Greenhouse Gas Protocol

Policies and Actions Accounting and Reporting Standard

First Draft for Review Group

November 2012

Introduction to this draft

This is the first draft of the *GHG Protocol Policies and Actions Standard* for review by the Review Group. This draft was developed by the Technical Working Groups (TWGs) between June and October 2012, with strategic input from the Advisory Committee. A preliminary version of this draft was reviewed by the Advisory Committee and Technical Working Groups in October 2012 and revised based on their feedback. This draft will subsequently be revised based on stakeholder feedback and pilot testing. See the table below for the full standard development timeline. Events relevant to the Review Group are marked in bold. Our current place in the timeline is marked in red.

Standard development timeline

Month	Activity
June 2012	First Advisory Committee meeting (June 6-7) First Technical Working Group (TWG) conference calls
June - August	TWG conference calls every two weeks (of both TWG#1 and TWG#2)
September	In-person TWG meeting (September 11-12)
October	Preliminary first draft (without sector detail) sent to Advisory Committee and TWGs for review (October 23 - November 5)
November	Preliminary first draft revised **First draft sent to Review Group (November 21 for review through January 11)**
December	**Stakeholder workshops to get feedback on first draft (in Doha/COP18 on December 2, Washington DC on December 13, and Beijing on December 19)**
January 2013	Stakeholder feedback compiled Sector sub-groups begin develop sector guidance/examples TWG call to discuss stakeholder feedback
February	Advisory Committee meeting #2 to discuss stakeholder feedback Sector sub-groups complete sector guidance/examples Preliminary second draft (with sector detail) compiled and sent to Advisory Committee and TWG
March	Preliminary second draft revised based on Advisory Committee and TWG feedback **Second draft (for pilot testing) completed**
April - August	Pilot testing in several countries/sectors (and pilot testing workshops)
September/ October	Technical Working Group meeting #2 to discuss pilot testing feedback Second draft revised based on pilot testing feedback (in consultation with Advisory Committee and TWGs)
November	**Final draft circulated for public comment**
Early 2014	Final draft revised **Standard published**

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Chapter 1: Introduction

Emissions of the anthropogenic greenhouse gases (GHG) that drive climate change and its impacts around the world are growing. According to climate scientists, global carbon dioxide emissions must be cut by as much as 85 percent below 2000 levels by 2050 to limit global mean temperature increase to 2 degrees Celsius above pre-industrial levels.[1] Temperature rise above this level will produce increasingly unpredictable and dangerous impacts for people and ecosystems. As a result, the need to accelerate efforts to reduce anthropogenic GHG emissions is increasingly urgent.

Countries, sub-national jurisdictions, financial institutions, and private sector organizations are planning and implementing a variety of climate change mitigation policies and actions, and many are also aiming to minimize the greenhouse gas impacts from other policies and actions they are undertaking. As a result, there is a growing need to quantify and communicate the greenhouse gas impacts of policies and actions in order to: design more effective policies; assess different policy options; evaluate policy effectiveness; track and report progress over time; estimate the overall impact of climate change mitigation programs; attract financial support for mitigation actions; and report to funders, among other needs.

Effective mitigation strategies require effective design, monitoring, and evaluation methodologies to ensure that policies and actions are sufficient to achieve GHG reduction goals and are effective in achieving their intended results.

1.1 The Greenhouse Gas Protocol

The Greenhouse Gas Protocol (GHG Protocol) is a multi-stakeholder partnership of businesses, nongovernmental organizations (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 greenhouse gas (GHG) accounting and reporting standards and tools, and to promote their adoption in order to achieve a low emissions economy worldwide.

The GHG Protocol has produced the following separate but complementary standards, protocols, and guidelines:

- ***GHG Protocol Corporate Accounting and Reporting Standard* (2004):** A standardized methodology for companies to quantify and report their corporate GHG emissions. Also referred to as the *Corporate Standard*.
- ***GHG Protocol for Project Accounting* (2005):** A guide for quantifying reductions from GHG-mitigation projects. Also referred to as the *Project Protocol.*
- ***GHG Protocol Land Use, Land-Use Change, and Forestry Guidance for GHG Project Accounting* (2006):** A guide to quantify and report reductions from land use, land-use change, and forestry, to be used in conjunction with the *Project Protocol.*
- ***GHG Protocol Guidelines for Quantifying GHG Reductions from Grid-Connected Electricity Projects* (2007):** A guide for quantifying reductions in emissions that either generate or reduce the consumption of electricity transmitted over power grids, to be used in conjunction with the *Project Protocol.*
- ***Measuring to Manage: A Guide to Designing GHG Accounting and Reporting Programs* (2007):** A guide for program developers on designing and implementing effective GHG programs based on accepted standards and methodologies.

[1] IPCC, Summary for Policymakers (Table SPM.5: Characteristics of post-TAR stabilization scenarios), in Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, ed. B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press, 2007).

- ***GHG Protocol for the U.S. Public Sector* (2010):** A step-by-step approach to measuring and reporting emissions from public sector organizations, complementary to the *Corporate Standard.*
- ***GHG Protocol Corporate Value Chain (Scope 3) Accounting and Reporting Standard* (2011):** A standardized methodology for companies to quantify and report their corporate value chain (scope 3) GHG emissions, to be used in conjunction with the *Corporate Standard*. Also referred to as the *Scope 3 Standard*.
- ***GHG Protocol Product Life Cycle Accounting and Reporting Standard* (2011):** A standardized methodology to quantify and report GHG emissions associated with individual products throughout their life cycle. Also referred to as the *Product Standard*.

1.2 Purpose of this standard

The *GHG Protocol Policies and Actions Accounting and Reporting Standard* (also referred to as the *Policies and Actions Standard*) provides requirements and guidance for organizations to quantify and report the change in GHG emissions resulting from the implementation of policies and actions. A policy is a plan of action adopted or pursued by an individual, government, business, or other party, and an action is an organized activity intended to achieve an objective. See section 1.4 for specific types of policies and actions.

This standard is designed to create more international consistency and transparency in the way national and sub-national governments, donor agencies and financial institutions, businesses, and civil society organizations quantify and report GHG reductions from policies and actions.

This standard is intended to guide users in answering the following questions:

- Before policy implementation: What effect is a given policy or action likely to have on GHG emissions?
- During policy implementation: How to track progress of a policy or action over time?
- During and after policy implementation: 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 evaluate the GHG effects of policies and actions in an accurate, consistent, transparent, complete, and relevant way, through the use of standardized approaches and principles
- To help decision-makers develop effective strategies for managing and reducing GHG emissions through a better understanding of expected and achieved emissions impacts
- To support consistent and transparent public reporting of emissions impacts and policy effectiveness according to a standardized set of reporting requirements.

1.3 Intended users

This standard is intended for a wide range of organizations and institutions, including government agencies at any level (e.g., national, state, provincial, municipal), donor agencies and financial institutions, companies, non-governmental organizations, and research institutions. Throughout this standard, the term "user" refers to the entity implementing the standard.

Examples of applicability to each type of audience include:

- **Governments (municipal, subnational, national):** Quantify GHG effects of policies and programs (e.g., energy efficiency programs, performance standards, emissions trading programs, taxes, incentives)
- **Donor agencies and financial institutions:** Quantify GHG effects of grants or loans (e.g., to support low emissions development strategies)

- **Businesses:** Quantify GHG effects of large-scale actions (e.g., deployment of new product lines or technologies)
- **Civil society organizations, NGOs, academia, and research institutions:** Carry out assessments of GHG effects from any of the above types of actions

1.4 Scope of the standard

This standard is designed to account for changes in GHG emissions resulting from policies and actions over a defined assessment period. It covers steps related to monitoring, reporting, and verification. The methodology is policy-neutral[2] and its use is voluntary. The methodology covers the seven greenhouse gases covered by the UNFCCC and Kyoto Protocol: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6), and nitrogen trifluoride (NF_3).

This standard is applicable to:

- All geographies (i.e., it is internationally applicable)
- All levels of government (municipal, subnational, national)
- Policies and actions in all sectors (e.g., in the energy supply, buildings, industry, transportation, waste, and AFOLU (agriculture, forestry, and other land use) sectors) as well as to cross-sector policy instruments (e.g., emissions trading programs, carbon taxes)
- All types of policies (e.g., regulations and standards, emissions trading programs, taxes and charges, subsidies and incentives, information instruments, research and development policies, voluntary agreements) by providing overarching principles, concepts, and procedures applicable to all policy types, though different methods are needed for different types of policies and some types are more difficult to evaluate than others
- Other types of actions, such as private sector actions (e.g., deployment of low-emission products or technologies), financing to support low emissions development strategies or policies, and government strategies that are framed in terms of desired outcomes (e.g., reducing deforestation or increasing renewable energy generation by 20% by 2020)
- Any policy or action, including policies and actions intended to reduce GHG emissions, policies and actions intended to meet non-GHG goals, and policies and actions that increase emissions.
- Both ex-ante assessment (i.e., quantifying future GHG effects of policies and actions before implementation) and ex-post assessment (i.e., quantifying historical GHG effects of policies and actions after implementation), which are further described in Chapter 3.

1.5 Relationship to GHG inventory accounting

National, subnational, and organizational GHG inventories are critical for enabling government agencies and companies/organizations to track changes in overall GHG emissions at a national, subnational, or organizational level. All jurisdictions and organizations should develop a GHG inventory as a first step to managing GHG emissions, following established standards such as the *GHG Protocol Corporate Standard* for companies and organizations, the IPCC *Guidelines for National Greenhouse Gas Inventories* for national governments, or the C40/ICLEI/WRI *Global Protocol for Community Emissions* for cities and sub-national jurisdictions.

However, changes in GHG inventories over time do not explain why emissions have grown or declined or reveal the effects of individual policies or actions compared to what would have happened in the absence of those policies and actions (i.e., a baseline scenario). Policy-level accounting is critical to achieving additional GHG management objectives, such as designing mitigation strategies and tracking GHG performance of individual policies and actions, and should be carried out as a complement to developing and updating a GHG inventory on a regular basis.

[2] "Policy-neutral" means the methodology is generic and not biased toward any specific policy instruments or policy agenda.

1.6 Relationship to the GHG Protocol for Project Accounting

This standard is based on a similar accounting framework and sequence of steps as the *GHG Protocol for Project Accounting* (or *Project Protocol*). Both involve quantifying changes in GHG emissions from the implementation of an action relative to a baseline scenario that defines what would have happened in the absence of that action. However, the *Project Protocol* applies to individual projects only (e.g., an individual solar photovoltaic installation), while this standard applies to policies and actions at a larger scale than an individual project (e.g., renewable energy policies at the sectoral or jurisdiction level). In addition, this standard is intended to support multiple objectives (see chapter 2), while project accounting is typically focused primarily on crediting or offsetting. This standard also addresses new methodological issues not common in project accounting, such as quantifying overlaps and interactions between policies or actions in a sector, setting a baseline at a larger scale than a project, and identifying and quantifying indirect or secondary effects at a scale larger than a project (e.g., international leakage of GHG emissions, which is further discussed in Chapter 6).

1.7 Relationship to the GHG Protocol Mitigation Goals Standard

The *GHG Protocol Policies and Actions Standard* and *GHG Protocol Mitigation Goals Standard* are both relevant to government jurisdictions and are intended to support tracking of progress toward meeting 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.

The *Policies and Actions Standard* accounts for GHG effects of specific policies and actions undertaken by a jurisdiction or organization, while the *Mitigation Goals Standard* accounts for overall progress toward national or subnational GHG reduction goals (see Table 1.1). Together with guidelines for developing national, subnational, or organizational GHG inventories (see section 1.5), the two standards provide a comprehensive approach to jurisdictions' GHG measurement and management.

The user's objectives should drive the use of a particular GHG Protocol accounting standard. The *Policies and Actions Standard* enables a user to understand the future expected effects and past observed effects of individual policies and actions, as a means toward achieving GHG reduction goals, while the *Mitigation Goals Standard* enables users to track overall progress toward meeting those goals based on observed changes in emissions relative to the goal level.

While each standard can be implemented independently, both standards are mutually supportive. For example, users can apply the *Mitigation Goals Standard* to understand the level of GHG reductions needed to meet a given GHG mitigation goal, then use the *Policies and Actions Standard* to quantify the GHG effects of selected policies and actions to determine if they are collectively sufficient to meet the goal. Conversely, users can first apply the *Policies and Actions Standard* to quantify expected GHG reductions from various mitigation policies and actions to understand the range of possible GHG reductions, then use the *Mitigation Goals Standard* to set a mitigation goal and track and report progress.

The effects of mitigation policies and actions should be reflected in an annual GHG inventory and ultimately help jurisdictions meet their GHG mitigation goals. However, in practice their effect may not be seen, especially if mitigation policies and actions are avoiding emissions relative to a baseline scenario, but not leading to absolute reductions in emissions.

Table 1.1: Comparison of GHG Protocol Policies and Actions Standard and Mitigation Goals Standard

Standard	Description
Policies and Actions Standard	Quantifying changes in GHG emissions and removals caused by specific policies and actions, relative to a baseline scenario. Examples include: change in emissions caused by increased energy efficiency, increased renewable energy, regulations and standards, trading programs, deployment of new technologies.
Mitigation Goals Standard	Tracking and reporting overall progress toward national or sub-national GHG emission goals, and quantifying GHG reductions associated with goals. Examples include: GHG reductions from a base year, GHG reductions from a baseline scenario, reductions in emissions intensity, or reductions to an absolute amount of emissions (e.g., zero in the case of carbon neutrality).

1.8 Relationship to cost-effectiveness analysis or cost-benefit analysis

The output from using this standard will be a value showing the change in GHG emissions caused by a policy or action, in tonnes of CO_2e. Such GHG values can then subsequently be used as for a cost-effectiveness analysis of the policy or action, or the GHG value can be converted into a monetary value and used within a cost-benefit analysis. This standard provides guidance for calculating the GHG value, but does not provide further guidance for conducting cost-effectiveness or cost-benefit analysis. More information on analyzing cost-effectiveness is expected to be provided in Appendix B.

1.9 GHG calculation tools and guidance

To help users implement the *Policies and Actions Standard*, the GHG Protocol website provides a variety of GHG calculation tools and guidance, including several cross-sector and sector-specific calculation tools, which provide step-by-step guidance, together with electronic worksheets to help users calculate GHG emissions from specific sources or sectors. All GHG calculation tools and guidance are available at www.ghgprotocol.org.

Users should consult the most recent IPCC *Guidelines for National Greenhouse Gas Inventories* (e.g., 2006) for guidance on quantifying GHG emissions from sources and removals by sinks. Users should also refer, as appropriate, to the *GHG Protocol for Project Accounting* and two related sector-specific guidelines: *GHG Protocol Guidelines for Quantifying GHG Reductions from Grid-Connected Electricity Projects* and *The Land Use, Land-Use Change, and Forestry (LULUCF) Guidance for GHG Project Accounting*. All GHG Protocol publications are available at www.ghgprotocol.org.

Users should also consult Appendix A for guidance on the collection, collation, and analysis of data.

1.10 Sector-specific guidance

This standard provides a general framework (i.e., overarching principles, concepts, and procedures) applicable to all sectors and types of policies and actions. Chapters 5 through 11 also include sector-specific guidance and examples for six sectors (i.e., energy supply, residential/commercial buildings, transportation, AFOLU, waste, and industry) as well as guidance and examples for selected cross-sector policy instruments. In addition, Appendix B provides a worked example for a biofuels policy. Beyond the guidance provided in this standard, additional sector-specific guidance may be needed in the future to provide more detailed quantification methodologies at a sector level. Visit www.ghgprotocol.org for existing sector guidance and calculation tools available or new sector guidance and tools under development.

1.11 Accounting for non-GHG impacts of policies and actions (co-benefits or other environmental, social, economic effects)

This standard is designed to help users quantify the GHG effect of policies and actions. However, policies and actions are implemented to meet multiple objectives. GHG mitigation policies may be implemented to meet GHG reduction goals as well as various other environmental, social, and economic goals. Other policies and actions may be implemented without any regard for their effect on GHG emissions or may increase emissions. In practice, decision-makers will need to understand the effect of policies and actions on a range of impacts (e.g., local air quality, energy security, public health, traffic fatalities and congestion, employment, economic activity, equity, etc.). Decision-makers should also consider adverse effects of GHG mitigation policies on other environmental impacts (e.g., fisheries impacts resulting from hydropower policies). The basic procedures outlined in this standard can also be used to quantify non-GHG impacts, especially those most clearly linked to GHG impacts (e.g., other air pollutants or energy use). However, additional quantification methods and data sources are needed to quantify non-GHG impacts beyond those that are included in this standard.

1.12 How this standard was developed

The GHG Protocol follows a broad and inclusive multi-stakeholder process to develop greenhouse gas accounting and reporting standards with participation from businesses, government agencies, NGOs, and academic institutions from around the world.

In June 2012, WRI launched a three-year process to develop the *GHG Protocol Policies and Actions Standard*. A 30-member Advisory Committee of experts provides strategic direction throughout the process. The first draft of the *Policies and Actions Standard* was developed in October 2012 by two Technical Working Groups consisting of over 50 members. In late 2012, a Review Group of over 100 members will review the draft standard and be invited to attend three stakeholder workshops (in Doha, Washington, and Beijing). In 2013, organizations from a variety of countries and sectors will pilot test the first draft and provide feedback on its practicality and usability. The standard will be published in early 2014 following additional opportunities for public comment.

1.13 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 *GHG Protocol Policies and Actions 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" may be used to provide guidance on implementing a requirement or to indicate when an action is or is not possible.

1.14 Limitations

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 quantification methodology rather than real world differences. Additional measures are necessary to enable valid comparisons, such as consistency in baseline assumptions, quantification methodologies, and data sources. Additional consistency can be provided through GHG reporting programs or more detailed sector-specific guidance (see section 1.10). To understand whether comparisons are valid, all methodologies and data sources used must be transparently reported. Comparable results can more likely be achieved if GHG assessments are undertaken by the same entity in order to ensure consistency of methodology between assessments.

Users should also exercise caution in using the methodology contained in this standard to generate GHG reductions for sale in the carbon market. This standard alone is not sufficient to support crediting. Additional specifications are necessary, including programmatic decisions about eligibility, procedures and registries for ensuring that each emission reduced is counted toward only a single goal or compliance obligation, length of crediting periods, etc. Sector-specific quantification methods are also needed beyond what is contained in this standard. However, this standard provides a foundation upon which further specifications can be built. In particular, the Tier 3 method contained in Chapters 7 through 11 should be used as the basis for any crediting programs (see Chapter 3 for an explanation of tiers).

Chapter 2: Objectives of policy accounting and reporting

Developing a GHG policy assessment is a key step towards developing effective GHG reduction strategies and effectively reducing emissions. The following objectives are frequently cited as reasons for developing a GHG assessment.

- Inform mitigation strategies based on an understanding of expected GHG effects of actions and policies (before implementation) and evaluation of actions and policies (after implementation)
- Track effectiveness and performance of policies and actions and evaluate their contribution toward meeting GHG reduction goals (after implementation)
- Report on the GHG effects of actions and policies
- Facilitate financial support for mitigation actions based on a quantification of GHG reductions, which may include market-based approaches (e.g., crediting of emission reductions)

Users should quantify the GHG effects of policies and actions with a sufficient level of accuracy to meet the stated objectives of the assessment. The level of accuracy required may vary by objective. For example, a lower level of accuracy may be sufficient to inform certain mitigation strategies depending on individual objectives, while a higher level of accuracy is needed to support market-based approaches based on quantified GHG reductions (e.g., crediting of emission reductions). Chapter 3 outlines tiered approaches that users should apply when making methodological choices depending on the objectives of the assessment.

Users should report the objective and intended audience of the GHG assessment.

[Placeholder for case studies]

Chapter 3: Key concepts, overview of steps, and summary of requirements

This chapter provides an overview of key concepts used in this standard, a summary of the steps involved in policy accounting and reporting, as well as a list of the requirements that must be followed for a GHG assessment to be in conformance with this standard.

3.1 Key concepts of policy accounting

This section outlines several key concepts of policy accounting, including:

- GHG assessment
- Accounting for changes in emissions (from policies and actions) versus accounting for emissions (in inventories)
- Ex-ante and ex-post assessment
- Attribution
- Avoiding double counting of GHG reductions
- Top-down and bottom-up approaches
- Tiered approaches

GHG assessment

This standard uses the term “GHG assessment” to refer to the quantification of changes in GHG emissions resulting from a policy or action. Typically “GHG appraisal” has been used to describe ex-ante GHG assessment, while “GHG evaluation” has been used to describe ex-post GHG assessment (see below). This standard uses “GHG assessment” to refer to both cases.

Accounting for changes in emissions (from policies and actions) versus accounting for emissions (in inventories)

This standard is intended to quantify the change in GHG emissions resulting from a policy or action, by quantifying individual GHG increases and GHG decreases resulting from the policy and determining an overall net change in emissions. This is distinct from quantifying the level of GHG emissions in a given year (typically through a GHG inventory). This standard and the *GHG Protocol for Project Accounting* are designed to account for changes in emissions, while national and subnational GHG inventories, the *GHG Protocol Corporate Standard*, *GHG Protocol Product Standard*, among others, are designed to account for emissions through GHG inventories. For more information on the relationship with GHG inventories, see section 1.5.

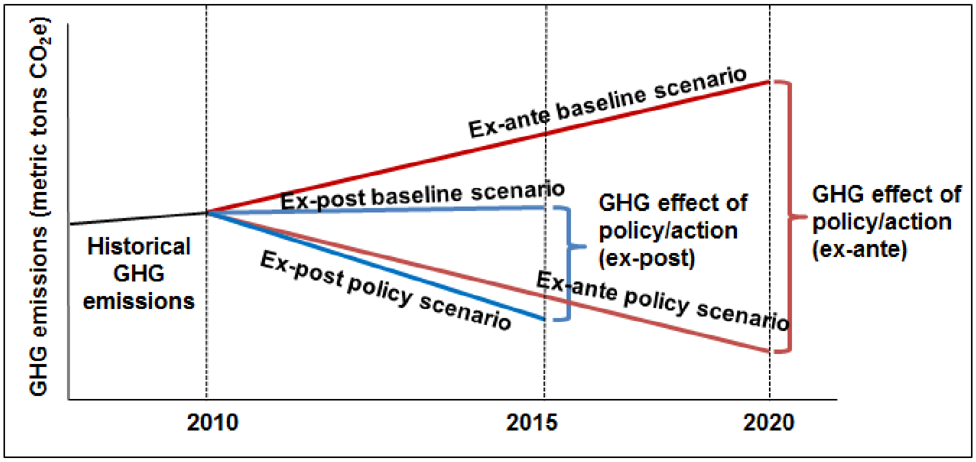
Ex-ante and ex-post assessment

Effective GHG management includes both:

- **Ex-ante assessment**: quantifying expected future GHG effects of policies and actions before their implementation
- **Ex-post assessment**: quantifying historical GHG effects of policies and actions after their implementation

See Figure 3.1 for a diagram illustrating the relationship between ex-ante and ex-post assessment. In the figure, a policy is implemented in 2010. In 2010, the expected future GHG effects of the policy through 2020 are quantified using ex-ante assessment, by defining an ex-ante baseline scenario and an ex-ante policy scenario. In 2015, the historical GHG effects of the policy to date are quantified using ex-post assessment, by defining a revised ex-post baseline scenario and ex-post policy scenario. Since conditions changed between 2010 and 2015, the quantified GHG effect of the policy differs between the ex-ante and ex-post assessment.

Figure 3.1: Relationship between ex-ante and ex-post assessment

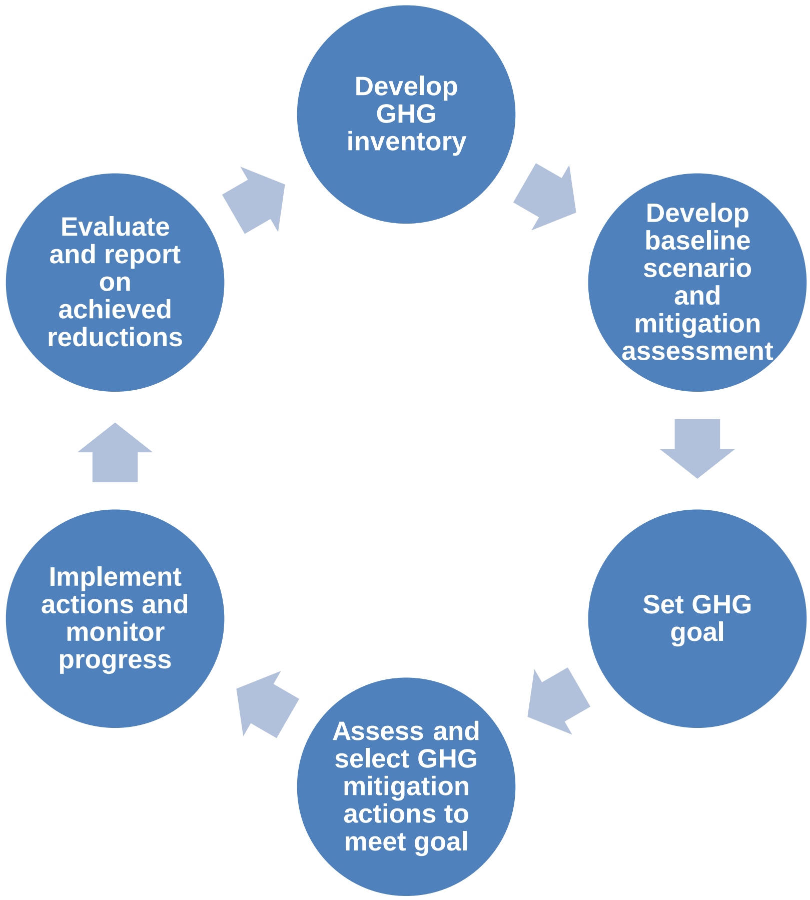


Decision-makers should apply GHG monitoring and assessment at multiple steps in the goal setting and policy cycle. Figure 3.1 outlines a sequence of steps that may be followed to set a GHG reduction goal, design and select GHG mitigation actions, implement actions, and monitor, evaluate, and report on their progress. The cycle is an iterative process whereby goal setting is informed by previous experience with policies and actions that have already been implemented. Figure 3.1 is an example only. Not all steps in Figure 3.1 may be relevant to all users.

