energy, thermal comfort, fuel poverty<br>• Stakeholder participation in policy-making processes |
| **Economic effects** | • Employment and job creation<br>• Productivity (such as agricultural yield)<br>• Prices of goods and services (such as decreased energy prices)<br>• Cost savings (such as decreased fuel costs)<br>• Overall economic activity (such as GDP) | • Household income<br>• Poverty reduction<br>• New business/investment opportunities<br>• Energy security/independence<br>• Imports and exports<br>• Inflation<br>• Budget surplus/deficit |

# *Appendix D*
# *Cost-Effectiveness and Cost-Benefit Analysis*

**This standard is designed to help inform policy development through estimation of GHG effects (see Chapter 2). In practice, policymakers will decide which policies to implement and how to evaluate their effectiveness within a broader context that also takes into account costs and a wider set of benefits.**

This appendix describes various cost analysis and decision support methods that can be used: cost-effectiveness analysis (CEA), cost-benefit analysis (CBA), and multicriteria analysis (MCA). These methods allow policymakers and analysts to evaluate and compare various options before implementation (to inform policy development ex-ante) or outcomes after implementation (to track performance ex-post), not only in terms of their GHG effects but also through a broader assessment of benefits and costs.

By following the steps in this standard, users determine the total net change in GHG emissions and removals caused by a policy or action. This GHG effect represents the effectiveness of the policy in reducing emissions, which is a fundamental input into any CEA, CBA, or MCA related to GHG emissions. After implementing this standard to estimate the total net GHG effect of a policy or action, users can optionally apply CEA, CBA, or MCA to the same policy or action.

## D.1 Comparison of methods

Cost-effectiveness analysis, cost-benefit analysis, and multicriteria analysis can be useful tools for policy evaluation. CEA compares the effectiveness of a policy to its costs and therefore requires two parameters: a measure of effectiveness and a measure of costs. CBA compares the benefits of a policy to its costs, and therefore requires two (or more) parameters: measure(s) of benefits and measure(s) of costs. Multicriteria analysis (MCA) compares alternative policy options, given multiple objectives (such as various environmental, social, and economic objectives), but, unlike CBA, it does not require that all benefits be quantified in monetary terms. See Table D.1 for a summary of the three approaches.

## D.2 Process for carrying out cost-effectiveness analysis and cost-benefit analysis

Table D.2 describes the process for carrying out CEA and CBA. Some steps are common to both methods.

The results of CEA can be presented using GHG abatement cost curves (sometimes called marginal abatement cost curves, or MAC curves). This step may be useful in ex-ante assessment to inform decision making in terms of selecting policies and actions among a set of policy options. A GHG abatement cost curve presents the cost and GHG reduction (or "abatement") potential of various mitigation options relative to a baseline scenario. GHG abatement cost curves can be presented as either a histogram or a curve. In either case, the following information is represented graphically to help policymakers prioritize mitigation options based on cost:

- The GHG reduction potential (in t $CO_2e$) of each mitigation option (as estimated ex-ante by using the *Policy and Action Standard*)
- The cost per tonne of $CO_2e$ reduced for each mitigation option and the total cost of each mitigation option
- The GHG reduction potential (in t $CO_2e$) and total cost across all mitigation options

For further guidance on CBA and GHG abatement cost curves, see the references below.

**Table D.1 Summary of methods**

| Method | Purpose | Advantages | Disadvantages |
|---|---|---|---|
| **Cost-effectiveness analysis (CEA)** | To compare policy options to determine which is most effective in achieving a single desired outcome for a given level of cost (such as GHG reduced per dollar), or which option achieves a given objective for the least cost | Simple method to compare policy effectiveness based on GHG emissions reduced per unit of money spent<br>Useful when benefits cannot be calculated or are uncertain | Does not consider wider benefits of the policy/action other than a single measure of effectiveness (such as GHG reduction) |
| **Cost-benefit analysis (CBA)** | To compare policy options to determine which has the greatest net benefit to society (the difference between their total social benefits and total social costs); or to analyze a single policy or action to determine whether its total benefits to society exceed its costs | Assesses broader benefits of a policy beyond a single measure of effectiveness (which may include environmental, social, and economic benefits) | Difficult to monetize non-economic benefits and determine appropriate discount rates; can underestimate non-economic benefits |
| **Multicriteria analysis (MCA)** | To compare policy options and determine the most preferred option, given multiple objectives | Incorporates a wide set of variables; does not require subjective assumptions about how to monetize non-economic benefits | Does not allow comparison of costs and benefits using a single unit of measure |