Ex-ante assessment of policies and actions is useful for providing a quantitative basis for policy development and allows policymakers and stakeholders to assess the impact of various potential policies and actions on emissions. Ex-post assessment, on the other hand, is used to evaluate the effectiveness of implemented policies and actions, which can serve a variety of purposes, including deciding whether to continue current activities or implement additional measures; demonstrating positive effects to encourage others to implement similar activities; or meeting requirements related to financing.

The various chapters in this standard provide guidance on different steps in the cycle. See Chapter 9 for guidance on assessing expected GHG effects of policies and actions prior to implementation, Chapter 10 for guidance on monitoring progress during implementation, and Chapter 11 for guidance on evaluating progress during and after implementation. Decision-makers may choose to use only certain chapters based on their needs (e.g., if policies and actions have already been assessed and implemented, users may only need to evaluate progress after implementation).

Figure 3.1: Example of goal setting and policy cycle



Attribution

This standard is designed to support users in understanding the change in GHG emissions that is attributable to a given policy or action. Attributing changes in emissions to an individual policy or action is difficult since GHG emissions change in a given jurisdiction or region for a wide variety of reasons, including:

- The effects of the policy or action being assessed
- The effects of other implemented policies or actions that affect the same emissions sources
- The effects of various external factors that affect emissions, such as changes in economic activity, population, energy prices, weather, autonomous technological improvements, structural shifts in the economy, etc.

For example, a jurisdiction may implement a GHG mitigation policy in the electricity sector and then observe that energy-related emissions in the following year have declined. However, just because emissions have decreased does not mean that the policy has caused a decrease in emissions. Correlation does not prove causation. In actuality, emissions may have declined because an economic downturn reduced demand for electricity, not because the policy has been successful.

Analysis is required to understand not only whether emissions have changed, but why they have changed, which involves attributing changes in GHG emissions to various factors, including the policy or action in question. This standard provides a methodology to attribute GHG reductions to individual policies and actions rather than other policies and actions or various external factors that affect emissions.

Avoiding double counting of GHG reductions

Multiple actors in society may implement similar or overlapping actions and each may claim GHG reductions resulting from their actions. For example, a government agency may implement a policy encouraging use of a more efficient technology, while businesses in that jurisdiction may deploy those same efficient technologies. Financial institutions may also provide financing to support the switch to a new technology. If the government agency, the affected businesses, and the financial institutions each claimed the same GHG reductions associated with implementing the same actions, the result would be double (or triple) counting.

GHG accounting for policies and actions is intended to facilitate the simultaneous action of multiple entities to reduce emissions throughout society. However, double counting between claimed reductions should be avoided. To avoid double counting, users should include other relevant policies and actions in the baseline scenario describing the most likely events or conditions that would have occurred in the absence of the policy intervention (see Chapter 8). Any remaining policy interactions should be quantified during the ex-ante or ex-post assessment (see Chapter 9 and Chapter 11).

If double counting between policies is suspected, GHG reductions from overlapping policies and actions should not be aggregated within a region to determine total emissions or reductions in that 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 (see Chapter 14). 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.

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 exclusive ownership of reductions through contractual agreements between buyers and sellers and recording all transactions in domestic or international registries (e.g., an international transaction log).

Bottom-up and top-down approaches

Multiple types of data and quantification methods can be used to quantify changes in emissions from policies and actions, including both bottom-up and top-down data and quantification methods.

<u>Bottom-up and top-down data</u>

- Bottom-up data are measured, monitored, or collected (e.g., using a measuring device such as a fuel meter) at the source-, entity-, or project-level (e.g., energy used at source level (by fuel type), output of production, etc.)
- Top-down data are macro-level statistics collected at the jurisdiction or sector level (e.g., energy use, population, GDP, fuel prices, etc.). Note that top-down data can be aggregated from bottom-up data sources.

<u>Bottom-up and top-down quantification methods</u>

- Bottom-up methods use bottom-up data to calculate or model the change in GHG emissions for each source, project, or entity (e.g., through changes in behavior or technology), then aggregate across all sources, projects, or entities to determine the total change in GHG emissions (e.g., using engineering models)
- Top-down methods use top-down data to calculate or model changes in GHG emissions based on changes in macro-level indicators (e.g., using econometric models or regression analysis)

For example, in terms of calculating the effects of energy efficiency policies, top down methods monitor the evolution of energy efficiency indicators whereas bottom up methods directly measure the savings at the project or entity level. 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. Further guidance on top-down and bottom-up approaches is provided in Chapter 11.

Tiered approaches

In many cases, users will confront a choice in the methodological options that are available to quantify changes in emissions. Often the methodological options present a tradeoff between accuracy or completeness on one hand and the cost of implementation on the other. In such cases, this standard provides a range of methods with varying levels of accuracy/completeness and cost of implementation, ranked by tier, rather than a single method. Users should select a tier based on a range of factors, including:

- Objectives of the assessment
- Level of accuracy required to meet stated objectives
- Data availability
- Capacity and resources

Table 3.1 presents an overview of tiers used in this standard. See detailed guidance on tiers provided in Chapters 7, 8, 9, and 11 for specific information on each tier within each chapter.

Users may use different tiers within different elements of the GHG assessment, rather than using a consistent tier throughout the entire standard, depending on their objective. For example, a user can primarily use Tier 2 methods, but occasionally use Tier 3 methods. However, to meet all objectives enabled by Tier 3 (e.g., to make a robust claim that specific actions have resulted in specific GHG reductions), Tier 3 methods must be applied consistently throughout the assessment.

Users may also implement simplified approaches (e.g., Tier 1 methods) in the short term and more rigorous approaches (e.g., Tier 3 methods) in the longer term.

Table 3.1: Overview of tiers used in the standard

Tier	Level of rigor/ accuracy	Quantification approach	Data sources	Use of resulting data
1	Lowest	Simplified approaches	Default or average data; use of existing data	Limited uses of data; typically cannot claim that specific actions (or groups of actions) result in specific GHG reductions
2	Intermediate	Intermediate approaches	Mix of data sources and quality	Some, but not all, uses of data are appropriate
3	Highest	Complex approaches (if relevant)	Source-specific data; collection of new data (if relevant)	All uses of data are appropriate; typically can claim that specific actions (or groups of actions) result in specific GHG reductions

3.2 Steps in policy accounting and reporting

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 3.2 for a simple outline of steps and Figure 3.3 for a more detailed outline of steps. See Table 3.2 for a description of steps with examples.

Figure 3.2: Overview of steps in policy accounting

Ch. 2	• Define objectives
Ch. 4	• Review accounting and reporting principles
Ch.5	• Define the policy or action, including whether to evaluate one policy or a package of policies
Ch. 6	• Map the causal chain including identifying all possible GHG effects
Ch. 7	• Select those effects that will be included in the GHG assessment boundary
Ch. 8	• Define the baseline scenario and determine baseline emissions
Ch. 9	• Quantify GHG effects ex-ante prior to policy implementation
Ch. 10	• Monitor performance indicators during policy implementation period
Ch.11	• Quantify GHG effects ex-post during or after policy implementation
Ch. 12	• Assess and manage uncertainty (relevant to Chapters 8, 9, 10, and 11)
Ch. 13	• Verify results (optional)
Ch. 14	• Report results and methodology used

Figure 3.3: Detailed steps in quantifying GHG effects of policies and actions

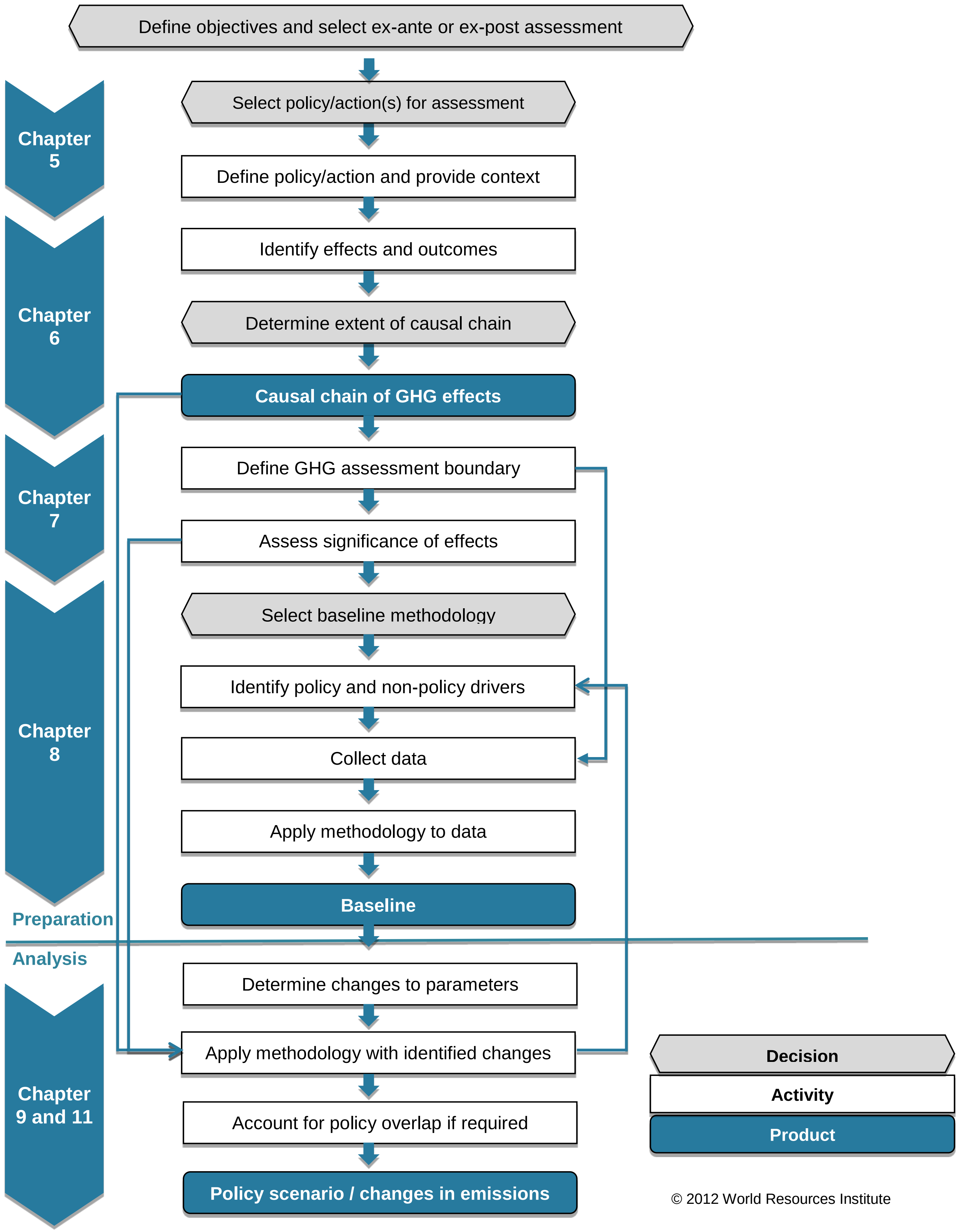
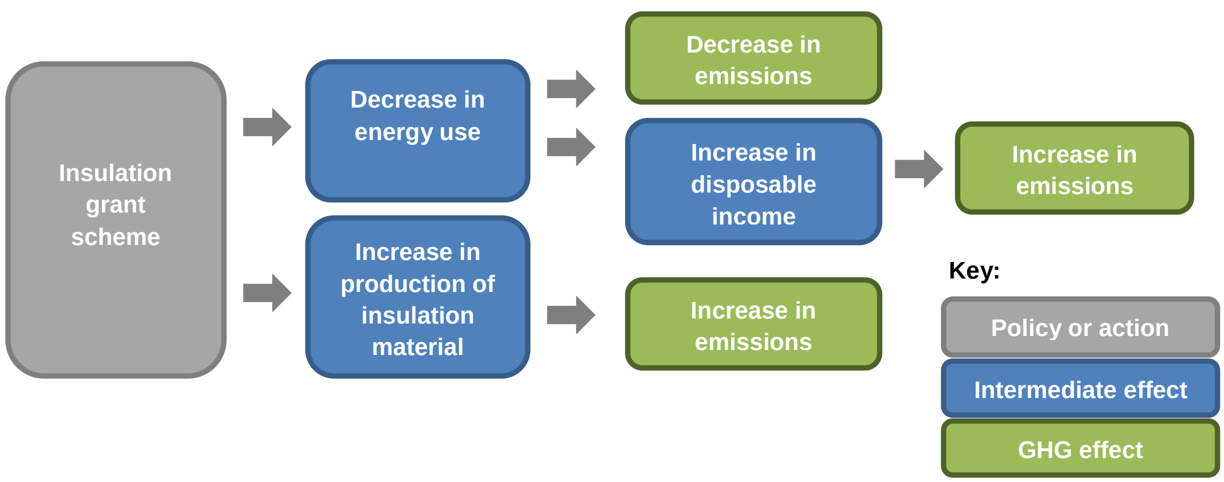


Table 3.2: Summary of steps and examples of output from each chapter

Chapter	Step	Example of output from following the guidance in each chapter
Chapter 2, Objectives	Define the objective of the GHG assessment	The objective is to inform the design of the policy (before implementation) and track and report on its effectiveness (after implementation)
Chapter 5, Defining the policy or action	Clearly describe the policy or action and decide whether to assess an individual policy/action or package of policies/actions.	The policy is a government grant scheme for loft insulation, aiming to insulate 1 million homes" (plus other descriptive information).
Chapter 6, Mapping the causal chain	Identify all the potential changes in emissions (both positive and negative) caused by the policy or action (or package of policies/actions).	See Figure 3.4 for a diagram of the causal chain.
Chapter 7, Defining the GHG assessment boundary	Based on the causal chain (Chapter 6), determine which effects of the policy are significant (i.e., in terms of size of change in emissions).	The change in emissions from the decrease in energy consumption is expected to be significant. Increase in emissions from increase in disposable income and increased production of insulation material is expected to be insignificant (based on an order of magnitude estimate).
Chapter 8, Determining baseline emissions	Based on the boundary (Chapter 7), for each emission source which is expected to change significantly, calculate baseline emissions. This can be done by identifying baseline parameters and parameter values.	The parameters that determine baseline emissions are baseline energy use and the baseline emission factor. The parameter values are 1 billion kWh per year, and 0.2 $kgCO_2e$/kWh. The baseline calculation is 1 billion *0.2 = 200,000,000 $kgCO_2e$ per year. Baseline energy use takes into account drivers that affect energy use (e.g., GDP as a driver of energy demand).
Chapter 9, Estimating GHG effects ex-ante	Quantify expected GHG effects of the policy/action before policy implementation. For each emission source which is identified as likely to change significantly in the boundary setting exercise (Chapter 7), and also using the values derived for the baseline (Chapter 8), calculate what the expected GHG effect of the policy or action and what emissions will be in the policy scenario.	The parameters that can be used to calculate "with policy" emissions are baseline energy use, the energy saving factor from the insulation policy, and the "with policy" scenario emission factor. The parameter values are 1 billion kWh per year, 25% energy saving factor, and 0.2 $kgCO_2e$/kWh. The policy scenario emissions calculation is 1 billion * (1 – 25%) * 0.2 = 150,000,000 $kgCO_2e$/year. The difference between baseline emissions and "with policy" emissions [excluding the other changes in emissions that also need to be included] = 50,000,000 $kgCO_2e$/year.
Chapter 10, Monitoring performance over time	The causal chain (Chapter 6), boundary (Chapter 7), and parameters identified (Chapters 8 and 9) can be used to inform the choice of monitoring indicators (e.g., number of homes insulated, actual observed energy consumption) to track performance during the policy implementation period. The indicators provide an	Only 200,000 homes have applied for the grant and so the total mitigation likely to be achieved is lower than planned. The parameters identified (Chapters 8 and 9) can also be used to inform a data collection exercise for ex-post assessment.

	indication of (rather than quantification of) the effects of the policy/action.	
Chapter 11, Quantifying GHG effects ex-post	Quantify GHG effects of the policy/action after policy implementation. Both the baseline and the "with policy" scenario emissions can be calculated (or recalculated if an ex ante baseline and quantification has been undertaken) with actual data (which is collected following the guidance in Chapter 10).	The parameter values in the baseline calculation can be updated with actual data for the identified baseline drivers (e.g., actual rather than predicted GDP data can be used). Similarly, for the "with policy" scenario calculations, the parameter value for energy use could be based on actual observed energy use rather than an estimate, and data on the actual number of homes that installed insulation.

Figure 3.4: Example of mapping the causal chain (from Table 3.2)



3.3 Checklist of requirements

This standard presents accounting and reporting requirements to help users develop a GHG assessment that represents a true and fair account of changes in GHG emissions resulting from a policy or action. Standardized approaches and principles are designed to increase the consistency and transparency of GHG assessments.

Table 3.3 provides a checklist of all the requirements included in this standard in order to help users keep track of the requirements contained in subsequent chapters. Each subsequent chapter provides additional guidance and explanations of relevant terms and concepts. Requirements are also summarized in a box at the beginning of each chapter that contains requirements.

Table 3.3: List of requirements in this standard

Chapter	Requirement
Chapter 4: Accounting and reporting principles	• GHG accounting and reporting shall be based on the following principles: relevance, completeness, consistency, transparency, and accuracy.

Chapter 5: Defining the policy or action	• Users shall clearly define and provide a detailed description of the policy or action (or package of policies/actions) that is assessed. • If assessments of both individual policies/actions and packages of policies/actions are undertaken these shall be defined separately, and shall be treated as discrete applications of this standard.
Chapter 6: Mapping the causal chain	• Users shall develop a map of the causal chain and a list of all potential effects considered in the analysis
Chapter 7: Defining the GHG assessment boundary	• Users shall include all seven UNFCCC/Kyoto Protocol gases (CO_2, CH_4, N_2O, SF_6, PFCs, HFCs, NF_3) in the assessment. • Users shall apply GWP values provided by the Intergovernmental Panel on Climate Change (IPCC) based on a 100-year time horizon and shall disclose the GWP values used to quantify emissions. • Users shall define the policy implementation period, the policy monitoring period, and the GHG assessment period. • Users shall document the tier selected and the criteria and methodology used to determine significance. • Users shall include all significant effects in the GHG assessment boundary, consistent with the chosen tier. • Users of Tier 2 and Tier 3 shall define a significance threshold for determining which GHG effects are significant in size and shall disclose and justify the significance threshold used. • Users of Tier 2 shall include all effects in the GHG assessment boundary except those that are either insignificant in size or very unlikely to occur, and shall not exclude from the GHG assessment boundary any effects that collectively account for more than 10% of the total expected change in GHG emissions from the policy or action (in absolute value terms). • Users of Tier 3 shall include all effects in the GHG assessment boundary, but may use less accurate quantification methods (e.g., the same methods used in the estimation step) to quantify GHG impacts for effects that are expected to be insignificant in size or very unlikely to occur. • Users shall disclose and justify any GHG effects excluded from the GHG assessment.
Chapter 8: Determining baseline emissions	• Users shall define an emissions estimation algorithm and all parameters, drivers, and assumptions required to estimate baseline emissions. • Users shall quantify all effects that have been included in the GHG assessment boundary. • Any effects that have not been quantified shall be disclosed and justified and described qualitatively.
Chapter 9: Quantifying GHG effects ex-ante	• Users shall quantify all effects that have been included in the GHG assessment boundary. • Any effects that have not been quantified shall be disclosed and justified and described qualitatively. • Users shall apply the same the frequency of ex-ante emissions estimates as was defined in the baseline scenario (e.g., every year through the end of GHG assessment period). • Users shall apply the same policy drivers, non-policy (e.g., socioeconomic) drivers, and assumptions for each driver used in the baseline scenario defined in Chapter 8 except for those specifically identified as drivers for the policy scenario in Chapter 9. • In cases where an intervention is not clearly permanent the user shall make the assumptions regarding the continuation of the measure transparent. In cases where the intervention is clearly time limited and the end of the measure lies within the analysis time frame, the user shall clearly identify if effects changes between the

	active period and the time after and how. • Assumptions on the scale of changes for parameters shall follow the principles of relevance, completeness, consistency, transparency, and accuracy presented in Chapter 4.
Chapter 10: Monitoring performance over time	• Users shall define the indicators, or metrics, to track the on-going performance of the policy or action. • Users shall create a plan for monitoring the main activities and the associated outcomes related to the policy or action. • Users shall monitor and report information on the indicators over time.
Chapter 11: Quantifying GHG effects ex-post	• Users shall quantify all effects that have been included in the GHG assessment boundary. • Any effects that have not been quantified shall be disclosed and justified and described qualitatively. • Users shall quantify policy interactions to determine the GHG effects of the policy or action being assessed rather than other policies or actions, if not already considered (e.g., in the baseline scenario). • Users shall correct for effects not previously considered in the baseline scenario, within the context of the chosen tier.
Chapter 12: Assessing uncertainty	• Users shall carry out uncertainty assessments and sensitivity analyses for key parameters and assumptions in the GHG assessment.
Chapter 14: Reporting	• See Chapter 14 for a list of reporting requirements

Chapter 4: Accounting and reporting principles

Generally accepted GHG accounting principles are intended to underpin and guide GHG accounting and reporting to ensure the reported GHG assessment represents a faithful, 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 quantifying and reporting changes in GHG emissions, especially where the guidelines provide flexibility.

Requirements in this chapter

- GHG accounting and reporting shall be based on the following principles: relevance, completeness, consistency, transparency, and accuracy.

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

Relevance: Ensure the GHG assessment appropriately reflects actual changes in GHG emissions and serves the decision-making needs of users – both internal and external to the reporting entity.

Completeness: Account for and report on all GHG emission sources and activities within the assessment boundary. Include all relevant information in the quantification of GHG reductions. Disclose and justify any specific exclusions.

Consistency: Use consistent methodologies to collect data and quantify changes in GHG emissions to allow for meaningful performance tracking of emissions and reductions over time. Transparently document any changes to the data, boundary, methods, or any other relevant factors in the time series.

Transparency: Provide clear and sufficient information for reviewers to assess the credibility and reliability of reported changes in GHG emissions. Disclose all relevant methods, calculations, assumptions, and associated uncertainties, and make appropriate references to the methodologies and data sources used.

Accuracy: Ensure that the quantification of changes in GHG emissions is systematically neither over nor under actual emissions, as far as can be judged, and that uncertainties are reduced as far as practicable. Achieve sufficient accuracy to enable users to make 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. Users should apply conservative assumptions, values, and procedures when uncertainty is high and the cost of measures to reduce uncertainty is not worth the increase in accuracy. Conservative values and assumptions are those that are more likely to overestimate GHG emissions or underestimate GHG reductions.

Guidance for applying the accounting and reporting principles

The primary function of these five principles is to guide the implementation of the *GHG Protocol Policies and Actions Standard* and the assurance of the GHG assessment, particularly when application of the standard in specific situations is ambiguous.

In practice, users may encounter tradeoffs between principles when developing a GHG assessment. For example, a user may find that achieving the most complete assessment requires using less accurate data, compromising overall accuracy. Conversely, achieving the most accurate assessment may require excluding activities with low accuracy, compromising overall completeness. Users should balance tradeoffs between principles depending on their objectives (see Chapter 2 for more information). Over time, as the accuracy and completeness of data increases, the tradeoff between these accounting principles will likely diminish.

Relevance

A relevant GHG report contains the information that users – both internal and external to the reporting entity – need for their decision making. Users should use the principle of relevance when determining whether to exclude any activities from the assessment boundary (see description of "Completeness" below). Users should also use the principle of relevance as a guide when selecting data sources. Users should collect data of sufficient quality to ensure that the assessment is relevant (i.e., that it appropriately reflects the GHG effects of the policy or action and serves the decision-making needs of users). Selection of data sources depends on individual objectives (see Chapter 2).

Completeness

Users should ensure that the GHG assessment appropriately reflects the GHG effects of the policy or action, and serves the decision-making needs of users, both internal and external to the reporting entity. In some situations, users may be unable to estimate emissions due to a lack of data or other limiting factors. Users should not exclude any activities from the assessment that would compromise the relevance of the reported data. In the case of any exclusions, it is important that all exclusions be documented and justified. Assurance providers can determine the potential impact and relevance of the exclusion on the overall assessment. More information on completeness is provided in Chapter 7.

Consistency

Users of GHG information typically track emissions information over time in order to identify trends and assess performance over time. The consistent application of accounting approaches, GHG assessment boundary, and calculation methodologies is essential to producing comparable GHG emissions data over time. If there are changes to the assessment boundary (e.g., inclusion of previously excluded activities), methods, data, or other factors affecting emission estimates, they need to be transparently documented and justified, and may warrant recalculation of baseline emissions.

Transparency

Transparency relates to the degree to which information on the processes, procedures, assumptions and limitations of the GHG assessment are disclosed in a clear, factual, neutral, and understandable manner based on clear documentation (i.e., an audit trail). Information should be recorded, compiled, and analyzed in a way that enables internal and external reviewers to attest to its credibility. Specific exclusions need to be clearly identified and justified, assumptions disclosed, and appropriate references provided for the methodologies applied and the data sources used. 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. A transparent report will provide a clear understanding of the relevant issues and a meaningful assessment of emissions performance over time. More information on reporting is provided in Chapter 14.

Accuracy

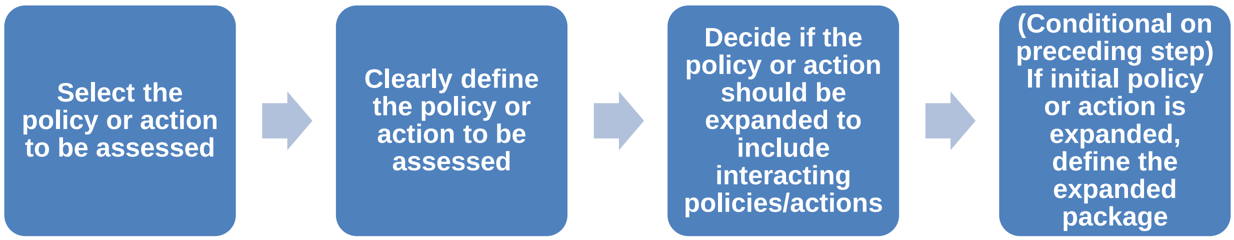
Data should be sufficiently accurate to enable intended users to make decisions with reasonable confidence that the reported information is credible. Users should quantify the GHG effects of policies and actions with a sufficient level of accuracy to meet the stated objectives of the assessment (see Chapter 2 for guidance on objectives and Chapter 3 for guidance on selecting tiers in the context of objectives). GHG measurements, estimates, or calculations should be systemically neither over nor under the actual emissions value, as far as can be judged. Users should reduce uncertainties in the quantification process as far as practicable and ensure the data are sufficiently accurate to serve decision-making needs. Reporting on measures taken to ensure accuracy and improve accuracy over time can help promote credibility and enhance transparency. Accuracy should be pursued as far as possible, but once uncertainty can no longer be practically reduced, conservative estimates should be used. Users should apply conservative assumptions, values, and procedures when uncertainty is high and the cost of measures to reduce uncertainty is not worth the increase in accuracy. Conservative values and assumptions are those that are more likely to overstate GHG emissions or underestimate GHG reductions.

[Placeholder for case studies of applying the accounting and reporting principles]

Chapter 5: Defining the policy or action

This chapter provides guidance on clearly defining the policy or action that will be assessed in subsequent chapters.

Figure 5.1: Overview of steps in the chapter



Requirements in this chapter

- Users shall clearly define and provide a detailed description of the policy or action (or package of policies/actions) that is assessed.
- If assessments of both individual policies/actions and packages of policies/actions are undertaken these shall be defined separately, and shall be treated as discrete applications of this standard.

5.1 Select the policy or action to be assessed

The first step is to select the policy or action that will be evaluated using this standard. Users may choose any type of policy or action, including policies and actions intended to reduce GHG emissions, policies and actions intended to meet non-GHG goals, and policies and actions that increase emissions. Users may choose sectoral policies (e.g., in the energy supply, buildings, waste, AFOLU, industry, and transportation sectors) as well as cross-sector policy instruments (e.g., emissions trading programs, carbon taxes).

Table 5.1 presents a typology of policies and actions which may be evaluated. Table 5.1 is intended to help users categorize their policies and actions into broad categories. Each broad type of policy or action (e.g., regulations and standards) contains many more specific types of policies within it (e.g., energy efficiency standards for new refrigerators). Note that some types of policies and actions outlined in Table 5.1 are more difficult to quantify than others, since the causal chain between implementation of the policy and its GHG effects may be less direct. This standard can be applied in principle to any policy type, though subsequent chapters may pose a variety of data collection and quantification challenges that ultimately hinder a complete and credible GHG assessment.

Table 5.1: Typology of policies and actions

Type of policy or action	Description
Regulations and standards[3]	These specify abatement technologies (technology standard) or minimum requirements for pollution output (performance standard). They may also set obligations or mandates for specific sectors (e.g., 20% of electricity supply must be from renewable sources).
Taxes and charges[3]	A levy imposed on each unit of activity by a source (e.g., fuel tax, carbon tax, traffic congestion charge, import or export tax).
Tradable permits[3]	A program that establishes a limit on aggregate emissions by specified sources, requires each source to hold permits equal to its actual emissions, and allows permits to be traded among sources. These are also known as emissions trading programs, emissions trading schemes (ETS), or cap-and-trade programs.

Voluntary agreements[3]	An agreement between a government authority and one or more private parties beyond compliance to regulated obligations (e.g., with the aim of improving environmental performance). Not all VAs are truly voluntary; some include rewards and/or penalties associated with participating in the agreement or achieving the commitments.
Subsidies and incentives[3]	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.
Information instruments[3]	Required public disclosure of information (e.g., environmentally related information), generally by industry to consumers. These include labeling programs, rating, and certification systems. Also information campaigns aimed at changing behavior.
Research and development (R&D)[3]	Activities that involve direct government funding and investment aimed at generating innovative approaches to the physical and social infrastructure (e.g., to reduce emissions). Examples of these are funding and incentives for technological advances.
Public procurement policies	Policies requiring that specific attributes (e.g., environmental attributes) are considered as part of public procurement processes.
Infrastructure programs	Provision of infrastructure (e.g., roads, high speed rail)
Deployment of new products or technologies	Public or private sector deployment of new products or technologies (e.g., that reduce emissions compared to existing products or technologies)
Financing and investment	Public or private sector grants or loans (e.g., to support development strategies or policies)
Strategies framed in terms of desired outcomes	Public or private sector strategies (e.g., increasing renewable energy share to 20% of total generation by 2015, reducing deforestation by 20% by 2020). Note that more specific types of policies and actions (i.e., the other types listed in this table) are needed to achieve the desired outcome.

5.2 Clearly define the policy or action assessed

Users shall clearly define and provide a detailed description of the policy or action (or package of policies/actions) that is assessed. A clear definition and description of the policy or action is necessary to accurately carry out subsequent steps in the assessment process (e.g., mapping the causal chain (Chapter 6), defining the GHG assessment boundary (Chapter 7), quantifying GHG effects (Chapters 8, 9, and 11), and monitoring progress (Chapter 10)). It is also important to have a clear definition of the policy or action assessed when communicating the results of the assessment to policymakers and other interested parties.

Table 5.2 provides a checklist of information that should be provided in order to clearly define the policy or action assessed. The list is not intended to be exhaustive and there may be other information which could also be useful for clearly defining the policy or action. Some of the information listed below may not be relevant to all policies or actions, and practitioner judgment should be used to determine the relevance of the checklist items to the specific policy or action being defined.

Table 5.2: Checklist of information to clearly define the policy or action assessed

Category	Information	Example/Explanation
Title	The title of the policy or action	*E.g. The EU Emissions Trading System*
Implementation	The status of the policy or action	*E.g. Proposed; on-going; or completed.*
	Date of commencement	The date the policy/action comes into effect, rather than the date that any supporting legislation is enacted.

	Date of completion (if applicable)	The date the policy/action ceases, such as the date a tax is no longer levied (if applicable), rather than the date that the policy/action no longer has an impact on GHG emissions.
Descriptors	Type of policy or action	The typology in Box 5.1 should be used, though other types of actions or policies not included in the list may be relevant.
	Primary emission sources targeted	Sources targeted, using categories of emission sources from the most recent IPCC *Guidelines for National GHG Inventories* (e.g., energy, industrial processes and product use, agriculture, forestry and other land use (AFOLU), waste, other), as well as end-use sectors as applicable (e.g., energy supply, transportation, residential and commercial buildings, industry)
	Key indicators	An indicator is a metric or piece of information that indicates the success or progress of a policy or action. Indicators can be either absolute (e.g., number of homes insulated) or intensity-based (e.g., gCO_2e/km). If there is not already an established key indicator associated with the policy, then an indicator may be selected in order to clearly define policy or action (more information on selecting indicators for monitoring is provided in Chapter 10). See Table 5.3 for examples of key indicators.
	Greenhouse gases targeted	The greenhouse gases that the policy or action aims to control, rather than the greenhouse gases that will be considered when assessing the effects of the policy/action (see Chapter 7 for information on the GHG assessment boundary). *E.g. the UK's Carbon Reduction Commitment mainly targets CO_2 emissions.*
	Geographical coverage	The jurisdiction where the policy/action is implemented or enforced, rather than all the jurisdictions where the policy/action has an impact. *E.g. the geographical coverage of the U.S. Renewable Fuels Standard is the United States.* All of the areas affected by the policy or action will be considered when mapping the causal chain (Chapter 6).
	Description of the specific interventions included in the policy or action	*E.g. size of subsidy or tax, value of grant fund, number of installations/companies/households targeted.*
	Intended effects of the policy or action	The outcome(s) the policy or action intends to achieve (e.g., purpose stated in legislation, regulation, or other document)
	Intended or target level of mitigation to be achieved	If relevant and available, the initial estimate or target level of mitigation expected from the policy or action, which may be useful for conveying the scale/significance of the policy/action.
	Title of legislation or regulations associated with the policy or action	*E.g. the pieces of primary legislation establishing the Renewable Fuels Standard are the Energy Policy Act (2005) and the Energy Security and Independence Act (2007).*
	Reference to relevant guidance documents	This should allow practitioners and other interested parties to access any guidance documents related to the policy or action (e.g., through websites).
Other information	The broader context/significance of the policy or action	Broader historical context for understanding the policy or action, such as other measures that the policy/action replaces, or the political context of the policy/action.
	Outline of non-GHG effects or co-benefits of the policy or action	Any anticipated non-GHG effects or co-benefits, such as energy security, air quality, jobs, etc., and any relevant target indicators. *E.g. the Renewable Fuels Standard aims to achieve increased fuel security and improved rural incomes.*

Examples of key indicators that may be included as part of the checklist are provided in Table 5.3.

Table 5.3: Examples of key indicators

Examples of policies	Examples of indicators
Renewable portfolio standard	Total electricity generation by source (e.g., wind power, solar power, coal, natural gas)
Public transit policies	Vehicle-kilometers traveled by mode (e.g., subway, bus, train, private car, taxi, bicycle)
Waste management policies	Tonnes of waste sent to landfills; tonnes of waste sent to recycling facilities; tonnes of waste sent to incineration facilities
Landfill gas management policies	Tonnes of methane captured and flared or used
Sustainable agriculture policies	Soil carbon content; tonnes of synthetic fertilizers applied; crop yields
Afforestation/reforestation policies	Area of forest by type

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

Users may assess either an individual policy or action, or a package of related policies or actions. Among the various considerations that will inform this decision, users should consider the degree of interaction between the policy or action being assessed and other proposed or existing policies and actions in a sector or jurisdiction.

This section is divided into three parts, and provides:

1. An explanation of how policies and actions interact
2. Advantages and disadvantages of assessing individual policies/actions versus packages of policies/actions
3. Guidance on identifying interacting policies and deciding whether to assess an individual policy/action or a package of related policies/actions (or whether to assess both individual policies/actions *and* a packages of policies/actions)

This section explains how to identify possible policy interactions in order to inform the choice of whether to assess an individual policy/action or a package. Regardless of this choice, users will likely have to consider and quantify policy interactions in subsequent steps in the GHG assessment. More detailed guidance on how to quantify policy interactions and allocate GHG effects between interacting policies and actions is provided in Chapter 8 (Determining baseline emissions, including identifying policy drivers included in the baseline scenario), Chapter 9 (Quantifying GHG effects ex-ante) and Chapter 11 (Quantifying GHG effects ex-post).

Explanation of how policies and actions interact

In many cases an individual policy or action will overlap or interact with other policies and actions, particularly if they affect emissions from the same source(s).
Policies and actions may interact with each other in one of three ways:

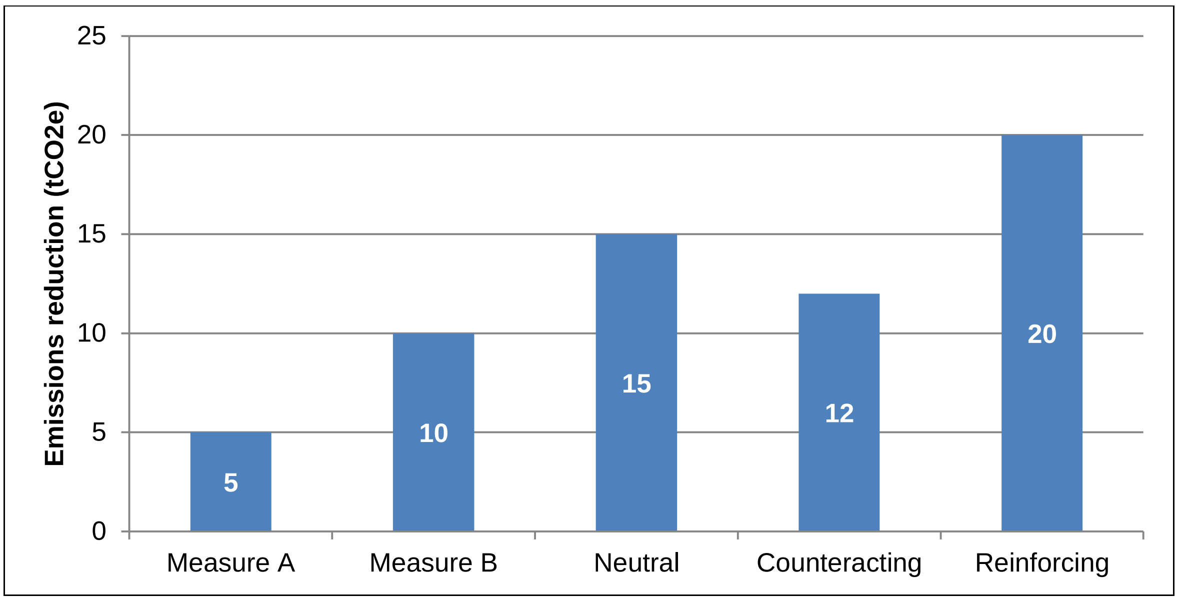
- **Neutral:** If there is no interaction between two interventions then the total change in GHG emissions achieved would be equal to the sum of each measure implemented on its own, and the interaction can be described as neutral.

- **Counteracting:** If the combination of interventions achieves less than the sum of GHG reductions that would be expected from each individual measure then the interventions can be described as counteracting. It is important to note that counteracting effects can occur for a number of reasons, such as multiple policies sharing the same goal but overlapping in their effects, or where multiple policies aim to use the same constrained resources (e.g. waste for energy versus waste for material recovery) and the implementation of one policy restricts the potential of other policies.

- **Reinforcing:** If the combination of interventions achieves more than the sum of GHG reductions that would be expected from each individual measure then the interventions can be described as reinforcing.

Figure 5.2 illustrates the three types of interactions between policies and actions. In the figure, Measure A reduces emissions by 5 tonnes CO_2e when implemented on its own and Measure B reduces emissions by 10 tonnes CO_2e when implemented on its own. See Box 5.1 for an example of interacting policies and actions.

Figure 5.2: Typology of possible interactions between policies and actions[3]



Box 5.1: Example of interacting policies and actions

Subsidies for loft insulation and a tax on domestic energy consumption both aim to reduce domestic energy consumption and emissions. It may be estimated that if the subsidy is implemented on its own, 10,000 households will install loft insulation, saving a total of 20,000 tCO_2e/year. If the energy tax is implemented on its own, it may be estimated that 20,000 households will install loft insulation, saving a total of 40,000 tCO_2e/year. If there were no interactions between these policies, then if both were implemented it may be expected that the total GHG reduction from both policies would be 60,000 tCO_2e/year.

However, it is possible that the policies may reinforce each other, perhaps because the combined incentives of both the subsidy and the tax are enough to persuade a much larger number of households that loft insulation is financially advantageous. For purposes of the example, the reinforcing effect causes a total of 50,000 households to install loft insulation, creating total savings of 100,000 tCO_2e/year.

GHG reduction if subsidy is introduced	20,000 tCO_2e/year
GHG reduction if tax is introduced	40,000 tCO_2e/year
Sum of GHG reductions from individual policies	60,000 tCO_2e/year

[3] Adapted from Boonekamp, P. G. M., “Actual interaction effects between policy measures for energy efficiency – A qualitative matrix method and quantitative simulation results for households,” *Energy*, 31 (14) 2006, pp. 2848–2873.

Actual GHG reductions achieved if both subsidy and tax are introduced (due to reinforcing effect)	100,000 tCO_2e/year

Conversely, it is possible that the combination of policies may overlap with each other and achieve less than the sum of each measure implemented individually. Continuing with the insulation example, a counteracting effect may occur if the number of households who would be willing to install insulation in the individual GHG reduction estimates overlap, i.e. in some cases they are the same households. The total number of households that install insulation when both policies are implemented is 25,000, with total savings of 50,000 tCO_2e/year, rather than 100,000 tCO_2e/year.

GHG reduction if subsidy is introduced	20,000 tCO_2e/year
GHG reduction if tax is introduced	40,000 tCO_2e/year
Sum of GHG reductions from individual policies	60,000 tCO_2e/year
Actual GHG reductions if both subsidy and tax are introduced (due to overlapping effect)	50,000 tCO_2e/year

These examples illustrate how individual policies can interact with other actions and policies, and why interactions need to be accounted for in order to accurately estimate the total level of GHG reductions when multiple interacting policies are implemented.

Advantages and disadvantages of assessing individual policies/actions versus packages of policies/actions

When a policy/action interacts with other policies/actions, there can be some advantages for assessing the all the policies/actions as a package, rather than individually, such as:

- Assessing a package of policies/actions will capture the interactions between them, and better reflect the total GHG effects if the policies are implemented at the same time. The estimated GHG effects from separate assessments for individual policies cannot be straightforwardly summed to calculate total GHG reductions (due to interactions).

- Assessing a package of policies/action may, in some cases, be simpler than undertaking individual assessments as it avoids the need to disaggregate the effects of individual policies/actions. It can be difficult to allocate emission savings between individual policies when they are targeting the same emission sources, or when the policies are mutually reinforcing or counteracting.

The difficulty of allocating impacts between policies may arise to a greater extent with ex-post evaluations. For example, there may be data on the total number of homes that have installed loft insulation, but it may be difficult to estimate how many of the installations are caused by a subsidy, and how many are caused by an energy tax. In such cases it may be simpler to assess the total impact of both policies as a package.

However, there are also some advantages to assessing policies/actions individually:

- Decision-makers may want information for assessing the effectiveness of individual policies/actions, in order to make decisions about which individual policies/actions are cost-effective and should be supported. Assessments of whole packages do not show the individual effectiveness of component policies/actions.

- Assessing an individual policy/action may, in some cases, be simpler than undertaking an assessment of a package of policies as the causal chain and range of impacts for a package of policies may become too complex and unwieldy.

Guidance on identifying interacting policies and deciding whether to assess an individual policy/action or a package of related policies/actions

Given the advantages and disadvantages outlined above, users should decide whether to assess an individual policy/action or a package of policies/actions, or whether both options should be undertaken (in order to gain information on both individual policies and packages of policies). This section provides a two-step process to help inform this decision:

- Step 1: Identify other policies/actions that interact with the initial policy/action, and which could be included in a package of policies/actions.
- Step 2: Consider a number of criteria to determine whether to assess individual policies/actions or a package of policies/actions.

These two steps are described in more detail in the following sections.

Step 1: Identify other related policies/actions and characterize the type and degree of interaction

One technique for identifying all interacting actions/policies is to map all the policies/actions that affect the same target indicator, or target the same emission source(s). See Box 5.2 for examples.

Box 5.2: Examples of mapping policies/actions that target the same emission source(s)

Policy of interest	Targeted emission source(s)	Other policies/actions targeting the same source(s)
Subsidy for loft insulation	Household space heating	Energy tax; information instruments
Appliance energy labels	Energy use in refrigerators	Energy efficiency standards; subsidies for new appliances
Fuel economy regulation	Emissions of new car fleet	Fuel taxes; biofuel subsidies; rebates for efficient cars

Some policies and actions may interact and affect the same parameters even if they do not target the same indicator, the same emission sources, or the same sector. For example, there may be two policies that aim to utilize the same constrained resource, such as wastes and residues: one policy might incentivize the use of wastes for energy generation, and another policy might incentivize the use of the same wastes for substituting primary material extraction. These two policies will interact (i.e., the implementation of one will constrain the GHG reduction potential of the other), but they do not target the same emission sources, or share a target indicator.

However, as a rule of thumb, identifying other policies and actions with the same indicator or the same targeted emission source(s) will give a reasonable list of the other policies and actions that can then be assessed for the type and degree of interaction.

Once a list of interacting policies and actions has been identified, the type and degree of interaction should be assessed. The typology of interactions described above may be used to identify whether the other actions/policies identified have no impact (neutral), counteract, or reinforce the original policy or action.

The assessment of the type and degree of interaction in this step should be qualitative (i.e., is the interaction considered to be neutral, counteracting, or reinforcing, and is the effect likely to be large or small), based on expert judgment or published studies of similar combinations of policies/actions. A quantitative assessment of the degree of interaction should generally not be undertaken in this step, as this would require many of the steps needed for a full assessment of both the individual policy/action and the package of policies/actions (which would make the question of which to assess redundant). Compiling this information on the likely type and scale of interaction is relevant for deciding whether to expand to a package of policies/actions or not (see Step 2).

Step 2: Evaluate a number of criteria to determine whether to assess an individual policy/action or a package of policies/actions

When making this choice, users should consider a number of factors, such as the practicality of conducting an individual or combined assessment, and the type of information that the intended end-user of the assessment requires. Table 5.4 provides a list of factors to consider.

Table 5.4: Criteria to consider for determining whether to assess an individual policy/action or a package of policies/actions

Criteria	Guidance
Do the end-users of the assessment results want to know the impact of individual policies/actions, e.g. in order to inform choices on which individual policies/actions to implement or continue supporting?	If "Yes" then undertake an individual assessment
Will the analysis be unmanageable if a package of policies/actions is assessed, e.g. is the causal-chain and range of impacts likely to become too complex?	If "Yes" then undertake an individual assessment
Are there large interactions between the identified policies/actions, either counteracting or reinforcing, which will be missed if policies/actions are assessed individually?[4]	If "Yes" then consider assessing a package of policies/actions
If the assessment is an ex-post evaluation, is it possible to disaggregate the observed impacts of interacting policies/actions?	If "No" then consider assessing a package of policies/actions

Users may conduct assessments for both individual policies *and* packages of policies. Doing so will yield more information than conducting only one option or the other. Undertaking both individual assessments and assessments for different combinations of policies should be considered if:

- The resources are available to undertake multiple analyses;
- The end-user requires information on both; and
- Undertaking both is practically feasible (e.g. disaggregation is possible, and the causal chain will not become too complex).

If assessments of both individual policies *and* packages of policies are undertaken these shall be defined as separate units of analysis, and shall be treated as discrete applications of this standard in order to avoid conflating the differing impacts and effects.

Chapter 9 (Quantifying GHG effects ex-ante) and Chapter 11 (Quantifying GHG effects ex-post) provide more detailed guidance on how to quantify interactions between policies/actions.

See Chapter 14 for reporting requirements related to defining the policy or action.

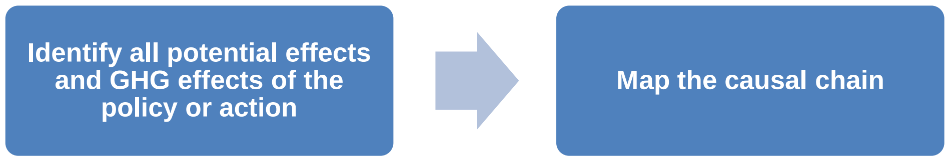
[Placeholder for sector-specific guidance and examples of defining the policy or action]

[4] An alternative option to expanding to a policy package in order to capture the effect of interactions is to include the interacting policies/actions in the baseline for an individual policy/action assessment. This is discussed in more detail in the Chapter 8 on establishing the baseline.

Chapter 6: Mapping the causal chain

The purpose of this chapter is to identify all potential GHG effects of a policy or action and include them in the causal map. Which of these impacts are to be quantified in subsequent chapters will be determined in Chapter 7 (Determining the GHG assessment boundary).

Figure 6.1: Overview of steps in the chapter



Requirements in this chapter

• Users shall develop a map of the causal chain and a list of all potential effects considered in the analysis

This chapter provides guidance on:

- **Identifying various types of effects**: The chapter outlines various types of effects that a policy or action can cause and provides guidance on the process of identifying and disclosing all possible effects of a policy or action. The intention is to encourage the user to consider all potential effects and interactions, making sure that less obvious effects, which may be potentially significant, are not inadvertently omitted.

- **Mapping the causal chain**: The chapter provides guidance on mapping a causal chain for the policy or action assessed. A causal chain is a conceptual diagram tracing the process by which the policy or action leads to GHG effects through a number of logical and sequential stages.

Mapping the causal chain is critical since it informs several future steps in the GHG assessment, including identifying which effects are included in the GHG assessment boundary (Chapter 7), which effects are included in the baseline scenario (Chapter 8) and quantified in the policy scenario (Chapters 9 and 11), and which indicators are monitored to track the performance of the policy or action (Chapter 10).

The two steps of: 1) identifying potential effects, and 2) mapping the causal chain can either occur in in parallel or in sequence.

6.1 Types of effects

Policies and actions result in many types of effects. An **effect** is a result of the policy or action (or package of policies or actions) being assessed (e.g., reduced energy use in households is an effect of an insulation promotion scheme.). A **GHG effect** is the net change in GHG emissions and removals resulting from the effects (e.g., the reduction in energy use from an insulation program will have different GHG effects depending on the types of fuels used for heating in the relevant area). GHG effects include both increases and decreases in emissions.

Policies and actions do not always act directly on greenhouse gas emissions. Instead, they often promote technical, environmental, economic, or social change which in turn affects GHG emissions. GHG effects may be several causal steps removed from the direct or immediate effects of a policy or action. Further, policies frequently have side effects or unintended consequences. Because policies often seek to influence complex systems (e.g., economies, societal behavior, large institutions), making a policy change can have counterintuitive or unexpected results. Thus, the scope of any GHG assessment should extend beyond the direct or immediate effects of the intervention(s).

Due to globalization and internationalized value chains, impacts of policies and actions often emerge beyond the country or region where they are implemented. Further, effects also have a temporal dimension. In some cases, policies and actions lead to effects quickly. In other cases, however, effects may take much longer to emerge and may also change over time. Thus, any assessment should identify short-term effects and, where possible, indicate whether long-term effects are likely to occur.