**Table D.2 Overview of steps in cost-effectiveness analysis and cost-benefit analysis**

| Step | Cost-effectiveness analysis | Cost-benefit analysis |
|---|---|---|
| **1.** | **Identify scope of the analysis** | |
| | CEA and CBA involve assessment of the impact of the policy on society as a whole. Users should include all members of the relevant society, such as in a country or a city, in the analysis. Users should define a time period that is sufficient to capture significant costs and benefits of the program, which should be consistent with the GHG assessment period defined in Chapter 7. | |
| **2.** | **Identify and estimate costs** | **Identify and estimate costs and benefits** |
| | The next step is to identify costs (and benefits) over the selected time period. Costs may include only the costs of implementing the policy (such as financial expenditures for policy implementation and compliance or costs of installing technology), or may also include the broader costs to other members of society (such as increased prices for goods and services or decreases in economic activity and income), as well as cost reductions associated with policies (such as reduced energy costs from increased energy efficiency). CBA should include a wide range of social, economic, and environmental costs and benefits. See Appendix C for potential non-GHG costs and benefits that may be included. Even though all costs and benefits cannot be known for certain, users should make a reasonable effort to identify and estimate those that are most significant. | |

**Table D.2** **Overview of steps in cost-effectiveness analysis and cost-benefit analysis (continued)**

| Step | Cost-effectiveness analysis | Cost-benefit analysis |
|---|---|---|
| **3.** | **Quantify effectiveness** | **Quantify and monetize benefits** |
| | Effectiveness is a measure of the quantifiable outcome central to the program's objectives. CEA typically involves only one measure of effectiveness. In this standard, it is assumed that the single measure of effectiveness is the total net change in GHG emissions and removals resulting from the policy or action (as quantified by applying this standard). | CBA involves quantifying a broader set of benefits and then assigning a monetary value as a proxy to represent benefits for social and environmental impacts that may not have an explicit economic or monetary value. CBA is dependent on the assumption that the value of non-economic impacts can be represented by the value that individuals are willing to pay to preserve or avoid damages. However, some benefits may be intangible, uncertain, subjective, or controversial to monetize. See Box D.1 for information on monetizing the benefits of avoiding climate change impacts. |
| **4.** | **Calculate present values for costs (and benefits)** | |
| | In economic theory, monetary impacts in the future are worth less to individuals than resources available today, since individuals can earn a return on investment on money they possess today, which they forego when receiving the same amount of money in the future. Thus, both CEA and CBA typically convert monetary values to their present value (or their equivalent value at the beginning of the policy or action) by using a discount rate. For GHG-related analyses, users should use a social discount rate, which reflects a society's relative valuation of today's well-being versus well-being in the future. Social discount rates can vary widely (for example, from 0% to over 10%), depending on how they address equity concerns with respect to future generations, among other considerations not accounted for in national interest rates or typical discount rates. (For more information on social discount rates, refer to ADB 2007). Present value is calculated as follows: $$PV = \frac{V_Y}{(1+r)^t}$$ Where PV = present value, $V_Y$ = Value in a particular year, r = discount rate, and t =number of years from present. | |
| **5.** | **Calculate cost-effectiveness** | **Calculate net present value** |
| | CEA results in a ratio of costs to effectiveness, as follows: $$\text{cost effectiveness} = \frac{PV(c)}{\text{effectiveness}} = \frac{\sum_{t=0}^{n} \frac{C_t}{(1+r)^t}}{\text{net reduction in t } CO_2e}$$ C = costs, t = year, n = analysis period | Once present values for costs and benefits are calculated, the result of the CBA is represented as the net present value (NPV) of all benefits and costs, representing the net social benefit: $$NPV = PV(B) - PV(C)$$ $$NPV = \sum_{t=0}^{n} \frac{B_t}{(1+r)^t} - \sum_{t=0}^{n} \frac{C_t}{(1+r)^t}$$ B = benefits, C = costs, t = year, n = analysis period |