See table 6.1 for a typology of effects that may result from policies and actions. The six types of effects are not mutually exclusive. An effect could be any combination of the characteristics listed in Table 6.1 (e.g., intentional but out-of-boundary and long-term effects, or unintentional but in-boundary and short-term effects).

Table 6.1: Typology of effects

Type of effect	Description	Example
Intended effects	Effects that are intentional, based on the original objectives of the policy or action	A vehicle fuel efficiency standard reduces fuel consumed and emissions released per kilometer driven (an intended effect), while it also decreases the cost of driving per kilometer which leads consumers to drive more, thereby reducing some of the emissions benefits (an unintended (rebound) effect)
Unintended effects	Effects that are unintentional, based on the original objectives of the policy or action Unintended effects include rebound effects	
In-boundary effects	Effects that occur inside a defined geographic and sectoral boundary	A vehicle fuel efficiency standard in the United States leads automakers to produce and sell more efficient cars, which reduces gasoline consumption in the United States (an in-boundary effect), while it also leads U.S. automakers to sell the same efficient cars in Canada, which reduces gasoline use in Canada (an out-of-boundary spillover effect). However, U.S. automakers may sell old models to countries without similar standards, increasing emissions in other countries (leakage).
Out-of-boundary effects **(including leakage and spillover effects)**	Effects that occur outside of a defined geographic and sectoral boundary Effects outside the boundary are called spillover effects if they reduce emissions outside the boundary or leakage if they increase emissions outside the boundary	
Short-term effects	Effects that are nearer in the causal chain and nearer in time (based on the number of stages in the causal chain and amount of time between the policy and the effect)	An energy efficiency regulation leads to more insulation installed in buildings within a year (a short-term effect), while it also leads consumers to save money by spending less money on energy, which leads them to spend more money on all other goods and services, thereby increasing emissions elsewhere in the economy (a long-term effect)
Long-term effects	Effects that are more distant in the causal chain and more distant in time (based on the number of stages in the causal chain and amount of time between the policy and the effect) Users should define the distinction between "short-term" and "long-term" based on the individual assessment.	

6.2 Guidance on identifying effects

After defining the policy or action (Chapter 5), the next step is to identify all the possible effects of the policy or action. To ensure a comprehensive assessment, users should identify all types of potential effects of the policy or action, to the extent possible, including each of the six types included in Table 6.1. Each policy or action can result in each type of effect. Users should be comprehensive in identifying effects that both increase and decrease emissions for each type. Note that while all potential effects are identified in this chapter, Chapter 7 (Defining the GHG assessment boundary) provides guidance on identifying the subset of all potential GHG effects that are significant and therefore required to be included in the GHG assessment boundary.

Defining the geographic and sectoral boundary of a policy or action

Users should first define the geographic and sectoral coverage of the policy or action in order to identify in-boundary and out-of-boundary effects. In-boundary effects are those that occur within that defined geographic and sectoral boundary, and out-of-boundary effects are those that occur outside of that defined boundary. For example, a city transportation policy may affect vehicles registered within the geographic boundary of the city (an in-boundary effect). However, the policy may also have GHG effects outside of the municipal boundary (e.g., on vehicles moving throughout the broader metropolitan area – an out-of-boundary effect).

GHG effects may also occur outside the sectoral coverage of a policy. For example, an electric vehicles policy may affect GHG emissions from the transportation sector (i.e., reduce tailpipe emissions from fossil fuel combustion). However, the policy will also likely have GHG effects in the energy supply sector (i.e., increased emissions from power plants).

Note that the causal chain will likely extend beyond the geographic boundary of the national or sub-national GHG inventory of the jurisdiction where the policy or action is implemented. Therefore, these out-of-boundary GHG effects will not contribute to GHG mitigation goals that apply only to emission sources within the jurisdictional boundary. To link the results of the GHG assessment to the GHG inventory and any related GHG mitigation goals, users should report GHG effects that occur within the jurisdiction's geographic boundary separately from GHG effects that occur outside of the geographic boundary. Users may report GHG separately by sector.

Methods for identifying effects

Various approaches and sources of information may be employed to identify effects, model cause-effect relationships, and establish impact hypotheses, such as:

- Previous policy assessments, evaluation studies, or other relevant literature for similar policies and circumstances to help identify various types of effects that are likely to be relevant
- Professional judgment or expert opinion
- Expert panels to facilitate exchange of information on different aspects of the impacts of a policy
- Consultation with those with local knowledge in the countries concerned of the causal chains being investigated
- Surveys involving appropriate experts and local/regional/national/global entities
- Consultation with statutory authorities, review of development plans, resource management plans and regulatory standards
- Use of complex computer models or geographic information systems (GIS)

Identifying various types of effects of any policy or action presents many challenges. In many circumstances, unintentional, out-of-boundary, long-term effects of policies and actions include less obvious environmental, economic, and social consequences than intentional, in-boundary, short-term effects. In addition, analysis of these long-term effects requires forecasting uncertain but reasonably foreseeable events. Hence, constructing causal chains appropriate for broad level assessments may initially seem complicated and may depend upon professional experience and judgment. However, as experience in the use of causal chain analysis grows, and knowledge is accumulated from different types of causal chains in different countries, this task should become more refined and routine (e.g., through the development of databases and technical manuals to assist in future assessments).

6.3 Guidance for developing a map of the causal chain

After identifying all the possible effects of the policy or action, the next step is to include them in a map of 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 number of interlinked logical and sequential stages.

Users should identify the relevant **inputs**, **activities**, **effects** and **GHG effects** associated with the policy or action. These should be consistent with the indicators to be monitored during implementation of the policy (see Chapter 10). Inputs, activities, effects, and GHG effects are defined as follows:

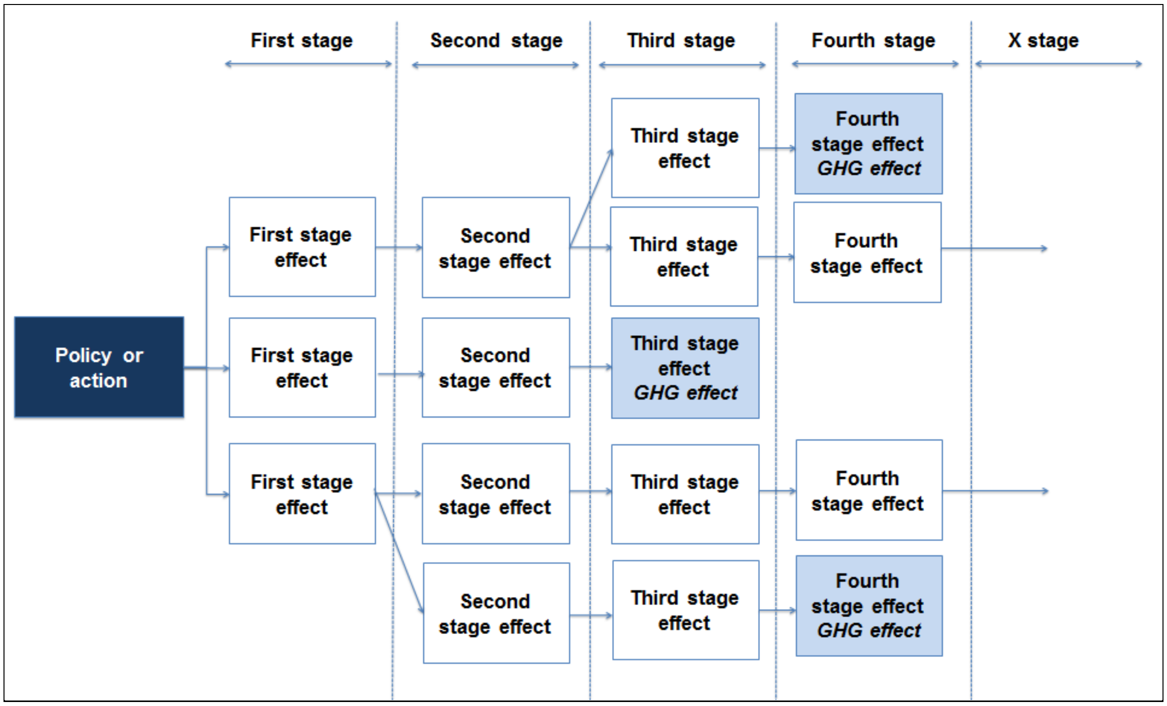
- **Inputs** associated within the policy or action, including investment expenditure and human resources
- **Activities** affected by the policy or action, and the impacts within the GHG assessment boundary
- **Effects** caused by the policy or action, including the increased deployment of technologies and changes in behavior (sometimes referred to as “outputs”)
- **GHG effects** of the policy or action, i.e., the net changes in GHG emissions and removals resulting from the effects (sometimes referred to as “outcomes”)

The causal chain is based on the concept that there are links and interaction pathways between individual elements of the environment, society, and economy. The method aims to identify the links that describe the pathway from the initial policy or action to the eventual GHG effects by drawing a visual diagram of the relationships between the policy or action, intermediate effects, and final GHG effects.

In order to prepare the causal chain, the effects of the policy or action should be divided into several sequential stages (see Figure 6.2). Stages represent the number of steps in the causal chain between the immediate effects of the policy or action, and subsequent effects that result from the initial (first-stage) effects. For example, a government incentive program for insulation (the policy or action assessed) leads consumers to purchase and install insulation (a first stage effect), which leads consumers to reduce their energy use in homes (a second stage effect), which turn leads to reduced GHG emissions from energy use (a third stage effect and a GHG effect).

Note that the causal chain identifies and maps all potential effects, but does not estimate the magnitude of the effects or quantify the values of the various emission sources identified. The magnitude of effects is quantified in subsequent chapters (Chapters 8, 9, and 11).

Figure 6.2: Mapping effects by stage



Prior to building the network of a causal chain (Figure 6.2), users may find it useful to undertake an analysis for each stage to identify interactions of each of the effects in a given stage with relevant environmental, social, and economic factors that will result in additional effects in the next stage of the causal chain. See Table 6.3 for an example of an impact assessment matrix that considers several environmental, social, and economic factors.

Table 6.3: Example of an impact assessment matrix

Effect(s) in a given stage	Project/source level	Subnational level	National level	Global level
Environmental factors				
GHG emissions				
Global environmental systems				
Ecosystems				
Habitats				
Resources				
Air pollutants (non-GHG)				
Water				
Soil				
Social factors (that may lead to changes in GHG emissions)				
Consumption				
Culture				
Values				
Health				
Demography				
Employment				
Recreation				
Economic factors (that may lead to changes in GHG emissions)				
Markets				

Technologies	
Resource management	
Industrial structures	
Regional development	
Business practices	
Trade	

All of the potential effects identified in section 6.2 should be included in the causal map. Since the six types of effects outlined in Table 6.1 are not mutually exclusive, users should be sure not to include the same effect twice. Users should develop a summary table of effects across all stages to highlight any effects that may have been counted twice.

Determine extent of the causal chain

The causal chain should be comprehensive to the extent possible, rather than be limited by geography, time, or data availability. Each segment of the causal chain should end once a GHG effect is reached. However, effects of an intervention can appear to be infinite. Thus, it is may be necessary to limit the appropriate scope and extent of a causal chain.

Users should use research results, peer-reviewed literature, cause and effect observations, or expert judgment to predict the consequences of any outcome. When relationships are largely undefined, a more general coverage of consequences (or lack of) is all that is necessary to draw the line and not proceed further in the causal chain. In these cases, the user should state that the knowledge of relationships necessary to make more definitive finding about various indirect effects is simply not available and cannot be reasonably determined under current capabilities.

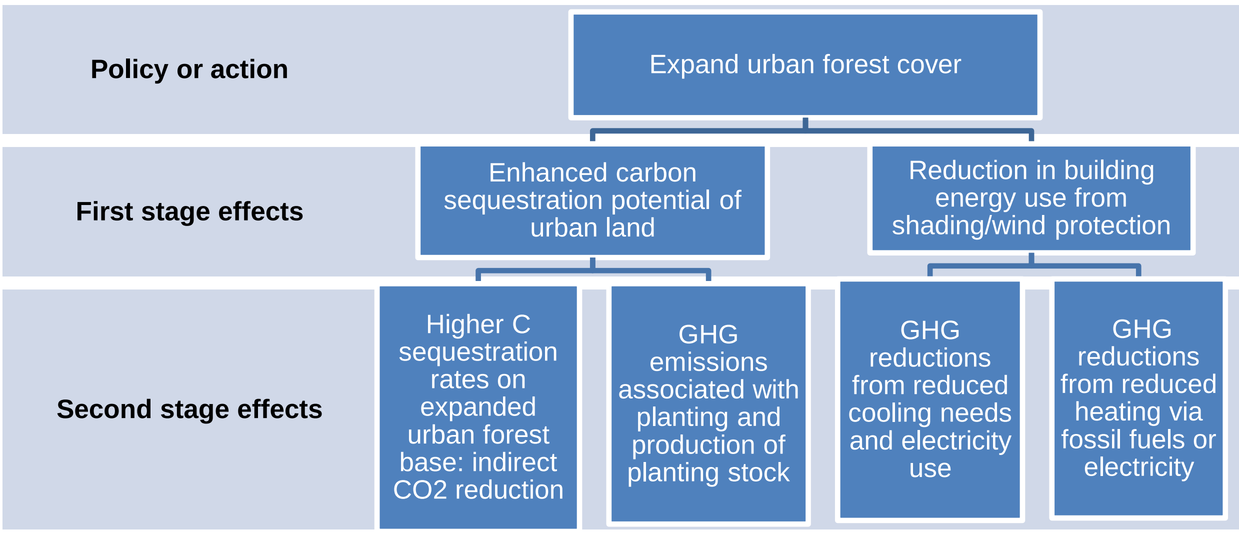
A single formula is not available for determining the appropriate scope and extent of a causal chain analysis. Ultimately, the user must determine the methods and extent of the analysis based on the scale and type of intervention proposed, its location, GHG emission reduction potential, and interactive nature, among other factors. However, whenever a boundary limitation is placed while developing the causal chain, it should be supported by evidence or analysis.

See Chapter 14 for reporting requirements related to mapping the causal chain.

6.4 Examples of mapping the causal chain[5]

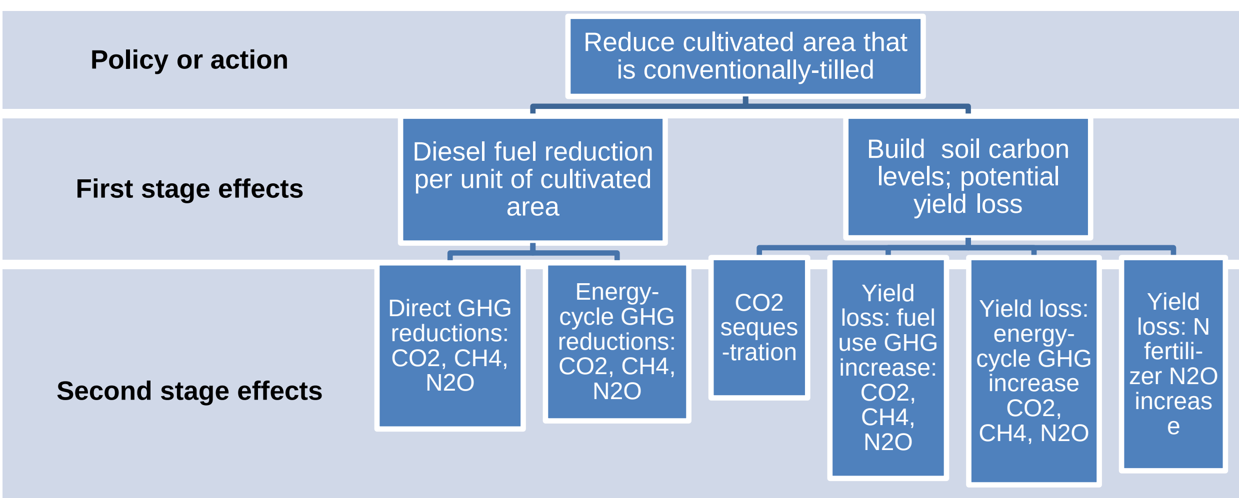
Example 1: Urban forestry

Policy design: Increase urban tree canopy cover from current US average of 27% to 36% cover by 2060. Policy includes strategic placement provisions whereby 75% of trees will be planted to achieve shading and wind protection benefits for residential, commercial, and institutional buildings. Of the strategic plantings, 90% will be planted in suburban areas and 10% in the areas dominated by high rise buildings.



Example 2: Soil carbon management via no-till/conservation tillage

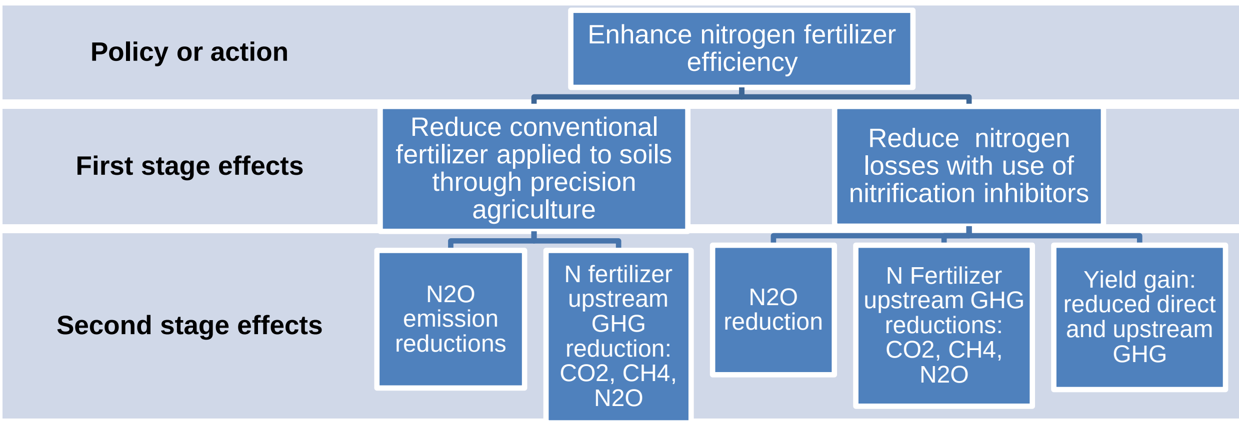
Policy design: Achieve half of the potential change in tillage practice [conversion from conventional to no-till (NT) or conservation tillage (CT) by 2030]; one-third of the converted management via no-till and two-thirds via conservation tillage.



[5] Source of examples: The Center for Climate Strategies (2012).

Example 3: Nutrient management via precision agriculture and use of nitrification inhibitors

Policy design: Address one-third of the potential area for reducing nitrogen (N) application rates by 2030; 75% of the acreage addressed through precision agriculture application techniques and 25% through the use of nitrification inhibitors.



[Placeholder for additional sector-specific guidance and examples of mapping the causal chain]

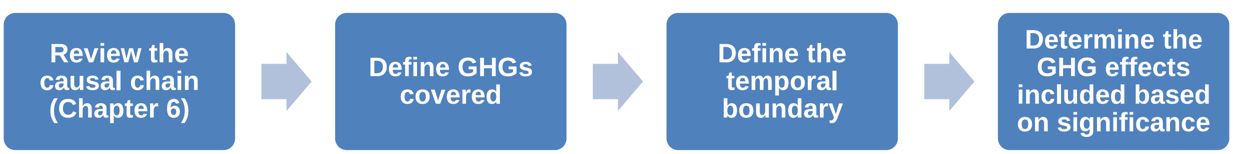
Chapter 7: Defining the GHG assessment boundary

The GHG assessment boundary defines the scope of the GHG assessment in terms of the GHGs included; the geographies and sectors covered; the time period covered; and the GHG effects for which GHG impacts are quantified.

Requirements in this chapter

- Users shall include all seven UNFCCC/Kyoto Protocol gases (CO_2, CH_4, N_2O, SF_6, PFCs, HFCs, NF_3) in the assessment.
- Users shall apply GWP values provided by the Intergovernmental Panel on Climate Change (IPCC) based on a 100-year time horizon and shall disclose the GWP values used to quantify emissions.
- Users shall define the policy implementation period, the policy monitoring period, and the GHG assessment period.
- Users shall document the tier selected and the criteria and methodology used to determine significance.
- Users shall include all significant effects in the GHG assessment boundary, consistent with the chosen tier.
- Users of Tier 2 and Tier 3 shall define a significance threshold for determining which GHG effects are significant in size and shall disclose and justify the significance threshold used.
- Users of Tier 2 shall include all effects in the GHG assessment boundary except those that are either insignificant in size or very unlikely to occur, and shall not exclude from the GHG assessment boundary any effects that collectively account for more than 10% of the total expected change in GHG emissions from the policy or action (in absolute value terms).
- Users of Tier 3 shall include all effects in the GHG assessment boundary, but may use less accurate quantification methods (e.g., the same methods used in the estimation step) to quantify GHG impacts for effects that are expected to be insignificant in size or very unlikely to occur.
- Users shall disclose and justify any GHG effects excluded from the GHG assessment.

Figure 7.1: Overview of steps in the chapter



7.1 GHGs included in the GHG assessment boundary

Users shall include within the scope of the GHG assessment the seven gases covered by the UNFCCC and Kyoto Protocol: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulphur hexafluoride (SF6), perfluorocarbons (PFCs), and hydrofluorocarbons (HFCs), and nitrogen trifluoride (NF_3). Users may also include additional greenhouse gases within the assessment, such as black carbon, CFCs, HCFCs, NO_X, etc. In this case, users should report the results with and without additional GHGs included.

Global warming potential (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, and convert GHG emissions data for non-CO_2 gases into units of carbon dioxide equivalent (CO_2e). Users shall apply GWP values provided by the Intergovernmental Panel on Climate Change (IPCC) based on a 100-year time horizon. Users shall disclose the GWP values used to quantify emissions. See Box 7.2 for guidance on optionally applying different climate impact timeframes.

7.2 Temporal boundary

There are several different temporal boundaries to consider when carrying out a GHG assessment of a policy. Users shall define the following three temporal boundaries for the GHG assessment:

- **Policy implementation period**: The time period during which the policy or action is in effect (defined in Chapter 5).
- **Policy monitoring period**: The time over which the policy is monitored. This may include pre-policy monitoring (i.e., including a base period) and post-policy monitoring (over which the permanence of the policy is assessed), in addition to monitoring during the policy implementation period.
- **GHG assessment period:** The time period over which GHG effects associated with the policy and its effects are assessed.

Emissions or removals resulting from the policy may occur after the policy implementation period ends. Users should define the GHG assessment period based on the timescales of the emissions sources identified in the causal chain and the time required for the interactions identified within the causal chain to occur and result in GHG effects (i.e., changes in emissions or removals). Whereas the choice of a policy implementation period and policy monitoring period involve policy considerations, users should define the GHG assessment period based on peer-reviewed scientific evidence of when the full range of GHG effects are expected to occur.

For policies expected to have immediate or very short-term GHG effects, the GHG assessment boundary may be the same or similar to the policy implementation period. However, for policies with long-term GHG effects (e.g., waste management policies that affect methane emissions from landfills, or biofuels or land use policies that affect biological carbon sequestration), the GHG assessment boundary may extend as much as 100 years beyond the end of the policy implementation period. GHG effects that occur within the GHG assessment period shall be included in the assessment, even if they occur in the future, unless determined to be insignificant (see section 7.4). See Box 7.1 and Figure 7.2 for an example of temporal boundaries for a biofuels policy.

Box 7.1: Example of temporal boundaries for a biofuels policy

Temporal boundary	Example
Policy implementation period	10 years: 1 January 2010 - 1 January 2020
Policy monitoring period	20 years: The relevant sources are monitored on an annual basis from 2005 to 2025 (including pre-implementation, during implementation, and post-implementation)
GHG assessment period	25 years after the policy implementation period ends. Emissions associated with fuel production and combustion in motor vehicles are assumed to occur within the year. Biofuels are expected to be produced with short rotation non-woody (e.g., agricultural) crops; however, the timing of land-use change may be delayed by up to five years. Changes in soil carbon storage associated with land-use change are expected to occur within 20 years of land conversion.

Figure 7.2: Example of temporal boundaries for a biofuels policy

	Years							
	2005 – 2009	**2010 - 2014**	**2015 - 2019**	**2020 - 2024**	**2025 - 2029**	**2030 - 2034**	**2035 - 2039**	**2040 - 2045**
Policy implementation period								
Policy monitoring period								

GHG assessment period							

Box 7.2: Climate impact timeframe

The climate impact timeframe is the time period over which the climate impacts of emissions are assessed, which is directly related to the choice of global warming potential (GWP) values that are used to relate non-CO_2 greenhouse gas emissions or other climate drivers to CO_2.[6] Many jurisdictions and organizations use 100-year GWP values to quantify GHG emissions, which assess GHG impact over a 100 year time period. Users shall apply GWP values provided by the Intergovernmental Panel on Climate Change (IPCC) based on a 100-year time horizon, but may also choose to evaluate GHG impacts over a shorter time period (e.g., 20 years) or a longer time period (e.g., 500 years), depending on policy objectives about whether to address near-term climate change (on the order of 20 years) or long-term climate change (on the order of 500 years). Users that apply GWP values other than 100-year values shall disclose and justify the choice of other GWP values and also report GHG effects using the 100 year GWP values. Consistent GWP values shall be used through the assessment.

7.3 Determine the GHG effects included in the assessment boundary

The causal map developed in Chapter 6 identifies all potential effects from a policy (or package of policies) and their associated GHG effects that have some likelihood of occurring. While all of the potential effects may have real impacts on GHG emissions, not all of these effects will be significant. Users shall include all significant effects in the GHG assessment boundary regardless of their type (i.e., intended, unintended, in-boundary, out-of-boundary, short-term, or long-term), within the context of the chosen tier (see below).