**Box D.1 Monetizing the benefits of avoiding climate change impacts**

The social cost of carbon (SCC) is a concept used to monetize climate change impacts. The SCC reflects the marginal benefits that society gains by avoiding an additional ton of $CO_2e$ emitted, expressed in the form of annual monetized costs. The SCC often includes changes in agriculture, human health, property, and ecosystem services in its derivation. While it is a useful concept, uncertainty about the timing and severity of climate change impacts and significant regional variation pose a challenge for quantifying damages from climate change. The timing of potential catastrophes in the future to be fed into a CBA can be difficult to determine, and the choice of a discount rate for SCC calculations results in widely ranging estimates. The use of SCC in a CBA can be valuable for decision making as long as uncertainties are acknowledged.

## D.3 Multicriteria analysis

Multicriteria analysis is a method for comparing alternative policy options and determining the most preferred option, given multiple objectives, such as various environmental, social, and economic objectives. Indicators related to each objective can be measured in various units, including monetary or non-monetary units, and can be quantitative or qualitative. For example, various environmental and social objectives may be measured using non-monetary indicators, while economic costs and benefits may be measured using monetary indicators. MCA involves establishing a given set of options, a set of criteria for comparing the options, and a method for ranking the options. MCA can be especially useful when significant environmental and social impacts exist and cannot readily be assigned monetary values. A CEA and/or CBA can also feed into the process of conducting an MCA. For further guidance on MCA, see the following references.

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# Abbreviations and Acronyms

| | |
|---|---|
| **AFOLU** | agriculture, forestry, and other land use |
| **AMVA** | Area Metropolitana del Valle de Aburra (Antioquia, Colombia) |
| **ANME** | National Agency for Energy Conservation (Tunisia) |
| **BAU** | business as usual |
| **Btu** | British thermal unit |
| **CAI** | Clean Air Institute |
| **CBA** | cost-benefit analysis |
| **CDM** | Clean Development Mechanism |
| **CEA** | cost-effectiveness analysis |
| **$CH_4$** | methane |
| **CO** | carbon monoxide |
| **$CO_2$** | carbon dioxide |
| **$CO_2e$** | carbon dioxide equivalent |
| **EE** | energy efficiency |
| **EEG** | Renewable Energy Act (Germany) |
| **EJ** | exajoule |
| **ETS** | emissions trading system |
| **FAO** | Food and Agriculture Organization of the United Nations |
| **g** | grams |
| **GDP** | gross domestic product |
| **GHG** | greenhouse gas |
| **GIZ** | Gesellschaft für Internationale Zusammenarbeit (German Corporation for International Cooperation) |
| **GWP** | global warming potential |
| **HCFC** | hydrochlorofluorocarbon |
| **HFC** | hydrofluorocarbon |
| **IEA** | International Energy Agency |
| **IGES** | Institute for Global Environmental Strategies |
| **IPCC** | Intergovernmental Panel on Climate Change |
| **kg** | kilogram |
| **km** | kilometer |
| **kWh** | kilowatt-hour |
| **kWp** | kilowatt-peak |
| **LEAP** | Long-Range Energy Alternatives Planning System |
| **LEDS** | low emissions development strategy |
| **LPG** | liquefied petroleum gas |
| **LULUCF** | land use, land-use change, and forestry |
| **MAC** | marginal abatement cost |
| **MCA** | multicriteria analysis |
| **MMBtu** | 1 million Btu |
| **MSW** | municipal solid waste |
| **Mt** | million tonnes |
| **Mtce** | million tonnes of coal equivalent |
| **Mt $CO_2e$** | million tonnes of carbon dioxide equivalent |
| **NAMA** | nationally appropriate mitigation action |
| **$NF_3$** | nitrogen trifluoride |
| **NGO** | non-governmental organization |
| **$NH_3$** | ammonia |
| **NMVOC** | non-methane volatile organic compound |
| **$NO_x$** | nitrogen oxide |
| **$N_2O$** | nitrous oxide |
| **OECD** | Organisation for Economic Co-operation and Development |
| **PFC** | perfluorocarbon |

| | |
|---|---|
| **PV** | photovoltaic |
| **QA** | quality assurance |
| **QC** | quality control |
| **RD&D** | research, development, and deployment |
| **REC** | renewable energy certificate |
| **SCC** | social cost of carbon |
| **SEI** | Stockholm Environment Institute |
| **$SF_6$** | sulfur hexafluoride |
| **$SO_2$** | sulfur dioxide |
| **SWH** | solar water heater |
| **t** | tonne (metric ton) |
| **T&D** | transmission and distribution |
| **UNDP** | United Nations Development Programme |
| **UNFCCC** | United Nations Framework Convention on Climate Change |
| **WBCSD** | World Business Council for Sustainable Development |
| **WRI** | World Resources Institute |

# Glossary

| | |
|---|---|
| **Absolute value** | The non-negative value of a number without regard to its sign. For example, the absolute value of 5 is 5, and the absolute value of -5 is also 5. |
| **Action** | See "policy or action." |
| **Activities** | When used as a type of indicator, the administrative activities involved in implementing the policy or 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 GHG emissions. Activity data is multiplied by an emissions factor to derive the GHG 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 traveled, and floor area of a building. |
| **Adopted policies and actions** | 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. |
| **Baseline emissions** | An estimate of GHG emissions, removals, or storage associated with a baseline scenario. |
| **Baseline scenario** | A reference case that represents the events or conditions most likely to occur in the absence of the policy or action (or package of policies or actions) being assessed. |
| **Baseline value** | The value of a parameter in the baseline scenario. |
| **Black carbon** | A climate forcing agent formed through the incomplete combustion of fossil fuels, biofuel, and biomass. |
| **Bottom-up data** | Data that are 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 GHG emissions for each source, project, or entity, then aggregate across all sources, projects, or entities to determine the total change in GHG emissions. |
| **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. |
| **Causal chain** | A conceptual diagram tracing the process by which the policy or action leads to GHG 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 (GWP) of each greenhouse gas, expressed in terms of the GWP of one unit of carbon dioxide. It is used to evaluate different greenhouse gases against a common basis. |

**Drivers** Socioeconomic or other conditions or other policies/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 policy or action. See intermediate effects, GHG effects, and non-GHG effects.

**Emission factor** A factor that converts activity data into GHG emissions data. For example, kg $CO_2$e emitted per liter of fuel consumed.

**Emissions** The release of greenhouse gases into the atmosphere.

**Emissions estimation method** An equation, algorithm, or model that quantitatively estimates GHG emissions. For example, a simple emissions estimation method is the following equation: GHG 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 GHG effects of policies and actions.

**Ex-ante baseline scenario** A forward-looking baseline scenario, typically established prior to implementation of the policy or 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 (IPCC 2006).

**Ex-post assessment** The process of estimating historical GHG effects of policies and actions.

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

**Free rider effect** Participants in a policy or program who would have implemented the technologies, practices, or processes associated with the policy or program in the absence of the policy or program.

**GHG** See greenhouse gas.

**GHG assessment** The estimation of changes in GHG emissions and removals resulting from a policy or action, either ex-ante or ex-post.

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

**GHG assessment period** The time period over which GHG effects resulting from the policy or action are assessed.

| | |
|---|---|
| **GHG effects** | Changes in GHG emissions by sources and removals by sinks that result from a policy or action. |
| **Global warming potential (GWP)** | A factor describing the radiative forcing impact (degree of harm to the atmosphere) of one unit of a given GHG relative to one unit of $CO_2$. |
| **Greenhouse gas (GHG)** | For the purposes of this standard, GHGs are the seven gases covered by the UNFCCC: carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2O$), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride ($SF_6$), and nitrogen trifluoride ($NF_3$). |
| **Implemented policies and actions** | 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 and are in force, (c) financial resources have been allocated, or (d) human resources have been mobilized. |
| **Independent policies** | Policies that do not interact with each other, such that the combined effect of implementing the policies together is equal to the sum of the individual effects of implementing them separately. |
| **Indicator** | See key performance indicator. |
| **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. |
| **Inputs** | Resources that go into implementing a policy or action, such as financing. |
| **Intended effects** | Effects that are intentional based on the original objectives of the policy or action. |
| **Interacting policies** | Policies that produce total effects, when implemented together, that differ from the sum of the individual effects had they been implemented separately. |
| **Intermediate effects** | Changes in behavior, technology, processes, or practices that result from a policy or action. |
| **Jurisdiction** | The geographic area within which an entity's (such as a government's) authority is exercised. |
| **Key performance 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. |
| **Leakage** | An increase in emissions outside the jurisdictional boundary that results from a policy or action implemented within that jurisdiction. |
| **Life-cycle effects** | Changes in upstream and downstream activities, such as extraction and production of energy and materials, or effects in sectors not targeted by the policy, resulting from the policy or action. |
| **Long-term effects** | Effects that are more distant in time, based on the amount of time between implementation of the policy and the effect. |
| **Macroeconomic effects** | Changes in macroeconomic conditions—such as GDP, income, employment, or structural changes in economic sectors—resulting from the policy or action. |
| **Market effects** | Changes in supply and demand or changes in prices resulting from the policy or action. |