Selecting a tier for determining significance

The determination of significant effects depends on the objectives of the assessment. This section describes how the tiers presented in Chapter 3 apply to determining which GHG effects should be considered significant and included in the GHG assessment boundary. See Table 7.1 for a description of tiers. The tiers range from more flexible and less rigorous (Tier 1) to less flexible and more rigorous (Tier 3). Users should apply the same criteria across all policies being evaluated, to the extent possible.

Table 7.1: Summary of tiers for determining which GHG effects are included in the assessment

<table>
<tr><th>Tier</th><th>Approach for determining significance of GHG effects</th><th>Level of completeness</th></tr>
<tr><td>Tier 1</td><td>Qualitative, user-defined assessment of significance</td><td>User-defined</td></tr>
<tr><td>Tier 2</td><td rowspan="2">Quantitative, risk-based assessment of significance (based on likelihood of the effect occurring and estimated magnitude of net change in emissions and removals resulting from the effect)</td><td>Most significant effects are included (see Table 7.2)</td></tr>
<tr><td>Tier 3</td><td>All effects are included, but less accurate quantification methods are used for insignificant effects (see Table 7.2)</td></tr>
</table>

The selection of the criteria will in large part be based on the objectives of the assessment and the resources available. See Chapter 3 for guidance on selecting tiers. Users shall document the tier selected and the criteria and methodology used to determine significance. Once the criteria are established, the user shall apply the criteria to each of the GHG effects identified in the causal chain map developed in Chapter 6.

[6] Weaver, A.J., Toward the Second Commitment Period of the Kyoto Protocol, *Science*, **332**, 795 (2011).

Qualitative approaches to determining significance (Tier 1)

Tier 1 provides the user flexibility to select specific significance criteria appropriate for their individual situation. Qualitative criteria may include, but are not limited to:

- Existing literature on the significance of GHG effects for various policy or action types
- Expert judgment
- Expected likelihood of occurrence
- Estimates of emissions magnitude
- Estimates of proxy or indicator data
- Direction or requirements of controlling program, treaty, guidance or agreement
- Relevance of potential impacts to the policy objectives and context
- Measurability and data availability
- Stakeholder interest and participation
- User resources and capacity

Users of the Tier 1 approach should incorporate quantitative criteria to the extent possible, both in terms of the expected magnitude of the emissions impacts and the likelihood of occurrence (outlined further below).

Quantitative approaches to determining significance (Tier 2 and Tier 3)

Users of Tier 2 and Tier 3 shall assess the likelihood of occurrence of each GHG effect and estimate the expected emissions impacts of each effect.

<u>Estimating likelihood of occurrence</u>

Users of Tier 2 and 3 should rank each of the potential effects identified in the causal chain by their suspected likelihood of occurrence. To the extent available, users should rely on published data and previous studies to estimate the likelihood of occurrence. Users may also rely upon modeling, expert judgment, and other methods to make their judgments. The likelihood of occurrence may change over time, and the implementation of the policy itself, or other policies, may affect the likelihood of occurrence. The user should take this into account using the best information available at the time of the assessment.

As a general rule, users should estimate likelihood based on the following rules of thumb:

- Very likely: 80% to 100% chance of occurring
- Likely: 50% to 80% chance of occurring
- Unlikely: 20% to 50% chance of occurring
- Very unlikely: 0% to 20% chance of occurring

See Box 7.3 for an example of ranking GHG effects by their likelihood of occurring.

Box 7.3: Example of ranking GHG effects by their likelihood of occurring.

In this simplified example, a policy has six GHG effects (A through F). Previous studies are used to determine their likelihood of occurring. The effects are then ranked from most likely to least likely.

GHG effect	Expected likelihood of occurring	Rank (most likely to least likely)
A	Likely	2
B	Very likely	1
C	Unlikely	4
D	Very unlikely	6
E	Unlikely	4
F	Likely	2

<u>Estimating expected magnitude of GHG effects</u>

After the likelihood of occurrence has been assessed, the user shall conduct initial estimates of the expected change in GHG emissions associated with each GHG effect included in the causal chain. Users shall estimate the net change in GHG emissions associated with each effect, including both increases and decreases in GHG emissions and removals associated with each effect.

Users shall, at a minimum, estimate the relative order of magnitude of the various GHG emissions effects, either in units of GHG emissions or other units (e.g., changes in activity data or other relevant parameters, such as vehicle kilometers traveled, electricity consumption, etc.). To be most accurate and complete, users should calculate expected changes in GHG emissions using equations or algorithms based on activity data and emission factors. In either case, net emissions should be estimated (taking into account both increases and decreases in GHG emissions by sources and removals by sinks).

GHG effects should then be ranked according to their expected absolute value. See Box 7.4 for an example of ranking GHG effects by their expected absolute value.

Box 7.4: Example of ranking GHG effects by their expected absolute value

The expected magnitudes of the six GHG effects (A through F) are estimated using initial estimation methods. Based on initial estimates, three effects are expected to result in net increases in emissions (A, B, and E), and three effects are expected to result in net decreases in emissions (C, D, and F). The effects are then ranked from largest to smallest based on their absolute value.

GHG effect	Expected net change in GHG emissions and removals from each effect	Expected net change in GHG emissions and removals (absolute value)	Percentage of total change (absolute value)	Rank (largest to smallest)
A	+ 1,000 $MTCO_2e$	1,000 $MTCO_2e$	8%	5
B	+ 3,000 $MTCO_2e$	3,000 $MTCO_2e$	24%	2
C	- 1,500 $MTCO_2e$	1,500 $MTCO_2e$	12%	4
D	- 2,000 $MTCO_2e$	2,000 $MTCO_2e$	16%	3
E	+ 200 $MTCO_2e$	200 $MTCO_2e$	2%	6
F	- 5,000 $MTCO_2e$	5,000 $MTCO_2e$	39%	1

Based on initial estimates, the expected total net change from the policy is -4,300 (i.e., a net decrease in emissions of 4,300 $MTCO_2e$). However, GHG effects should be ranked in terms of absolute value. The total sum of GHG effects in absolute value is 12,700 $MTCO_2e$. In this example, GHG effect F represents 39% of the total expected change (in absolute value), while GHG effect E represents 2%.

<u>Defining a significance threshold and selecting all significant effects</u>

Next, users should combine the likelihood of each effect occurring with the expected magnitude of each effect to determine which effects are included in the GHG assessment boundary.

Users shall define a significance threshold for determining which GHG effects are significant in size. As a rule of thumb, users should consider the largest GHG effects that collectively account for 90% of the total expected change in emissions and removals (in absolute value terms) to be significant. Users shall disclose and justify the significance threshold used.

Table 7.2 outlines thresholds for including GHG effects in the GHG assessment boundary for Tier 2 and Tier 3. The definition of "significant" in Table 7.2 depends on the significance threshold chosen by the user.

Under Tier 2, users shall include all effects in the GHG assessment boundary except those that are either insignificant in size (e.g., effects that collectively account for less than 10% of the total expected change in emissions and removals) <u>or</u> very unlikely to occur (e.g., less than 20% chance of occurring), which may be excluded if disclosed and justified. Under Tier 2, users shall not exclude from the GHG assessment boundary any effects that collectively account for more than 10% of the total expected change in GHG emissions from the policy or action (in absolute value terms).

Under Tier 3, users shall include all effects in the GHG assessment boundary, but may use less accurate quantification methods (e.g., the same methods used in the estimation step) to quantify GHG effects that are expected to be insignificant in size (e.g., effects that collectively account for less than 10% of the total expected change in emissions and removals) or very unlikely to occur (e.g., less than 20% chance of occurring). Under Tier 3, users may exclude effects that are both insignificant <u>and</u> very unlikely to occur if disclosed and justified. The added burden of Tier 3 compared to Tier 2 is expected to be small since the same GHG estimates resulting from the estimation step used to determine significance may be used to estimate insignificant effects under Tier 3.

Table 7.2: Approach to including GHG effects in the GHG assessment boundary for Tier 2 and Tier 3

<table>
<tr><td colspan="2" rowspan="2"></td><td colspan="2">Estimated magnitude of net change in GHG emissions and removals (in absolute value)</td></tr>
<tr><td>Significant (e.g., collectively account for 90% or more of total change)</td><td>Insignificant (e.g., collectively account for 10% or less of total change)</td></tr>
<tr><td rowspan="4">Estimated likelihood of occurring</td><td>Very likely
(80-100% chance)</td><td rowspan="3">Included under Tier 2
Included under Tier 3</td><td rowspan="3">Excluded under Tier 2
Estimated under Tier 3</td></tr>
<tr><td>Likely
(50-80% chance)</td></tr>
<tr><td>Unlikely
(20-50% chance)</td></tr>
<tr><td>Very unlikely
(0-20% chance)</td><td>Excluded under Tier 2
Estimated under Tier 3</td><td>Excluded under Tier 2
Excluded under Tier 3</td></tr>
</table>

See Box 7.5 for an example of selecting GHG effects for inclusion in the GHG assessment boundary.

Box 7.5: Example of selecting GHG effects for inclusion in the GHG assessment boundary

The outputs from Box 7.3 and Box 7.4 are combined to assess the expected likelihood and expected magnitude of each of the six GHG effects (A through F) to determine which effects should be included in the GHG assessment boundary. Each GHG effect is included except for effect E, since effect E is expected to be small in size (2%) and unlikely to occur.

GHG effect	Likelihood of occurring	Rank (most likely to least)	Percentage of total change (absolute value)	Rank (largest to smallest)	Included under Tier 2?	Included under Tier 3?
A	Likely	2	8%	5	Included	Included
B	Very likely	1	24%	2	Included	Included
C	Unlikely	4	12%	4	Included	Included
D	Very unlikely	6	16%	3	Excluded	Included
E	Unlikely	4	2%	6	Excluded	Estimated
F	Likely	2	39%	1	Included	Included

Users should strive for completeness, but it is acknowledged that accounting for all GHG effects of a policy or action may not be feasible. In some situations, users may be unable to estimate GHG effects due to a lack of data or other limiting factors. 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 serves the decision-making needs of users of the assessment report. Any GHG effects excluded from the GHG assessment shall be disclosed and justified.

<u>Reevaluating significance through an iterative process</u>

The application of the significance criteria is an iterative process. Firstly, the inclusion of additional GHG effects which are determined to be significant may reduce the overall change in GHG emissions attributed to the policy or group of policies. This, in turn, may result in a smaller net GHG emissions change against which additional potential GHG effects are evaluated, resulting in the inclusion of additional potential impacts as significant. Secondly, the emissions estimates carried out in this step in the assessment will be subject to revision when GHG effects are quantified in more detail in Chapters 8, 9, and 11. To the extent that more accurate quantification results in significant differences in the magnitude of GHG changes for each effect, a reevaluation of significance may be necessary.

See Chapter 14 for reporting requirements related to defining the GHG assessment boundary.

[Placeholder for sector-specific guidance and examples of defining the GHG assessment boundary]

Chapter 8: Determining baseline emissions

This standard is designed to quantify the change in GHG emissions resulting from a given policy or action relative to what would have happened otherwise. This requires a reference case against which GHG effects are quantified (i.e., a baseline scenario). In order to determine the effect of a policy or action, it is necessary to understand what would have happened in the absence of that policy or action.

Defining the baseline scenario is a critical step, since establishing a credible and realistic scenario of would have happened in the absence of the policy or action has a direct and significant impact on the estimated GHG effect of the policy or action.

In many cases, the step of determining baseline emissions (explained in this chapter) precedes data collection and quantification of GHG effects (explained in Chapters 9, 10, and 11). However, some methods (e.g., econometric models) may address these steps in parallel rather than in sequence.

Requirements in this chapter

- Users shall define an emissions estimation algorithm and all parameters, drivers, and assumptions required to estimate baseline emissions.
- Users shall quantify all effects that have been included in the GHG assessment boundary.
- Any effects that have not been quantified shall be disclosed and justified and described qualitatively.

8.1 Key concepts and terms

This standard uses the term “baseline” rather than other terms sometimes used to describe the same concept, such as counterfactual, reference case, reference scenario, or business-as-usual scenario. This chapter makes a distinction between two related concepts.

- Baseline scenario
- Baseline emissions

A **baseline scenario** is a set of assumptions and data describing the most likely events or conditions that would have occurred in the absence of the policy intervention, based on available information. The baseline scenario depends on assumptions related to key drivers (e.g., policies, technologies, management methods, costs, etc.).

Baseline emissions are an estimate of GHG emissions, removals, or storage associated with a baseline scenario. Elements that are required to calculate the baseline emissions include the baseline emissions factors and baseline activity data. The extent of data collection depends on the GHG assessment boundary, including the temporal boundary (see Chapter 7).

Baseline scenarios also depend on whether they are ex-ante or ex-post. An **ex-ante baseline scenario** is a baseline scenario that is established prior to implementation of the policy or policies based on forecasts of external drivers (e.g., projected population, economic activity, or other conditions that affect emissions).

Conversely, an **ex-post baseline scenario** is a baseline scenario that is established during or after implementation of the policy or policies and may include adjustments to the ex-ante forecasts of external drivers based on observed historic data (e.g., changes in population, economic activity, or other conditions that affect emissions), if an ex-ante assessment was undertaken.

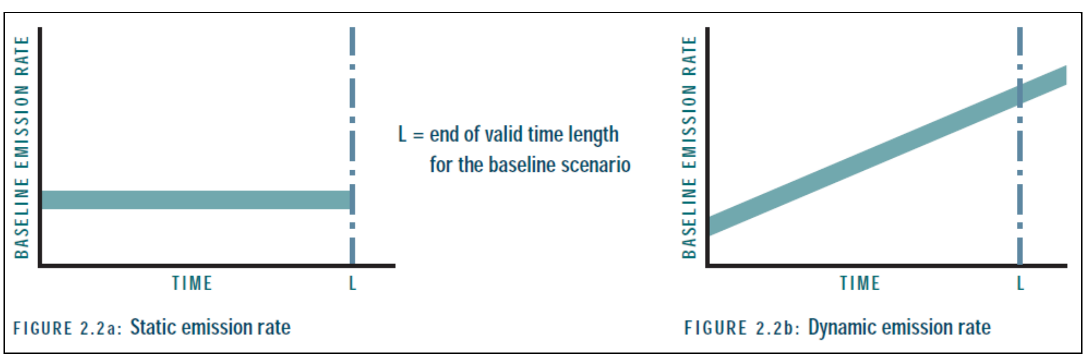
Baseline scenarios and baseline emissions may include both static (fixed) elements and dynamic (changing) elements.[7] For example, baseline emissions may be calculated using static emission factors, but dynamic activity data. Figure 8.1 demonstrates the concept of static and dynamic as applied to emission factors. While these generally mean fixed in time or changing in time, these terms also have been used in different ways in the context of GHG accounting.[8] While individual elements of a baseline scenario and baseline emissions are either static or dynamic, an entire baseline scenario typically consists of static and dynamic elements, so is not referred to as either static or dynamic overall.

See Table 8.1 for a summary of terms and definitions.

Table 8.1: Key terms and definitions

Term	Definition
Baseline scenario	A set of assumptions and data describing the most likely events or conditions that would have occurred in the absence of the policy intervention, based on available information. Elements that are required to define a baseline scenario include baseline assumptions (e.g., related to policies, technologies, management methods, cost, etc.)
Baseline emissions	An estimate of GHG emissions, removals, or storage associated with a baseline scenario. Elements that are required to calculate the baseline emissions include the baseline emissions factors and baseline activity data.
Ex-ante baseline scenario	A baseline scenario that is established prior to implementation of the policy or policies based on trends in historical data and on forecasts of external drivers (e.g., projected population, economic activity, or other conditions that affect emissions).
Ex-post baseline scenario	A baseline scenario that is established during or after implementation of the policy or policies and may include adjustments to the ex-ante forecasts of external drivers based on observed historic data (e.g., changes in population, economic activity, or other conditions that affect emissions).
Static	A descriptor for an element of a baseline scenario or baseline emissions calculation (e.g., emission factor) that does not change over time.
Dynamic	A descriptor for an element of a baseline scenario or baseline emissions calculation (e.g., emission factor) that changes over time.

Figure 8.1: Illustration of static and dynamic as applied to emission factors[9]



[7] The terms static and dynamic are not necessarily specific to *baseline* scenarios and could also apply equally to *policy* scenario elements.
[8] For example, CDM and carbon finance groups have tended to use the term dynamic baseline in the context of ex-post accounting to specify that a baseline may be changed over the course of project implementation.
[9] Source: WRI/WBCSD GHG Protocol for Project Accounting

Ex-ante and ex-post baseline scenarios

Baseline scenarios can either be developed prior to implementation of a policy or action (i.e., ex-ante) or after a policy or action has already been implemented (i.e., ex-post). Ex-ante baseline scenarios are used to quantify GHG effects in Chapter 9, while ex-post baseline scenarios are used to quantify GHG effects in Chapter 11.

Ex-ante baseline scenarios by definition require forecasted data in additional to historical data, and should incorporate the best data available at the time of the analysis. Ex-post baseline scenarios should be revised with more up-to-date information (if an ex-ante baseline scenario was first developed) to reflect observed changes that occurred since the ex-ante baseline was first projected (which may have included assumptions that turned out to be false), as long as the changes are not as a result of the policy being measured. The methods for incorporating these data into a baseline scenario and baseline emissions calculation are the same, however, and the approach described below is appropriate for both ex-ante and ex-post assessment.

8.2 Choose type of comparison (relevant for ex-post assessment only): cross sectional or time series[10]

Quantifying the GHG effects of a given 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 (i.e., the baseline scenario).

This comparison can be done in one of two ways:

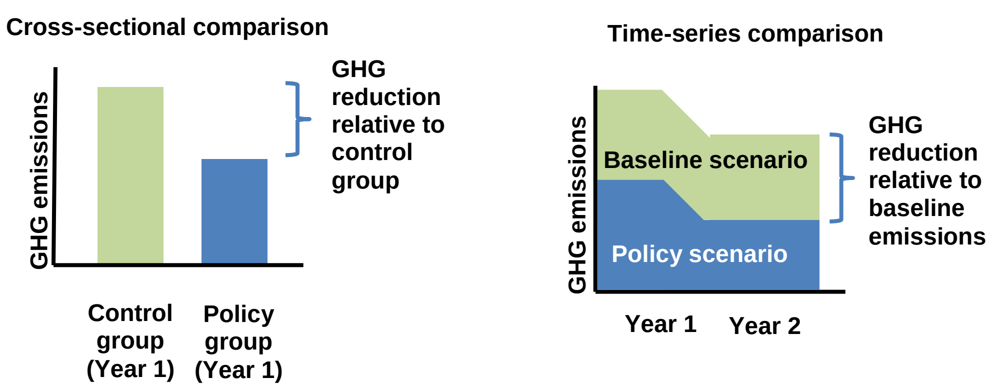
- **Cross-sectional comparison**: a comparison of one group or region affected by a policy or action with an equivalent group or region that is not affected by that policy or action, or

- **Time-series comparison**: a comparison of one group or region affected by a policy or action over time (e.g., before and after implementation).

While the time-series approach can be used for both ex-ante and ex-post assessments, the cross-sectional approach can be used for ex-post assessments only. Therefore, users only need to choose between the two approaches when carrying out an ex-post assessment.

Figure 8.2 illustrates the difference between the two approaches.

Figure 8.2: Comparison of a cross-sectional approach and a time-series approach



[10] Adapted from the United Kingdom HM Treasury, *The Magenta Book: Guidance for Evaluation*, Chapter 9, "Empirical Impact Evaluation," 97-124, 2011.

Whether to choose a cross-sectional or time-series approach for ex-post assessment depends on several factors, including:

- The type of policy or action
- The availability of an appropriate comparison group that would be needed to implement the cross-sectional approach (i.e., if no suitable comparison group exists, the time series approach should be used)

To reliably and credibly implement a cross-sectional approach, those actors that are affected by the policy (i.e., the policy group) and those actors that are not affected by the policy (i.e., the control group) must be otherwise equivalent. Under ideal experimental conditions, the two groups would be randomly assigned (e.g., through randomized controlled trials) to ensure that any differences between the groups is a result of the policy, rather than any underlying systematic differences or biases. In practice, random assignment in the context of large-scale policies and actions is seldom feasible.

Where random assignment is not possible, two other methods can be used to avoid "selection bias" and ensure valid comparisons:

- Using non-random groups where participation in either group does not depend on any factors expected to affect emissions, such that they can be treated as equivalent
- Using regression analysis to remove the "selection bias" between the non-equivalent groups

In addition, the evaluator must ensure that the actors that are part of the control group are not directly or indirectly affected by the policy.

Examples of policies or actions where a cross-sectional approach may be feasible include:

- Policies or actions that are implemented in one sub-national jurisdiction, but not in a similar neighboring jurisdiction (assuming that the sub-national jurisdictions are otherwise equivalent)
- Voluntary agreements where selected actors agree to participate in a GHG mitigation program (assuming that those actors that choose to participate and those that choose not to participate are otherwise equivalent)
- Incentive programs where selected actors agree to participate (those actors that choose to participate and those that choose not to participate are otherwise equivalent)

Examples of policies or actions where a cross-sectional approach may not be feasible include:

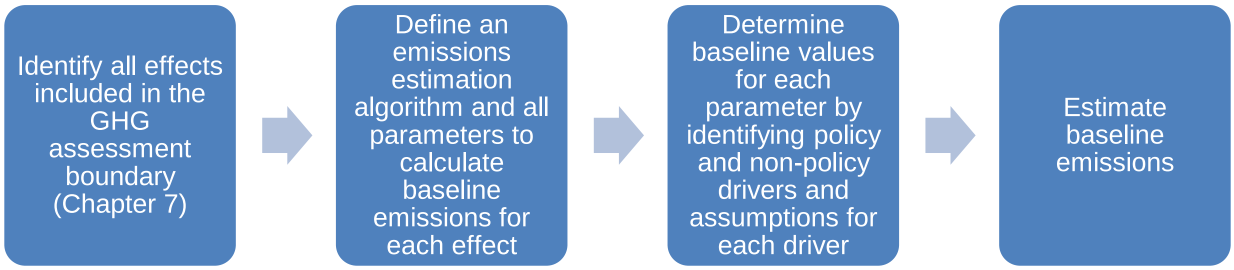
- Regulations and standards (e.g., performance standards) applied to all relevant actors within an entire sector
- Taxes or charges (e.g., energy tax) applied to an entire jurisdiction
- Tradable permits (e.g., emissions trading programs) applied to an entire sector

Section 8.3 provides guidance on implementing the time series approach, while section 8.4 provides guidance on implementing the cross-sectional approach.

8.3 Estimating baseline emissions using the time series approach (for ex-ante and ex-post assessments)

This section outlines the main steps in estimating baseline emissions using the time series approach. See Figure 8.3 for a flow chart of the key steps.

Figure 8.3: Overview of steps in estimating baseline emissions using the time series approach



While the overall approach to the development of a baseline scenario may follow the same general steps, the way each step is carried out may depend on the objectives of the assessment (see Chapter 2). A tiered approach is provided in this chapter to allow for various levels of detail and rigor depending on the objectives of individual users (see section 8.4).

Step 1: Identify all effects of the policy or action included in the GHG assessment boundary

The first step is to identify all significant effects of the policy or action (based on those mapped in Chapter 6 and included as significant in Chapter 7) to determine the extent of data that needs to be collected and the extent of effects that need to be quantified. The assessment boundary determines the geographic extent and temporal range of the analysis as well as the variety of effects to be quantified (i.e., intended and unintended effects, in-boundary and out-of-boundary effects, and short-term and long-term effects).

The causal chain identifies and maps all potential effects, but does not quantify the magnitude of the effects or quantify the values of the various emission sources identified. The magnitude of the effects is quantified by first determining baseline emissions for each effect in this chapter, then quantifying the change in GHG emissions compared to the baseline scenario (either in Chapter 9 for ex-ante assessment or Chapter 11 for ex-post assessment).

Step 2: Define the emissions estimation algorithm and all parameters needed to quantify baseline emissions for each effect

For each emission source (or sink) that is expected to be affected by the policy or action, users should first identify an algorithm for calculating the emissions (or removals) from that source, then identify the parameters needed to calculate emissions.

Define the emissions estimation algorithm

The emissions estimation algorithm can take the form of:

- Simple equations
- Complex models
- A combination of methods

See Equation 8.1 and Equation 8.2 for examples of simple equations that can be used.

Equation 8.1

GHG Emissions = Activity Data x Emission Factor

Equation 8.2

GHG Emissions = (Activity x Efficiency x GHG intensity) + Non energy emissions – GHG Removals

Activity data is 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.

An **emission factor** is a factor that converts activity data into GHG emissions data (e.g., kg CO_2e emitted per liter of fuel consumed).

For certain types of policies or actions, simple equations will not be possible or appropriate. For example, an emission trading scheme may lead to emission reductions by creating a market for tradable permits, which influences individual business decisions that are difficult to measure, monitor, or estimate. For other policies, the emissions reduction strategy may be so complex as to require a complex modeling approach where parameters serve as input data to the model and the algorithm for estimating emissions is embedded within the model itself. A variety of models can be used to determine the baseline scenario and quantify baseline emissions.

Uses may use bottom-up data and methods, top-down data and methods, or a combination of bottom-up and top-down data and methods (for more information, see section 3.1).

Section 8.4 provides tiered approaches for determining baseline emissions, including selecting emissions estimation algorithms. Users may implement any approach for estimating baseline emissions that adhere to the guiding principles of accuracy, completeness, consistency, relevance and transparency (see Chapter 4) in the context of the user's defined objectives (see Chapter 2), so long as the methodology is clearly reported and assumptions are transparent.

Users shall report the emissions estimation algorithm used (including any models used) to quantify baseline emissions. For some models, this may require the user to extract and simplify key sections of model documentation such that the algorithm is clearly stated and accessible to relevant stakeholders.

See Appendix A for guidance on the collection, collation, and analysis of data, and Chapter 12 for guidance on assessing uncertainty.