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

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

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

**Net GHG emissions** The aggregation of GHG emissions (positive emissions) and removals (negative emissions).

**Non-GHG effects** Changes in environmental, social, or economic conditions other than GHG emissions or climate change mitigation that result from a policy or 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 GHG 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 policy or action, such as weather variations.

**Other policies or actions** Policies, actions, and projects—other than the policy or action being assessed—that are expected to affect the emissions sources and sinks included in the GHG 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.

**Overlapping policies** Policies that interact with each other and that, when implemented together, have a combined effect less than the sum of their individual effects when implemented separately. This includes both policies that have the same or complementary goals (such as national and subnational energy efficiency standards for appliances), as well as policies that have different or opposing goals (such as a fuel tax and a fuel subsidy). The latter are sometimes referred to as counteracting policies.

**Parameter** A variable such as activity data or an emission factor that is part of an emissions estimation method. For example, "emissions per kWh 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 uncertainty** Uncertainty regarding whether a parameter value used in the assessment accurately represents the true value of a parameter.

**Parameter value** The value of a parameter. For example, 0.5 is a parameter value for the parameter "emissions per kWh of electricity."

**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.

**Planned policies and actions** 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 or implemented.

**Policy or action** An intervention taken or mandated by a government, institution, or other entity, which may include laws, regulations, and standards; taxes, charges, subsidies, and incentives; information instruments; voluntary agreements; implementation of new technologies, processes, or practices; and public or private sector financing and investment, among others.

**Policy implementation period** The time period during which the policy or action is in effect.

**Policy monitoring period** The time over which the policy is monitored. This may include pre-policy monitoring and post-policy monitoring in addition to monitoring during the policy implementation period.

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

**Policy scenario emissions** An estimate of GHG emissions and removals associated with the policy scenario.

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

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

**Rebound effect** Marginal increases in energy-using activities or behavior 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 policies** Policies 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 GHG emissions from the atmosphere through sequestration or absorption, such as when $CO_2$ is absorbed by biogenic materials during photosynthesis.

**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 policy and the effect.

**Sink** Any process, activity, or mechanism that increases storage or removals of greenhouse gases from the atmosphere.

**Source** Any process, activity, or mechanism that releases 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 policy or action being assessed (also called multiplier effects).

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

**Top-down data** Macro-level statistics collected at the jurisdiction or sector level, such as energy use, population, GDP, or fuel prices.

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

**Trade effects** Changes in imports and exports resulting from the policy or action.

**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 policy or action. Unintended effects may include a variety of effects, such as rebound effects, lack of compliance or enforcement, effects on behavior once a policy is announced but before it is implemented, and effects on members of society not targeted by the policy or action.

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## Dedication

This standard is dedicated to Andrei Bourrouet, a member of the Advisory Committee, who passed away in 2013. Andrei was the environmental representative from the Costa Rican Institute of Electricity, and formerly the Viceminister of Energy and Environmental Management at the Costa Rican Ministry of Environment, Energy, and Telecommunications. Andrei devoted his career to furthering climate change policymaking in Costa Rica and internationally.

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Natural resources are at the foundation of economic opportunity and human well-being. But today, we are depleting Earth's resources at rates that are not sustainable, endangering economies and people's lives. People depend on clean water, fertile land, healthy forests, and a stable climate. Livable cities and clean energy are essential for a sustainable planet. We must address these urgent, global challenges this decade.

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