<u>Define the parameters in the emissions estimation algorithm</u>

Users shall define all parameters required to estimate baseline emissions using the emissions estimation algorithm. The defined parameters will guide the user to collect the necessary data to quantify baseline emissions. Users should include all parameters that are significant and for which data are available to calculate baseline emissions with sufficient accuracy to meet the stated objectives.

Step 3: Determine baseline values for each parameter

Once parameters are identified, the next step is to determine baseline values for each parameter. To determine do so, users should first decide whether to develop new baseline values or use baseline values from published data sources. Users shall justify the choice of whether to develop new baseline data and assumptions or to use published baseline data and assumptions.

Users should use conservative assumptions to define baseline values for each parameter when uncertainty is high. Conservative values and assumptions are those that are more likely to underestimate GHG emissions in the baseline scenario.

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 (e.g., IEA, IPCC, World Bank, UN FAO, etc.), and economic and engineering analyses and models.

Users should use high-quality, peer-reviewed data from recognized, credible sources when available. Sources of data can vary in quality. When selecting data sources, users should apply the data quality indicators in Table 8.2 as a guide to obtaining the highest quality data available. The data quality indicators describe the representativeness of data (in terms of technology, time, and geography) and the quality of data measurements (i.e., completeness and reliability of data). Users should select data that are the most representative in terms of technology, time, and geography; most complete; and most reliable. When uncertainty exists, users should choose conservative values.

Users shall document and report all sources of data used, including activity data, emission factors, and assumptions from published sources.

Table 8.2: 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 (e.g., country, city, or site)
Completeness	The degree to which the data is statistically representative of the relevant activity. Completeness includes the percentage of locations for which data is available and used out of the total number that relate to a specific activity. Completeness also addresses seasonal and other normal fluctuations in data.
Reliability	The degree to which the sources, data collection methods and verification procedures used to obtain the data are dependable.

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 is available that supports the level of accuracy needed to meet the stated objectives. Users shall report a detailed description of the methodology used to develop new baseline data and assumptions.

To develop new baseline values, users should:

- Collect historical data for the parameter
- Identify the significant policy and non-policy drivers that affect each parameter
- Determine 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 in the time series is available. Users should collect data with as high a frequency as is available (e.g., monthly data should be preferred over quarterly data, which should be preferred over annual data), where multiple sources of data exist.

Identify significant policy 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 activities being quantified. This is a critical step, since establishing which drivers are responsible for emission activities and determining reasonable assumptions about their "most likely" values in the absence of the policy being assessed has a significant impact on the resulting baseline emissions estimate, and consequently on the eventual estimate of the GHG effect of the policy or action.

Drivers that affect emissions activities are divided into two types:

- **Policy drivers**, i.e., policies (such as performance standards or emissions regulations) that affect emission activities, and
- **Non-policy (e.g., socioeconomic) drivers**, i.e., other conditions such as economic factors or consumer preferences that may influence emission activities in other ways.

This section explains the types of drivers that should be considered in establishing a baseline scenario.

Policy drivers

In addition to the policy or action being assessed, there are likely to be other policies and regulations that affect emission activities and may interact directly with the assessed policy or action. All other policies that also affect baseline emissions should be included in the baseline scenario.

All existing policies, regulations, and GHG projects (e.g., CDM projects) in the relevant sector and jurisdiction should be included in the baseline scenario. Any existing policies, regulations, and projects that are excluded from the baseline scenario shall be disclosed and justified. If policy drivers are excluded, users should undertake an analysis (e.g., cost analysis, barrier analysis, additional tests) to demonstrate why an existing policy or action should not be included in the baseline scenario. Users shall report all policy drivers that are included in the baseline scenario.

Users may identify additional policy drivers when defining the policy scenario (in Chapter 9) that were not considered when defining the baseline scenario (in Chapter 8). If additional drivers are identified in Chapter 9, users may need to subsequently revise the baseline scenario to incorporate these new drivers.

Examples of policy drivers are provided in Table 8.3.

Table 8.3: Examples of policy drivers that may be included in a baseline scenario

Examples of policies or actions being assessed	Examples of policy drivers in the baseline scenario
Renewable portfolio standard	Feed-in tariffs, production tax credits or renewable incentives, REC markets, utility regulations and interconnect fees, rate structures
Subsides for public transit	Fuel taxes, tolls on bridges, tunnels, highways
Composting, anaerobic digestion, or other organics management policies	Mandatory landfill diversion rates, regulations covering waste combustion, inclusion of these activities as offset mechanisms in voluntary or mandatory carbon markets
Landfill gas management	Mandatory landfill diversion rates, regulations covering waste combustion, inclusion of these 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	Inclusion in voluntary/mandatory carbon markets

Non-policy (e.g., socioeconomic) drivers

Non-policy drivers include a wide range of factors that can influence emissions. Users should consider the following types of non-policy drivers:

- Economic activity (e.g., GDP or household disposable income), which can be an important driver of demand (e.g., for energy)
- Population
- Energy prices (e.g., prices of natural gas, petroleum products, coal, biofuels, electricity)Weather (e.g., heating degree days, cooling degree days)
- Autonomous technological improvement (e.g., decarbonization of economic sectors)
- Structural effects (e.g., structural changes in economic sectors, shifts from industry to service sector jobs, shifts of industrial production between countries)
- Changes in consumer preferences (e.g., preferences for certain types of vehicles)
- Other relevant drivers

Any driver whose change between the baseline scenario and the policy scenario would result in a significant change in calculated emissions should be addressed in the baseline scenario. Comparing ex-ante to ex-post evaluation of similar policies can be useful in identifying the key parameters that are likely to drive changes. To identify significant drivers that should be included in the baseline scenario, users may follow a similar approach to that provided in section 7.4 on identifying significant effects.

Examples of non-policy drivers by policy type are shown in Table 8.4. Users shall report all non-policy (e.g., socioeconomic) drivers that are included in the baseline scenario and disclose and justify any relevant drivers that are excluded from the baseline scenario.

Table 8.4: Examples of socioeconomic drivers that may be included in a baseline scenario

Examples of policies	Examples of socioeconomic 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/access to transit alternatives, socioeconomic status of commuters, GDP
Composting, anaerobic digestion, or other organics management	Landfill tipping fees, value of recycled commodities, waste collection and transport costs, population, 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 agro-forestry practices, fertilizer & seed prices, population, GDP
Afforestation/reforestation policy	Opportunity costs for land owners (e.g. rangeland or crop land), value of forest products (fiber or timber), suitability of lands to support forest growth, population, GDP

<u>Determine baseline values for each parameter, based on assumptions for each driver</u>

Once key drivers have been identified, realistic and justifiable assumptions must be made on the change in each driver over the GHG assessment period. Assumptions should be reasonable and based on reliable, peer-reviewed sources. If a variety of assumptions are available from reliable, peer-reviewed sources or uncertainty exists, users should select the more conservative assumptions (i.e., those that are more likely to underestimate GHG emissions in the baseline scenario).

Users should then determine 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 with information on drivers and assumptions for each driver over the GHG assessment period. See Figure 8.4 for different trends the parameter can take over time.

Each parameter in the baseline scenario may be assumed to be either static or dynamic over the assessment period. The choice should be based on evidence of the most likely scenario for that individual parameter (for example, published, peer-reviewed studies and reports by reputable sources). Users should use dynamic assumptions and identify appropriate assumptions for those parameters and drivers that are most significant and have the greatest bearing on the emissions estimates.

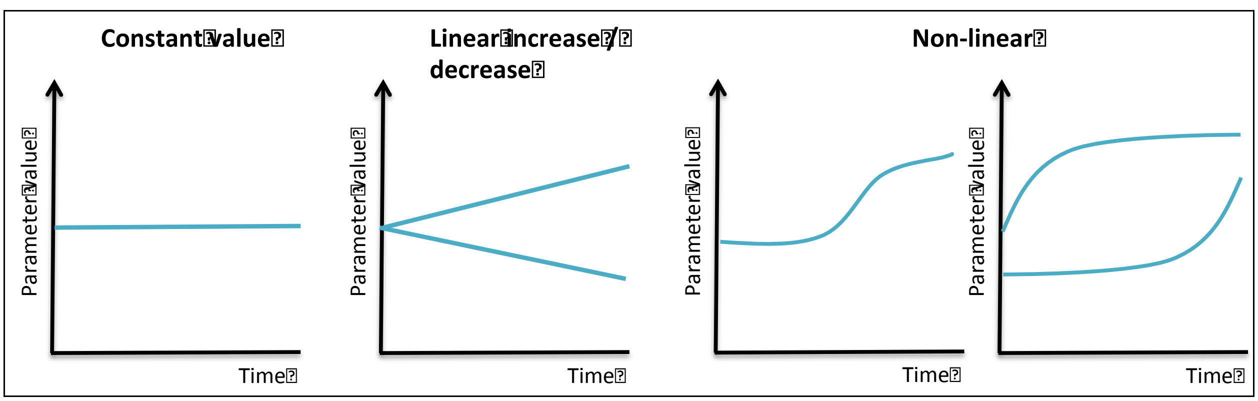
If a parameter is assumed to be static, historical data or other peer-reviewed sources should be used to establish a reasonable value that represents the most likely value of the parameter during the time period over which the policy has an impact, but the value should use appropriate baseline assumptions (i.e., assuming that the policy is not implemented).

If a parameter is assumed to be dynamic, the most likely trend should be used based on underlying drivers and assumptions. A linear extrapolation of historical trends may be used provided that there are justifiable reasons to assume that historical trends would continue during the assessment period. If baseline assumptions lead to a trend that is different from the historical trend, the user shall disclose and justify all assumptions regarding policy and non-policy drivers that are used to establish the emission rate or formulate the trend of emissions activity for the parameters of interest.

Users shall identify which elements of the baseline scenario and baseline emissions calculations are static and which are dynamic. The use of static and dynamic elements can depend on data availability and the objectives of the assessment.

Users shall disclose and justify their methodology and choice of assumptions with peer-reviewed literature, government statistics, expert advice, or other evidence. See Box 8.2 for guidance on disclosing assumptions included in models.

Figure 8.4: Different shapes of parameter changes over time



Box 8.2: Disclosing assumptions included in models

Sometimes models of emissions activities or emissions rates are based on more complex relationships among and between key drivers and underlying assumptions. When models are being used to derive baseline emissions, the process is no different than if individual data elements are being collected and assembled. However, it can be more difficult for a non-modeler to see and understand the drivers and assumptions being used. While model documentation may include detailed descriptions of data sources, and assumptions being used, these details are often buried within dense technical texts that contain information far beyond just these critical elements of the baseline scenario.

If a user selects a modeled approach for establishing a baseline scenario, the key assumptions and data used to develop the baseline scenario shall be reported. This may require the user to review model documentation and extract relevant information on key drivers and assumptions about those drivers with appropriate justifications and citations, to enable end users to understand the key information that shapes the baseline scenario.

<u>Step 4: Estimate baseline emissions</u>

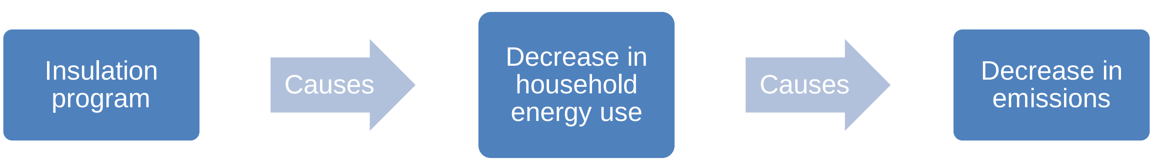
The final step is to quantify baseline emissions using the emissions estimation algorithm and the baseline values for each parameter identified in prior steps. Baseline emissions should be quantified for each effect analyzed, as well as aggregated across all effects to determine total baseline emissions. For the time series approach, this typically requires the user to multiply an array of data representing activity data for the time period of the assessment by an array of emission factor data for all the relevant parameters.

Modeled analyses may have more complicated methods for projecting baseline activity data and emission factors and may use more complex algorithms for combining these data to produce baseline emissions estimates, but generally will use the same methodology and algorithms for calculating baseline emissions and policy scenario emissions. Generally the input data and assumptions will lead to the differences between the scenarios. As long as the methodologies and algorithms for a model have been subjected to peer review and are well-documented elsewhere, the assessment documentation may cite this prior work without repeating it and simply explain why the selected model was chosen for use in the assessment.

See Box 8.3 for an example of estimating baseline emissions following the steps outlined in this section.

Box 8.3: Simplified example of estimating baseline emissions for an insulation program

A causal chain is first mapped in Chapter 6 to describe the causes and effects flowing from an insulation program, as follows:



To determine baseline emissions for an insulation program, the following four steps are carried out:

<u>Step 1: Identify all effects of the policy or action included in the GHG assessment boundary</u>

- A significant effect identified in the causal map (in Chapter 6) and included in the GHG assessment boundary (in Chapter 7) is a reduction in household energy use due to insulation

<u>Step 2: Define an emissions estimation algorithm and all parameters to calculate baseline emissions for each effect</u>

- Baseline emissions for household energy consumption (tCO_2e) = historic household energy use (MWh) * (1 + % change in GDP) * baseline emission factor (tCO_2e/MWh)

<u>Step 3: Determine baseline values for each parameter by identifying policy and non-policy drivers and assumptions for each driver</u>

- GDP is a key non-policy driver of baseline household energy use
- The baseline value for household energy use is estimated based on average annual household energy use over the past five years multiplied by (1 + % change in GDP).
- Historic household energy use (average annual consumption over the last five years) = 100,000 MWh
- Change in GDP = 2%
- Emission factor for energy use is $0.2tCO_2e$/MWh

Step 4: Estimate baseline emissions

- Baseline emissions for household energy use (tCO_2e) = 100,000 MWh x (1 + 2%) x 0.2tCO_2e/MWh = 20,400 tCO2e

The above steps should be repeated for other effects included in the GHG assessment boundary.

8.4 Tiered approaches using the time-series approach

Users may need to balance the accuracy of the baseline quantification against capacity and resources for undertaking the analysis in the context of objectives. This section describes how the tiers presented in Chapter 3 apply to determining baseline emissions using the time-series approach. Table 8.5 outlines tiers related methodological options in the baseline estimation process.

Table 8.5: Tiered methodological options related to determining baseline emissions

Tier	Emissions estimation algorithm	Policy drivers included	Non-policy drivers included	Assumptions about drivers and parameters	Source of data for drivers and parameters
Tier 1	Simple equation with fewer parameters	Few drivers	Few drivers	Most assumed to be static or linear extrapolations of historical trends	International default values
Tier 2	Moderately complex equation with several parameters	Many significant drivers	Many significant drivers	Combination	Combination
Tier 3	Complex, customized model with many parameters	All significant drivers	All significant drivers	Most based on complex modelling	Jurisdiction-specific data

The following questions may be helpful when choosing between tiers:

- Does a parameter have a significant influence on the baseline emissions?
- Are the data available to conduct a Tier 3 analysis of a given parameter?
- Can data be collected for a Tier 3 analysis without jeopardizing the ability to assess other parameters in the baseline emissions calculation?

One key aspect of the tiers is the selection of parameters, policy drivers, and non-policy drivers included in the baseline scenario. Users shall report any significance threshold or other justification used to determine which parameters, policy drivers, and non-policy drivers are included in the analysis.

As an example, a government user may decide to use a Tier 3 approach since the policy is being assessed for compliance, and may decide to use a complex, customized model to estimate baseline emissions and include any policy in the baseline scenario that is expected to affect baseline emissions by more than one percent over the assessment period.

As another example, a non-government user may decide to use a Tier 1 approach to understand the potential reduction benefits of a proposed government program. Under a Tier 1 approach, the user may use a relatively simple estimation algorithm that includes only a few major policy and non-policy drivers.

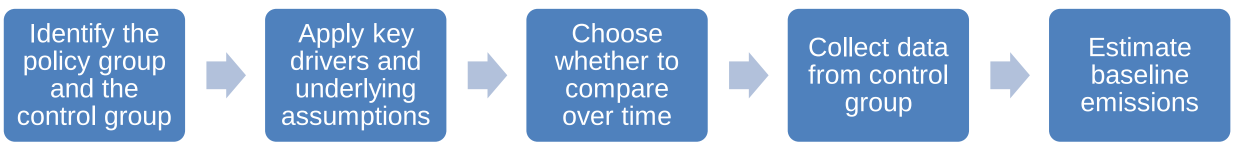
Users shall disclose and justify the choice of tier used, the sensitivity threshold or other approach used for deciding which drivers are included in the baseline scenario, and the basis for selecting an emissions estimation algorithm. The same approach and reporting requirements related to tier selection will also apply to steps carried out in Chapter 9 and Chapter 11.

8.5 Estimating baseline emissions using the cross-sectional approach (for ex-post assessment only)

As outlined in section 8.2, users may use a cross-sectional approach to defining the baseline scenario when carrying out an ex-post assessment. A cross-sectional comparison is a comparison of 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. Cross-sectional comparisons cannot be used for ex-ante assessments, since comparative data for the control group and policy group during policy implementation cannot be observed prior to policy implementation.

Estimating baseline emissions using the cross-sectional approach involves five steps, outlined in Figure 8.5.

Figure 8.5: Overview of steps using the cross-sectional approach



<u>Identify the policy group and the control group</u>

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

<u>Identify key drivers and underlying assumptions</u>

The next step is to identify the key drivers that affect emissions of both the policy group and control group to determine whether the groups are equivalent. If they are not determined to be equivalent, appropriate modeling must be carried out to remove any bias in the results.

Ideally, the policy group and the control 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 control group. More information on the nature of policy and non-policy drivers is provided in the section on time-series approaches below.

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

- Geography (e.g., facilities in the same city, sub-national region, country)
- Time (e.g., facilities built within the same time period)
- Technology (e.g., facilities using the same technology)
- Policy drivers (e.g., facilities are subject to the same set of policies and regulations, except for the policy being analyzed)
- Non-policy (e.g., socioeconomic) drivers (e.g., facilities are subject to the same external trends, such as the same changes in economic activity, population, weather, and energy prices)

If the conditions for the policy group and control group are equivalent, the difference between the policy group and control group after implementation of the policy can be attributed to the existence of the policy, rather than to other factors.

For ex-post assessment, observed values for each driver for each group can be compared directly to determine whether they are the same or significantly different.

In cases where observed values (for ex-post assessment) differ between the two groups, the drivers should be assessed to determine whether they are likely to affect emissions of the groups (e.g., based on historical data or previous studies/evaluations). If material differences do exist that may affect the outcome, regression analysis should be carried out to control for the effects of all relevant external drivers.

Choose whether to compare over time

Users may either:

- Compare the policy group and the control group at a single point in time (e.g., data for the policy group in 2012 is compared to data for the control group in 2012); or
- Compare the policy group and the control group at multiple points in time (e.g., data for the policy group in 2012, 2013, and 2014 is compared to data for the control group in 2012, 2013, and 2014).

In general, users should compare the policy group and control group at multiple points in time to better account for changes that may occur between the groups over time (e.g., fluctuations in external drivers such as weather that occur during the policy implementation period). Note that this approach incorporates elements of both cross-sectional and time-series data.

Collect data from control group

Next, relevant data (e.g., activity data and emission factors) must be collected from the control group. For examples of data needs, see Box 8.4. Either top-down or bottom-up data may be used. To collect bottom-up data, sampling may be used to collect data from a large number of individual sources (e.g., facilities). If so, appropriate statistical sampling procedures should be used.

Box 8.4: Example of key parameters for the Mexican Sustainable Housing Nationally Appropriate Mitigation Action (NAMA)[11]

The Mexican Sustainable Housing NAMA aims to: (1) extend penetration of basic efficiency standards to the entire new housing market in Mexico, and (2) upgrade efficiency standards to more ambitious levels. The monitoring plan outlines the following parameters and data sources for monitoring and quantifying emissions.

- Electricity consumption (Direct and continuous metering of electricity consumption (including generation from PV). If available, utility billing records can be used.)
- Emission factor of the grid electricity (As per CDM Tool to calculate emission factor for an electricity system, or use published data.)
- Transmission and distribution loss (Data from utility or an official government body.)
- Fuel consumption (Direct and continuous metering of fuel consumption. If available, utility billing records or fuel purchase invoices can be used.)
- Net calorific value of the fuel (Values provided by the fuel supplier in invoices, own measurement,

[11] Source: CONAVI, SEMARNAT. Supported NAMA for Sustainable Housing in Mexico - Mitigation Actions and Financing Packages. Mexico City 2011 (available for download at: www.conavi.gob.mx/viviendasustentable), 32.

or regional or national default value.)

- Gross floor area of a building unit (Building plan, or onsite measurement. All housing units covered under this NAMA are expected to have the floor area of 40 m^2.)

Note: Data are collected at the building level from a sample of buildings

Estimate baseline emissions

Baseline emissions can then be calculated by multiplying activity data by the relevant emission factor, both collected in the previous step.

In rare cases where the policy group and control group are equivalent (i.e., there are no differences in external drivers), the outcomes of each group in terms of emissions can be compared directly. A statistical test should be employed to ensure the difference in values cannot be attributed to chance (e.g., a t-test). If the difference between the groups is significant, the difference can be attributed to the policy.

In most cases, differences in external drivers are expected to exist between the groups. In such cases, the drivers should be controlled for using regression analysis or other statistical methods to isolate the effect of the policy. This entails including data for each relevant external driver (e.g., economic activity, population, energy prices, weather, etc.) as explanatory variables in the regression model, as well as proxies for relevant policies that may differ between the two groups (other than the policy being analyzed). If the expanded regression model shows a significant effect of the policy, then the policy can be assumed to have an effect on the policy group (relative to the control group).

See Box 8.5 for guidance on quantifying non-GHG effects of policies and actions.

See Chapter 12 for guidance on uncertainty and sensitivity analysis, and Appendix A for guidance on evaluating data quality.

See Chapter 14 for reporting requirements related to determining baseline emissions.

Box 8.5: Quantifying non-GHG effects of policies and actions

Consistent with prior steps in the process of quantifying GHG effects of policies and actions, there are several ways to apply the guidance for quantifying GHG emissions (either baseline emissions, ex-ante emissions estimates, or ex-post emissions estimates) to non-GHG effects such as air pollutants and energy savings that are co-benefits of GHG reduction efforts. For example, many sources that result in GHG emissions also affect emissions of co-pollutants (black carbon, sulfur dioxide (SO_2) or nitrogen oxides ($NO_{X)}$). There also may be indirect ways that reducing GHG emissions could lead to co-benefits for which separate parameters would be needed in the quantification process.

This is generally true for the other steps in the quantification processes described in Chapters 8, 9, and 11. These chapters explore key quantification concepts such as: the emissions estimation equation; identification of parameters and parameter values based on drivers and assumptions; and quantification of effects. As users consider methods and approaches that are appropriate to the GHG assessment, co-benefit quantification can be viewed through the same lens with respect to process, data quality, and tier hierarchy as the GHG quantification approaches described.

[Placeholder for sector-specific guidance and examples of determining baseline emissions]

Chapter 9: Quantifying GHG effects ex-ante

Before implementing a policy or action, decision-makers need to understand the expected effect that policy or action will likely have on future GHG emissions. This type of analysis is called *ex-ante assessment*.

Ex-ante assessment supports several objectives (see Chapter 2), including:

- Inform mitigation strategies based on an understanding of the expected GHG effects of policies and actions before implementation
- Report on expected GHG reductions from policies and actions that are under consideration or in the implementation process
- Attract support (e.g., financing) for mitigation actions based on an understanding of their expected future GHG effects

This chapter provides a step-by-step method for quantifying the expected future change in GHG emissions from implementation of a policy, relative to the baseline scenario defined in Chapter 8.

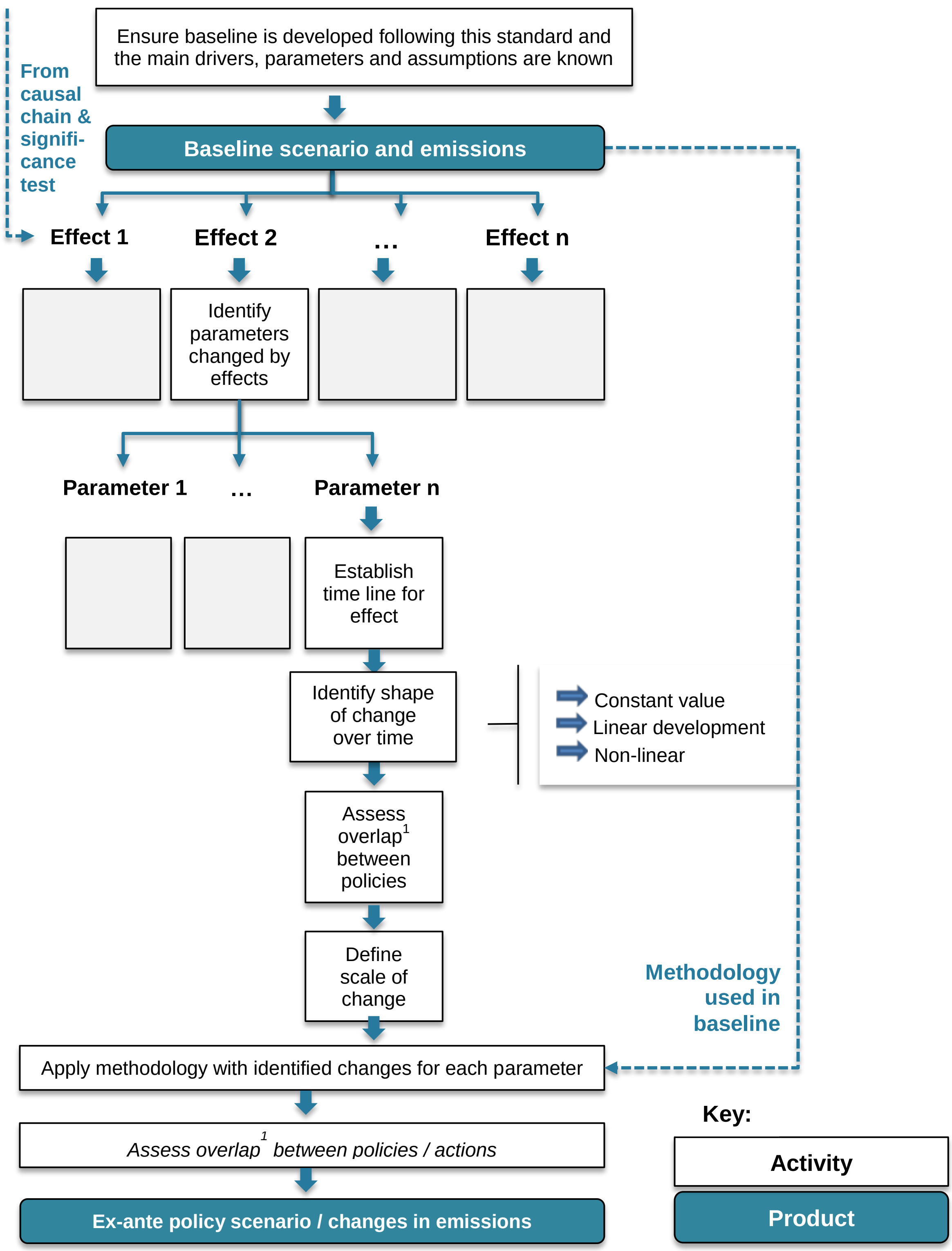
Requirements in this chapter

- Users shall quantify all effects that have been included in the GHG assessment boundary.
- Any effects that have not been quantified shall be disclosed and justified and described qualitatively.
- Users shall apply the same the frequency of ex-ante emissions estimates as was defined in the baseline scenario (e.g., every year through the end of GHG assessment period).
- Users shall apply the same policy drivers, non-policy (e.g., socioeconomic) drivers, and assumptions for each driver used in the baseline scenario defined in Chapter 8 except for those specifically identified as drivers for the policy scenario in Chapter 9.
- In cases where an intervention is not clearly permanent the user shall make the assumptions regarding the continuation of the measure transparent. In cases where the intervention is clearly time limited and the end of the measure lies within the analysis time frame, the user shall clearly identify if effects changes between the active period and the time after and how.
- Assumptions on the scale of changes for parameters shall follow the principles of relevance, completeness, consistency, transparency, and accuracy presented in Chapter 4.

Estimating the expected change in GHG emissions resulting from the policy

Figure 9.1 provides an overview of the steps needed to estimate the effect on GHG emission for the policy.

Figure 9.1: Steps for ex-ante assessment of policies and actions



[1] *Steps to account for policy overlap depend on method chosen (see section 9.4 for more detail)*

9.1 Identify policy effects for quantification

Before quantifying expected GHG impacts ex-ante, users first need to apply the decisions made in previous chapters relevant to ex-ante assessment. Table 9.1 presents the list of decisions from previous chapters that users must apply in Chapter 9, along with their specific relevance to Chapter 9.

The main decisions on which effects to cover with the analysis have therefore already been taken, for example by defining how far to draw the causal chain (how many steps) and through the significance test as defined in Chapter 7. Where such effects are deemed significant the user shall include a discussion of these effects in the report and should quantify them or at least provide an order of magnitude estimate.

The user shall quantify all impacts that have been identified within the causal chain that are within the boundary defined and that have been assessed as significant. If there are reasons preventing the quantification of individual impacts even though they would be required, the user shall provide the rationale for the exclusion of such effects and report on the effect qualitatively.

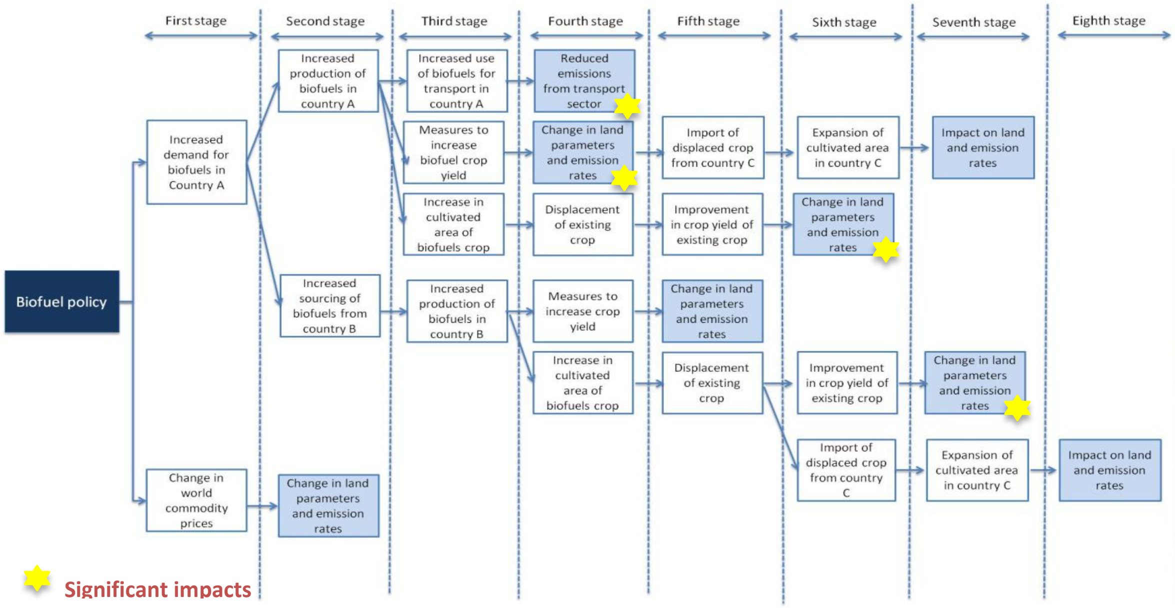
See Box 9.1 for an example of identifying effects for quantification.

Table 9.1. Decisions from previous chapters to be applied in chapter 9

Decisions from previous chapters to be applied in Chapter 9	Relevance to Chapter 9
Refer to the causal map defined in Chapter 6 and the significance evaluation defined in Chapter 7	• In chapter 9, users will quantify the expected changes for each GHG effect identified in the causal map and included in the GHG assessment boundary • In chapter 9, users will quantify how these emission sources are expected to change over time as a result of the policy intervention • All effects that have been assessed as significant shall be quantified
Apply the baseline approach chosen in Chapter 8	• Users shall apply the same the frequency of ex-ante emissions estimates as was defined in the baseline scenario (e.g., every month, every year, every five years, etc. through the end of the temporal boundary) • Users shall apply the same policy drivers, non-policy (e.g., socioeconomic) drivers, and assumptions for each driver used in the baseline scenario defined in Chapter 8 except for those specifically identified as drivers for the policy scenario in Chapter 9. • Users shall not use a cross-sectional baseline for ex-ante assessment of policy effects because cross-sectional baselines are only relevant for ex-post assessment.

Box 9.1: Example of identifying effects for quantification

In the illustrative example provided below, a large number of potential impacts were identified in the causal chain in Chapter 6. Only four of these were identified as significant when the GHG assessment boundary was defined in Chapter 7. (This example is only an illustration and does not reflect a real world assessment).



The effects to be considered within the analysis are:

1. Reduced emissions from transport sector in country A
2. Change in land parameters and emission rates in country A based on
   2.1. measures to increase biofuel crop yield;
   2.2. increase in cultivated area of biofuel crops.
3. Change in land parameters and emission rates in country B due to the increased demand

9.2 Identify affected parameters

The purpose of this step of the analysis is to move from the more logic and abstract impact definition of the causal chain to computable parameters within the GHG emissions methodology.

To do this the user may find it useful to use general emissions equations such as Equation 9.1 and Equation 9.2 (also presented as Equation 8.1 and Equation 8.2 in Chapter 8) as a starting point to clarify which element(s) is (are) affected by the different effects:

Equation 9.1

GHG Emissions = Activity Data x Emission Factor

Equation 9.2

GHG Emissions = (Activity x Efficiency x GHG intensity) + Non energy emissions – GHG Removals

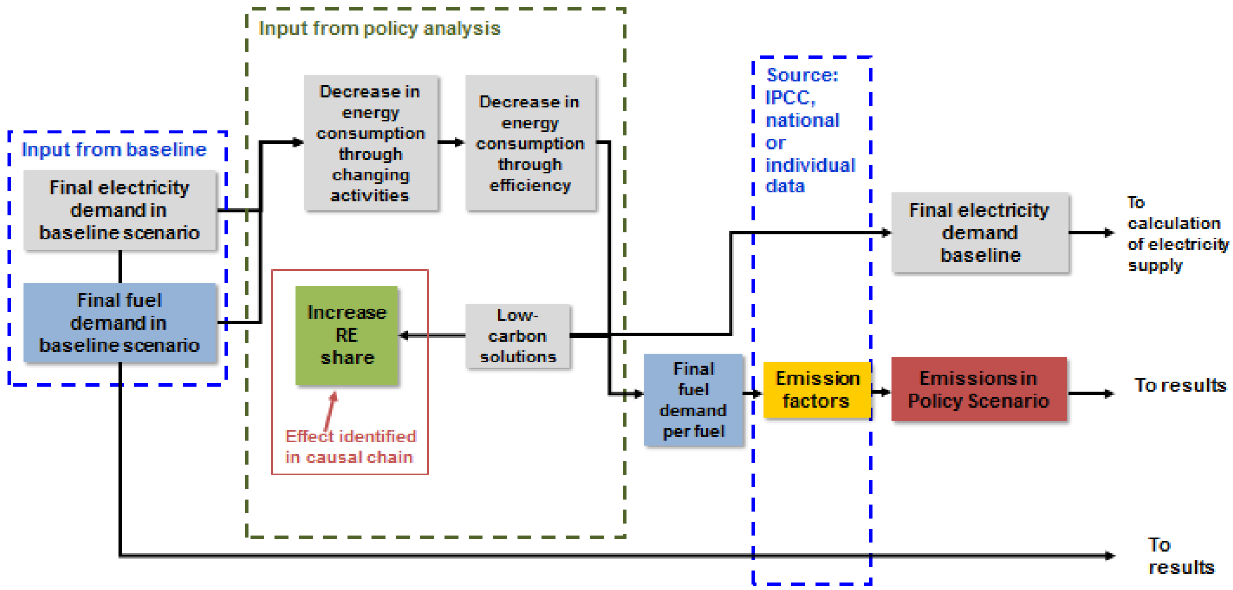
The methodology selected in the baseline development will be a more or less detailed elaboration of this basic equation. Also complex models can be traced back to these fundamental elements, so it is useful to start here and then become more and more detailed up to the level required by the algorithm chosen.

Based on the equation above the different parameters and their relationship can be illustrated in a flow chart as shown in Box 9.2. Illustrating the flow of the calculation graphically is a useful and often applied method to clarify where in the algorithm the effects trigger change.

The more complex the equation is the easier it is usually to identify the direct relationship between policy effect and parameter values, while more simplified approaches usually require more assumptions on the relationship between policy and parameters.

Box 9.2: Example of identifying parameters affected by policy[12]

Based on the previous example for a biofuels policy, the relationships between parameters within a defined algorithm are identified. The example assumes a simplified model approach based on fuel consumption. In this model the biofuels policy effect number 1: ‘Reduced emissions from transport in country A’ would affect the parameter ‘share of renewables’ in the calculation.



The share of renewables would then in fact be broken down further to the different fuel types. The policy would then influence the share of biofuels, which would then cause changes to the shares of the other fuels used (see example further below).

Another example with a more detailed level of calculation could require a number of different parameters to look at. An incentive scheme to replace inefficient appliances (compare examples in chapter 8) could require more parameter changes:

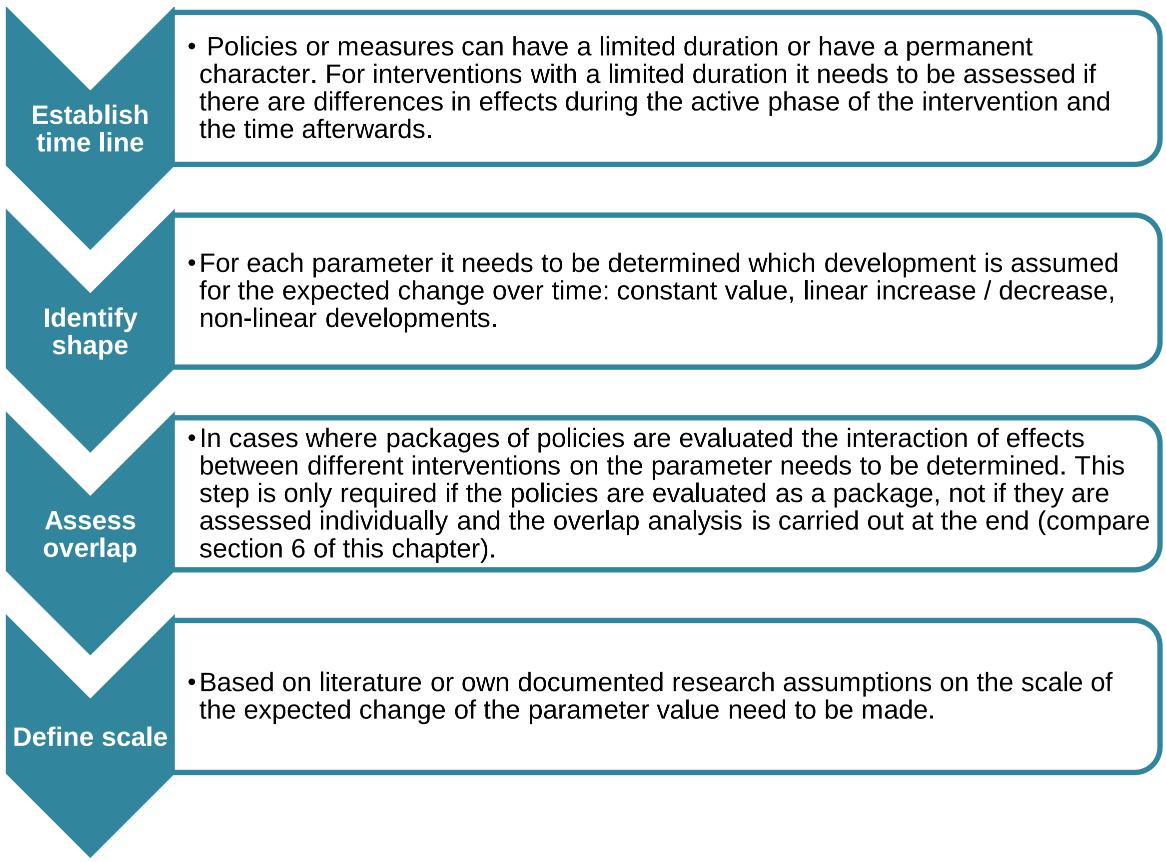
- Number of appliances replaced
- Average energy saving per appliance replaced
- Age structure of appliances replaced
- Lifecycle emissions of different types of appliances

[12] Adapated from Höhne et al. (2011) , available at www.climateactiontracker.org/assets/publications/publications/WP1_MethodologyCountryAssessment_website_2011.pdf

9.3 Define expected effects on parameters and define parameter values

The determination of actual effects on the identified parameters requires a number of steps, outlined in Figure 9.2.

Figure 9.2: Steps for defining effects on parameters



<u>Establishing the time line</u>

There are two dimensions to this analysis:

1. Defining the actual duration of the intervention in relation to the overall analysis time line.
2. Identifying points in time when effects are expected to change significantly, either because the intervention ends or because the policy is designed to change over time.

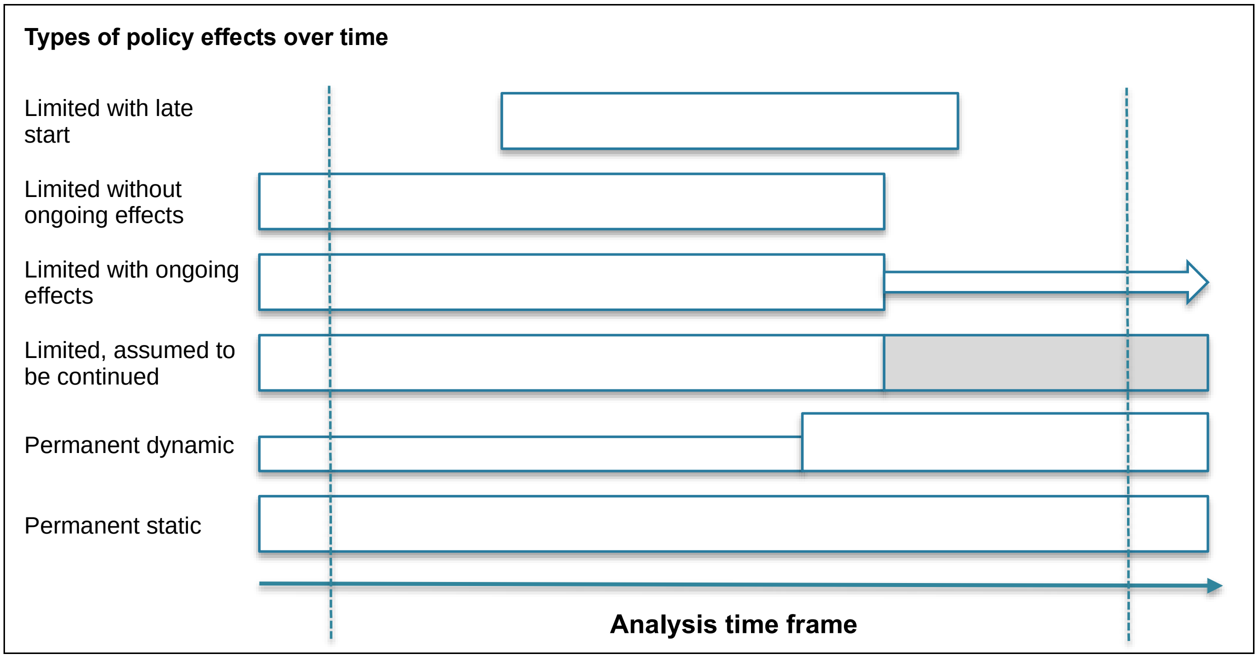
Many policies are designed to operate permanently over the full time span as defined in the analysis boundary. Such policies include for example taxes, emissions trading systems and regulations. Although there is always the possibility that such policies are discontinued, for example by changes in Government, the user may assume for this analysis that an intervention stay in place unless an end date is explicitly embedded in the design of the intervention.

However, also for permanent policies different effects over time can be relevant, if the policy is designed to change over time, for example increasing the tax or the standard imposed in different steps over time. One example for this is the U.S. emissions standards for light duty vehicles, which were designed in different phases, 2012 - 2016 and 2017 - 2025, with increasing requirements.

Other policies are not designed to be permanent. This often includes incentive schemes, where the budget is allocated for a specific time frame to support the deployment of specific technologies or to fund other activities. Examples for these types of interventions are the low energy housing loans provided by the German KfW to support household energy efficiency and renewable energy investment or support for energy audits that help households identify potential energy savings.

In many cases these policies are not explicitly designed to be permanent as they also depend on the availability of budgets, but in reality many have a quasi-permanent character, while others are only one-off initiatives.

Figure 9.3: Illustrating policy effects over different time lines



In cases where an intervention is not clearly permanent the user shall make the assumptions regarding the continuation of the measure transparent. In cases where the intervention is clearly time limited and the end of the measure lies within the analysis time frame, the user shall clearly identify if effects changes between the active period and the time after and how.

<u>Identifying the shape</u>

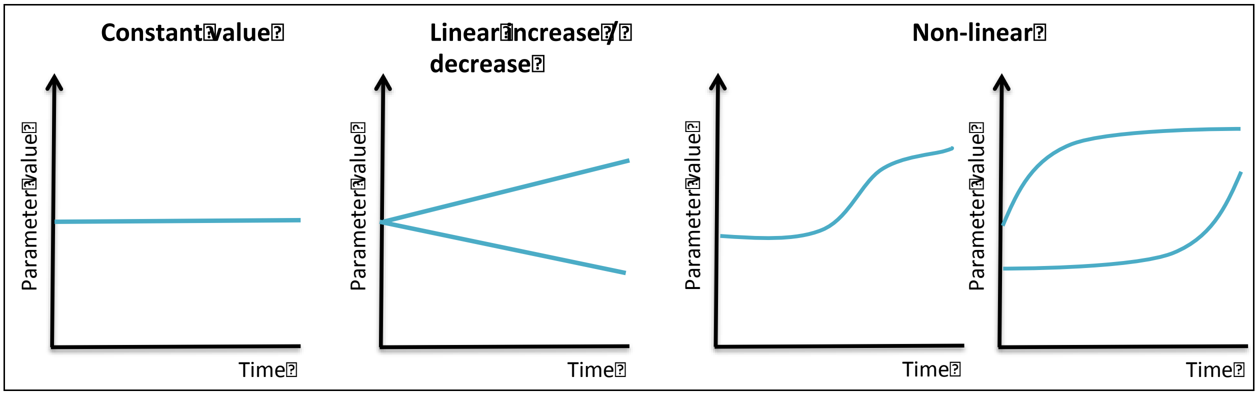
The next step is to define how the change of parameters is expected over time. In reality, the shape of the expected change is determined by a number of factors. These include economic patterns that are connected to new product development and deployment (often referred to as 'learning-curves') or economies of scale. But they also reflect the penetration of effects that influence the behavior of actors which could, depending on the situation for example be slow in the beginning but then pick up speed as products become more socially accepted or even convert to status symbols.

There are different possibilities as illustrated in Figure 9.4 and the user should decide in each case which development is most appropriate to use based on:

- Objectives of the assessment;
- Type of policy used;
- Algorithm chosen for calculation; and
- Data availability.

Assumptions made on the shape of the changes shall be transparently reported and should be based on peer-reviewed literature or own analysis. In the latter case the user shall detail methodology and assumptions used for this analysis.

Figure 9.4: Different shapes of parameter changes over time



Defining the scale

Assumptions on the scale of the expected change shall be based on literature reviews (e.g., results from either time-series or cross-sectional studies) and/or new analysis. Assumptions shall follow the principles of relevance, completeness, consistency, transparency, and accuracy (see Chapter 4). The informed reader should be enabled to easily follow the rationale of the argumentation provided.

Existing literature will likely not have an identical context of the analysis. Therefore adjustments to results found in literature will often be needed to adapt to the assumptions made in the baseline development for the analysis at hand. The user shall transparently document all adjustments made to results from literature.

To do this a useful method is to summarize results in tables as illustrated in Table 9.2.

Table 9.2: Reporting table of assumptions on parameter changes

Parameter	Baseline value	Policy scenario value(s)	Time line of effect	Shape of effect	Source(s) used	Comments / explanations

The example in Box 9.3 provides an illustration of how this can work in practice.

Box 9.3: Example of identifying and reporting expected changes in parameters

The table below provides more detail on expected changes using the same biofuels policy example used to identify the parameters.

Example of identifying parameter changes

	Share baseline	Share new biofuel	Assumptions on division of rest across other fuels	Shares new
Coal	-			
Oil	90%		biofuel replaces oil products only	84%
Gas	5%		stays constant	5%
Nuclear	-			
Hydro	-			
Geothermal	-			
Solar/wind/other	-			
Biomass/waste	4%	10%		10%
Electricity	1%		stays constant	1%

In a more detailed model, the transport fuels could be broken down to another level, differentiating different transport fuel types (gasoline, diesel, etc.), various gas fuels (LPG, CNG, etc.) and the different biofuel types (ethanol, biodiesel, etc.).

Example of reporting parameter changes

Parameter	Baseline value	Policy scenario value(s)	Time line of effect	Shape of effect	Source(s) used	Comments / explanations
Share of biofuels	4%	10%	Full analysis period	Linear increase	Policy specification, national transport institute	Biofuel only replaces oil-based fuels, not electricity or gas, because…

9.4 Ensure consistency with baseline

The drivers and assumptions shall be the same between the baseline scenario and policy scenario except for those affected by the policy and identified in this step.

To establish the expected change in GHG emissions resulting from the policy a baseline needs to be determined using the methodology provided in Chapter 8. Alternatively an existing forecast may be used for the baseline (e.g., from a government agency). In this case the same model or assumptions shall be used to estimate the policy scenario in order to ensure the methodology is the same. Any differences need to be reconciled.

If the assumptions on parameters affected by the policy as identified by this analysis cannot be determined from the given information available for the baseline, the user should develop their own baseline according to the methodology laid out in Chapter 8.

9.5 Quantify expected GHG effects resulting from the policy

Note that the same methods, models, data and assumptions should be used to define the baseline scenario and the policy scenario unless explicitly identified in section 9.4 above.

There is no basic difference in quantification whether models or simplified methods are used. Values for identified parameters will be adjusted according to the defined assumptions while all other data and assumptions are kept at baseline values and the quantification process is completed as for the baseline scenario.

Results should be checked for plausibility, for example by comparing to existing studies with a similar scope (e.g., quantification of a similar policy in another geographic region or time frame).

9.6 Address policy interactions and overlaps

As described in Chapter 5, policies or actions can interact to produce total effects that may differ from the sum of the individual effects of each individual policy. Users should understand the interactions in order to accurately quantify the GHG effect of a policy or package of policies. Situations in which policies may interact can be grouped into two categories:

- **Influence the same parameters:** Policies may explicitly target the same indicator(s) (i.e. parameters deliberately affected by a policy) or influence the same other parameter(s) (i.e. elements of the emissions equation). In other words, they may have the same goal but use different tools to achieve the same outcome. Policies may also unintentionally influence the same parameters while pursuing different goals.

- **Influence integrated systems:** Policies may interact due to effects on economic, environmental, or social systems of which both policies are a part, even when the policies do not have the same goal or influence the same parameters directly. For example, a subsidy for one energy technology may have systemic effects on energy supply/demand dynamics, influencing an energy market where other policies are in effect.

Policy interactions can also be categorized into three types based on their effect, as outlined in Chapter 5:

- **Neutral:** The effects of policies are added together but do not interact. In this case, the net effect is equal to the sum of its parts. No further analysis of interaction is required, as the analysis of each individual policy will capture all relevant effects.
- **Reinforcing:** Policies provide synergies (i.e. reinforce each other). In this case, the net effect is greater than the sum of its parts and further analysis may be required to accurately estimate the overall effect.
- **Counteracting:** Policies have contradicting effects (i.e. one policy reduces the effects of another). In this case, the net effect is less than the sum of its parts and further analysis may be required to accurately estimate the overall effect.

These interaction effects can occur between policies included in the baseline with policies analyzed, or within a set of policies that is analyzed as a package. The interaction between two policies may impact more than one parameter, and it may impact different parameters in different ways. For example, the interaction of two policies may be reinforcing with respect to one parameter and counteracting with respect to another. Therefore, it is preferable to conduct a parameter-specific analysis of interaction effects. As noted in Chapter 5, policies and actions may also interact even if they do not share any parameters or do not cover the same emissions source. In these cases, a more detailed analysis of the broader economic, social, and environmental system in which the policies operate would be required to estimate the interaction effect.

Table 9.3 provides a non-exhaustive list of some possible policy interactions of each type. These are provided as an illustrative example; the set of possible interactions will vary depending on the definition of the causal chain with respect to the policy or policies being analyzed. Box 9.4 provides an example of interactions occurring at different points in the causal chain

Table 9.3: Policy interaction types and examples

Interaction Type	Possible Interactions	Example
Neutral	Effect on same parameter(s) but with no reinforcing effect	Regional and national production tax credits that have an aggregate effect on renewable energy production that is equal to the sum of the two policies individually
	Effect on different parameter(s) with no interactions via integrated systems	An RPS and production tax credit that affect different renewable energy technologies
Reinforcing	Neutral effect on same parameter(s) with reinforcing effects on emissions	Two efficiency upgrade rebate programs in a city have a neutral effect on total residential energy consumption reduced. However, the combined effect of both policies allows the city to take a coal plant offline, reducing the carbon intensity of grid-purchased electricity across the city
	Positively reinforcing effect on same parameter(s)	Two wind energy production tax credits that stack, pushing wind energy into grid parity and stimulating more generation than either credit would individually
Counteracting	Overlapping effect on parameter(s)	A regional RPS requiring 10% renewable energy that is subsumed by a national RPS requiring 20% renewable energy
	Negatively reinforcing effect on same parameter(s)	A regional RPS requiring 10% non-biomass renewable energy causes utilities to shift investments away from biomass, reducing the effect of a biomass production tax credit

Box 9.4: Example of interactions occurring at different points in the causal chain

A reinforcing or counteracting effect may occur at different points in the causal chain defined in Chapter 6 (e.g., it may affect drivers, parameters, or other factors). When such an effect is introduced into the causal chain, it will affect all subsequent elements of the causal chain.

These two examples illustrate interaction effects occurring at different points in the causal chain:

- **Example 1:** Two production tax credits of 10 cents/kWh for wind energy "stack," producing an aggregate credit of 20 cents/kWh. This pushes wind energy into grid parity, stimulating more wind energy production (a key parameter) than either credit would individually. In this case, the reinforcing effect is introduced at the parameter level.
- **Example 2:** Two production tax credits are implemented: one of 10 cents/kWh for solar energy and one of 10 cents/kWh for wind energy. Each credit increases production of its respective energy type (both key parameter) with no interaction between the two. However, the combined production of both energy types allows utilities to displace coal-fired base load power rather than just gas-fired peak load power, causing more emission reductions than either policy would have caused on its own. In this case, the reinforcing effect is introduced at the emissions level.

Multiple interaction effects may accrue in the same causal chain. For example, the reinforcing effects from Example 1 and Example 2 above could both occur in the same causal chain. Two production tax credits for the same energy technology may produce a reinforcing effect on production (per Example 1), which in turn produces a reinforcing effect on emissions due to displacing base load power (per Example 2). In this case, reinforcing effects occur both in terms of wind energy installed and emissions avoided. Both of these effects would need to be considered for a comprehensive analysis. The overall interaction type for a set of policies (i.e. neutral, reinforcing, or counteracting) is determined by their aggregate effect on emissions, regardless of where individual reinforcing or counteracting effects occur within the causal chain. However, all reinforcing and counteracting effects would need to be calculated in order to accurately determine the aggregate effect.

Steps for accounting for policy interactions

To account for the effect of policy interactions, the user shall complete the following steps:

1. **Determine whether a Tier 1, 2, or 3 methodology is appropriate for each element of the analysis (see Table 9.4 for a description of tiers).** This decision may be made depending upon data availability, expected impact of policy interactions, desired level of accuracy, funding considerations, or other factors. This decision shall be clearly disclosed and justified.
   Note that in the event that a single policy (rather than a package of policies) is being analyzed and the user selects a Tier 1 approach for the third element in Table 9.4, no interaction analysis will be conducted. In this case, the only potential policy interaction would be between the policy in question and baseline polices, which would be considered only under the Tier 2 or 3 approaches. Omitting the interaction analysis may be necessary due to resource or data constraints, but this approach may substantially reduce the accuracy of the analysis if interaction effects are significant. Where possible, the user should perform a qualitative assessment of potential interactions even if quantifying these interactions is not an option. In any case, the user shall clearly disclose and justify this decision.

2. **Develop a list of all policies that may potentially interact with policies being analyzed.** This list shall be developed in accordance with the methodological tiers selected in Step 1. Depending on the tier selected, the list may include the policy or policies being analyzed as well as policies included in the baseline.

3. **Complete policy interaction matrix or similar list of potential interactions.** Once the list of potentially interacting policies is determined, these policies should be configured into a policy interaction matrix. One axis of this matrix should contain the policy or policies being analyzed. The other axis should contain all other policies with which the analyzed policies may interact, per the list developed in Step 2. Each cell on this matrix represents a pair of potentially interacting policies. This step will help the user visualize potential interactions and frame the interaction analysis in Step 4. Note that if a Tier 2 or 3 method was selected for "Number of policies per interaction effect," then interaction effects between groups of three or more policies will need to be considered when relevant. In that case, a policy interaction matrix may not fully capture all interactions, so the user will need to develop a separate list of each potential interaction to supplement or replace the matrix.

   For each pair or group of policies that may interact, the user shall then make a qualitative determination of whether a non-neutral interaction may occur. Factors to be considered include:

   - Do the policies affect the same drivers or parameters?
   - Do the policies overlap in terms of the time period they affect?
   - Are there any potential time lags between a policy and its effect or its interactions?
   - Do the policies have effects on broader systems that may in turn affect other policies?

   It may be uncertain whether a pair or group of policies will have non-neutral interaction effects. If there is a significant possibility of non-neutral effects, the interaction should be analyzed in Step 4. See Figure 9.5 and Figure 9.6 for examples of policy interaction matrices.

4. **Conduct an interaction analysis for each non-neutral interaction.** Once a list of likely non-neutral policy interactions is established, the user shall conduct an analysis of each interaction to determine its effect on ex ante estimates. The specific method chosen will depend on many factors including the tier of analysis selected in Step 1, available data and software tools, and the extent of expected interactions. As part of this analysis, the user should determine the total change in relevant drivers and parameters that is attributable to each interaction. In some estimation methods and models, interactions between policies will be calculated automatically.

   For interactions between policies in a package, the effect of interactions need not be attributed to individual policies, since the group is being assessed as a whole.

   However, the situation changes when an analyzed policy interacts with a baseline policy. (See Box 9.5 for an example). In such a case, the analyzed policy causes a change in the effectiveness in the baseline policy via their interaction. The user must therefore make a determination on how to attribute the interaction effect in order to ensure that the effect of the analyzed policy or policies (including interaction effects) is consistently estimated. The user has three options:

   - **Attribute the entire effect to the analyzed policy or policies**, such that all changes over and above the baseline are assumed to be the result of the analyzed policy or policies. This is the recommended approach unless there are extenuating reasons to attribute some or all of the interaction effect to baseline policies. Such reasons will be determined by the use and shall be disclosed and justified.
   - **Attribute the entire effect to the baseline policy or policies**, such that only the direct effect of the analyzed policy or policies is estimated in the policy scenario.
   - **Split the effect between analyzed and baseline policies**, such that each of the policies is allocated a share of the reinforcing or counteracting effect between them.

5. **Incorporate interaction adjustments into ex-ante estimates and baseline estimates where applicable.** Once interaction effects are estimated under Step 4, these effects shall be aggregated up and applied to the broader ex ante estimates. Depending on the methodology

used, these effects could be aggregated at the driver, parameter, or emissions level before being incorporated into overall estimates.

Box 9.5: Example of analyzed policy interacting with a baseline policy

Take an example of two production tax credits for solar energy. One is a national production tax credit for 10 cents/kWh that is included in the baseline. The second is a potential regional credit for 15 cents/kWh that is being analyzed. Assume that a 20 cent credit is required to make solar cost-competitive with standard generation. The baseline estimate would have included the effect of the 10 cent credit, but that effect would not be sufficient to push solar into cost-competitiveness. Nor would the 15 cent credit be sufficient on its own. But taken together, the two credits combine to push solar into cost-competitiveness, causing solar development to increase rapidly. The baseline analysis would capture the direct effect of the 10 cent baseline credit, but it would not capture the additional interaction effect brought on by having both policies in place simultaneously. Therefore, users must analyze the interaction effect in order to determine the true impact of the new policy.

Figure 9.5: Generic example of a policy interaction matrix

	Analyzed Policies				Baseline Policies			
	1	2	3	Etc.	A	B	C	Etc.
Policy 1	N/A							
Policy 2		N/A						
Policy 3			N/A					
Etc.								

Figure 9.6: Detailed example of a policy interaction matrix[13]

	Legislation on:			Taxes	Support via:		Information:		Agree-	Procu-	R&D	Tra-
Measure	applicat.	use	inform.		finan.	audits	options	use	ments	rement		ding
Legislation application												
Legislation use	-											
Legislation information	- - -	0										
Regulatory taxes	- -	- -	+									
Support (financial)	- - -	-	+++	- -								
Support (audits)	- - -	- -	- -	+	+							
Information (options)	- - -	0	- - -	+	+	- - -						
Information (use)	-	- - -	0	+++	0	-	0					
Agreements	- - -	-	-	-	+	-	-	-				
Procurement	- - -	0	+	+	+	+	-	0	-			
R & D-promotion	-	0	0	++	+++	0	+	0	0	++		
Emission trading	- -	- -	0	- - -	- -	-	+	++	-	0	+	

Key:

- Counteracting: - - - strong/- - modest/ - marginal interaction
- Reinforcing: +++ strong/++ modest/+ marginal interaction
- Neutral (no interaction) = 0

[13] Source: Boonekamp/Faberi (2012)

Tiered approaches for policy interaction analysis

The accuracy and completeness of the policy interaction analysis must be balanced against the capacity and resources for undertaking the analysis as well as the project objectives. This section describes how the tiers presented in Chapter 3 apply to quantifying policy interactions. Table 9.4 presents three key elements of such an analysis as well as three tiers of analytical rigor for each element. The selection of tiers is discussed in Step 1 of the "Steps for Accounting for Policy Interactions" section.

Table 9.4: Interaction analysis tiers

Element of Analysis		Tier 1	Tier 2	Tier 3
1	Number of policies per interaction effect	Pairs of policies	Pairs of policies; more than two policies if effect is expected to be large	All known interacting policies
2	Part(s) of causal chain assessed	Indicators for the same emissions source only	All known interacting parameters for the same emissions source only	All known interacting parameters across all relevant emissions sources
3	Interaction between package and baseline policies to be assessed	None (interactions within package only*)	Interactions with a subset of baseline policies	Interactions with all baseline policies

***** *If a single policy is being analyzed and the Tier 1 methodology is selected for this element, no interaction analysis will be conducted (as there is only one policy in the "package" so it will have no interaction effects).*

Examples of Tier 1, 2, and 3 approaches are illustrated here. Consider a scenario in which a package of two production tax credits for wind energy (one regional and one national) is being analyzed. Also, an RPS policy requiring 10% wind power is included in the baseline. The two production tax credits are expected to have a non-neutral interaction with each other. The RPS policy is also expected to have non-neutral interactions with the two packaged policies.

- Under a **Tier 1** approach, only the interaction between the two production tax credits would be considered (Elements 1 and 3), and only to the extent that they influence the same parameter (i.e. wind energy production) (Element 2).
- Under a **Tier 2** approach, the interaction effects between the individual credits is considered, as is the interaction effect between the RPS and each of the credits (Element 3). The collective interaction effect of all three policies combined is expected to be small, so this effect is not considered (Element 1). In addition, any interaction effects of the two credits on relevant parts of the causal chain other than parameters (e.g. on emissions factors due to fuel-switching) are considered (Element 2).
- Under a **Tier 3** approach, all complex interaction effects between all three policies combined are considered (Elements 1 and 3). In addition to the effects of these policies on parameters in the causal chain within the electricity production sector, more systemic effects throughout other sectors that may influence or be influenced by these policies are also considered (Element 2).

See Chapter 12 for guidance on uncertainty and sensitivity analysis, and Appendix A for guidance on evaluating data quality.

See Chapter 14 for reporting requirements related to quantifying GHG effects ex-ante.

[Placeholder for sector-specific guidance and examples of estimating GHG effects ex-ante]

Chapter 10: Monitoring performance over time

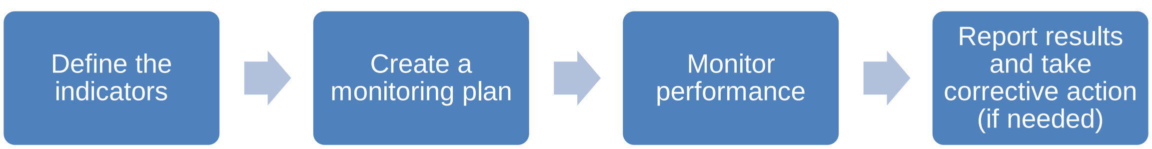
Users should monitor the ongoing performance of the policy or action over time to demonstrate whether the action is on track and delivering results in line with expectations. Where progress is not on track, monitoring can inform any necessary corrective action. Monitoring is also useful for understanding the main activities and outcomes induced by the policy or action, which may be useful for policymakers, investors, or other stakeholders

This chapter describes the requirements and provides guidance relating to the monitoring of the performance of the policy or action over time. It is concerned with the ongoing monitoring of current policies and actions under implementation, which is generally less onerous than quantifying the GHG effects of policies and actions, as detailed in Chapter 9 (for ex-ante assessment) and Chapter 11 (for ex-post assessment).

Where possible, the monitoring plan should be established during the policy design phase, rather than after the policy has been designed and implemented.

The main steps of this chapter are summarized in Figure 10.1.

Figure 10.1: Overview of steps in the chapter



Requirements in this chapter

Users shall: • Define the indicators, or metrics, to track the on-going performance of the policy or action • Create a plan for monitoring the main activities and the associated outcomes related to the policy or action • Monitor and report information on the indicators over time

10.1 Define the indicators, or metrics, to track the on-going performance of the policy or action

Users shall define and justify the indicators, or metrics, that will be used to track progress of the policy or action.

Users should define indicators in terms of the relevant **inputs**, **activities**, **effects** and **GHG effects** associated with the policy or action. This logic and selection of indicators should be consistent with the causal chain defined in Chapter 6.

The various types of indicators are defined as follows:

- **Inputs** associated within the policy or action, including investment expenditure and human resources;
- **Activities** affected by the policy or action, taking into account the relationships captured within the causal chain analysis, and the impacts within the GHG assessment boundary;
- **Effects** caused by the policy or action, including the increased deployment of technologies and changes in behavior (sometimes referred to as “outputs”)
- **GHG effects** of the policy or action, i.e., the net changes in GHG emissions and removals resulting from the effects (sometimes referred to as “outcomes”)

The selection of the indicators should be tailored to the policy or action in question. This may reflect the nature of the action (for example, certain indicators may be more appropriate for some types of policies and actions than others) the requirements of stakeholders, and also the availability of existing data and the cost of collecting new data. The complexity or level of effort required to compile the indicators is also a relevant factor; it is expected that the calculation of the monitoring indictors should be less onerous that the quantification of the GHG impacts.

See Box 10.1 for information on using changes in GHG emissions as an indicator, and Table 10.1 for examples of indicators for various policies or actions.

Where relevant, users should also monitor the policy drivers and non-policy drivers identified in Chapter 8 to determine the extent to which the original assumptions about those drivers remain valid.

Box 10.1: Using changes in GHG emissions as an indicator

The quantification of the GHG emissions is a requirement of the ex-ante assessment of the policy or action (Chapter 9) and its ex-post evaluation (Chapter 10). However, it is not the intention that impacts on GHG emissions should be defined as an on-going monitoring metric, since the work involved in performing this calculation is likely to be onerous for an on-going activity. However, the performance indicators that are selected may also be useful as part of any subsequent calculation of the GHG emissions impacts.

Table 10.1: Examples of indicators for monitoring the performance of different policies and actions

Indicator type	Subsidy scheme	Grant scheme	Public transport investment	Awareness raising program
Example	**Subsidization of insulation measures for houses**	**Grants for renewable lamps replacing kerosene lamps**	**Optimization of routes and fleet renovation in public transport**	**Energy efficiency program for freight transport**
Input	Money, skills, awareness raising (marketing)	Money, skills natural resources, Technology	Money, skills, optimization studies	Money, skills, technology, infrastructure for drivers training workshops
Activity	Number of energy surveys carried out to test eligibility for insulation measures	Number of renewable lamps sold	Number of scrapped vehicles; percentage of fleet renovation; kilometers saved	Number of trained drivers; number of vehicles with improved technologies; number of companies that have participated in the training drivers program
Effect	Number of installations of each insulation measure	Market share of renewable lamps in 2015, 2020, and 2025	25% of routes optimization by 2019; 50% of routes optimization by 2022; 5% of fleet renovation by 2021	35% of new vehicles and 5% of used cars include self-inflating tire, air conditioning systems, and improved aerodynamic systems by 2016
GHG effect	GHG emissions	Volume of	GHG emissions	GHG emissions

	avoided from energy savings of households with insulation measures	kerosene used for domestic lighting by 2030	avoided; 100% of routes optimization by 2025; 100% of public transport renovation by 2035 (replacement of vehicles with more than 12 years old); decrease in traveling time; increase of the number of trips in public transport	avoided; percentage of fuel saved; 100% of freight transport drivers have been trained; 100% of new vehicles have all the improved technologies

10.2 Create a monitoring plan

Users shall create a plan for monitoring the main activities and the associated outcomes related to the policy or action. A monitoring plan is important to ensure that the necessary data can be collected and analyzed.

For each of the indicators or metrics, the following should be described in a monitoring plan:

- The sources of data that will be used to develop the indictors (existing data sources, as well as additional data collected specifically to inform the indicators)
- Whether the data are measured, modeled, calculated or estimated; the level of uncertainty in any measurements or estimates; and how this uncertainty will be accounted for
- The procedures for collecting and analyzing the data required for each of the indicators
- The measurement or other data collection methods used
- The frequency of monitoring activities

Monitoring the performance indicators for the policy or action can be achieved through:

- Direct measurement of performance (e.g., for inputs: tracking of the financial transfer of funds, or the hours of labor spent by the program managers)
- Indirect measures of performance, combined with calculation (e.g., for outcomes: the number of technologies and the calculated performance of those technologies)

Direct measurement may be easier at the start of the causal chain (i.e., for input related indicators), with indirect measures more applicable further down the causal chain (i.e., for monitoring outcome related indicators).

Both direct measurement and calculation-based approaches are subject to uncertainties. The relative accuracy of these approaches depends on the instruments used, the quality of data collected, and the rigor of the quality control measures, as well as on the assumptions underlying any calculations. All data uncertainties should be fully described and explained, and any calculation assumptions should also be assumed. Guidance on uncertainty is provided in Chapter 12. Guidance on the collection, collation and analysis of data is provided in Appendix A.

The monitoring plan should also describe processes for how data will be collected and stored, such as:

- Agency or team responsible for coordinating 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 and tools (e.g., software systems) to be used for collecting and managing; and
- Procedures for internal auditing, quality assurance, and quality control.

The monitoring plan should be consistent with the accounting and reporting principles (see Chapter 4).

10.3 Monitor the indicators over time

Each of the indicators should be monitored over time, in accordance with the monitoring plan. The monitoring results should be reported. The level of detail of information reported, and the frequency of reporting, should be tailored to the relevant audience.

Monitoring should always be conducted in a way that allows a transparent assessment of the relevant indicators. Every time the indicators are calculated it is important to check the accuracy, completeness, and consistency of the monitored data.

The performance indicators are likely to provide useful information on the validity of the assumptions made in the ex-ante assessment of the policy, and in the development of the baseline scenario. This may include information on:

- Whether the policy or action has been implemented as expected
- Whether the assumptions on key parameters within the ex-ante assessment remain valid

Where the monitoring data indicates that the assumptions used within the ex-ante assessment are no longer valid then this should be noted, and the results from the monitoring should be taken into account when updating the ex-ante estimates.

Frequency of monitoring

The frequency of monitoring should be determined based on the needs of decision-makers and stakeholders, following the principle of relevance. The appropriate frequency may depend on the nature of the indicators. 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.

Relationship with indicators at other levels of aggregation

In some cases, indicators and monitoring metrics may be developed at a higher level of aggregation than at the level of a policy or action – for example at the sector level. However, these indicators will themselves be related to the performance of the individual policy or action. An example is described in Box 10.2.

Box 10.2: Example of indicators used by the UK Committee on Climate Change

In the United Kingdom, the Committee on Climate Change is an independent body responsible for advising the Government on setting and meeting GHG mitigation goals. The Committee has developed a series of indicators, at a sectoral level, to track whether the combination of policies is on track, and to spot early signs of slippage. The Committee uses the indicators for its annual assessment of progress. In the residential sector, an indicator relating to the installation of insulation measures per years has been developed, and compared with the annual progress under the main policy (CERT) that stimulates the take up of the measure.

Insulation measures	Total needed to achieve carbon budgets (from 2008)	Delivered under CERT in 08/09	Installations needed per year to achieve carbon budgets
Lofts	10 million (by 2015)	0.7 million	1.3 million
Cavity walls	7.5 million (by 2015)	0.5 million	1 million
Solid walls	2.3 million (by 2022)	8600	165,000

Relationship with indicator for non-climate related objectives

Frequently, policies have more than one objective. This may mean that a policy has been designed to deliver reduction in emissions, but at the same time deliver other (frequently economic) objectives. In this instance the monitoring metrics may be designed to combine the climate objectives with the wider objectives, or the climate metrics may be presented alongside wider objective as part of a package of indicators. An illustration is provided in Box 10.3.

Box 10.3: Example of the UK ICF

The United Kingdom's International Climate Fund (ICF) is the UK's primary channel of climate change finance. To ensure the consistent assessment of financed projects, the ICF will use a set of high level indicators to measure impact and value for money. Some illustrative examples of indicators that will be used to monitor the results of the ICF, in relation to the theme Low Carbon Development, are:

i. Tonnes of CO_2 equivalent reduced or avoided (with cost per tonne of emissions abated as measure of value for money)
ii. Number of poor people (women and men) with access to low carbon energy
iii. Gigawatts (GW) of low carbon energy capacity supported in developing countries
iv. Number of jobs created (women/men/poor people) in low carbon development
v. Volume of leveraged low carbon finance (including private finance and MDB finance)
vi. Leveraged ratio of UK public finance (including to private finance, and MDB finance)
vii. Number of low carbon policy plans drawn up and implemented

See Chapter 12 for guidance on uncertainty and sensitivity analysis, and Appendix A for guidance on evaluating data quality.

See Chapter 14 for reporting requirements related to monitoring performance over time.

[Placeholder for sector-specific guidance and examples of monitoring performance over time]

Chapter 11: Quantifying GHG effects ex-post

After a policy or action is implemented, decision-makers need to understand the effect that policy or action had on GHG emissions during the implementation period. This type of analysis is called ex-post evaluation*.* Ex-post evaluation includes developing an estimate of the effect of the policy compared to a baseline scenario.

Ex-post evaluation supports several objectives (see Chapter 2), including:

- Tracking effectiveness and performance of policies and actions and evaluating their contribution toward meeting GHG reduction goals
- Evaluating progress during policy implementation to determine whether readjusting the policy is necessary
- Reporting on the GHG effects of actions and policies
- Facilitating financial support for mitigation actions based on a quantification of GHG reductions, which may include market-based approaches (e.g., crediting of emission reductions)

This chapter provides guidance on quantifying expected reductions ex-post for different types of policies/actions and sectors. It also provides guidance on evaluation quality measures such as data normalization and corrections. The guidance is illustrated using energy efficiency policies and actions as examples. The steps may need to be adapted to the specific policy and sector under consideration, depending for example on the availability and quality of data needed to carry out the assessment.

Requirements in this chapter

- Users shall quantify all effects that have been included in the GHG assessment boundary.
- Any effects that have not been quantified shall be disclosed and justified and described qualitatively.
- Users shall quantify policy interactions to determine the GHG effects of the policy or action being assessed rather than other policies or actions, if not already considered (e.g., in the baseline scenario)
- Users shall correct for effects not previously considered in the baseline scenario, within the context of the chosen tier

Figure 11.1: Overview of steps in quantifying GHG effects ex-post

11.1 Select an ex-post assessment method

Multiple types of data and quantification methods can be used to quantify changes in emissions from policies and actions, including both bottom-up and top-down data and quantification methods. This section provides a classification of ex-post evaluation and quantification methods that a user may use for their policy or action. Ex-post evaluations are classified into two overall categories:

- **Top-down methods** use top-down data to calculate or model changes in GHG emissions based on changes in macro-level statistical time series indicators (e.g., using econometric models or regression analysis)
- **Bottom-up methods** use bottom-up data to calculate or model the change in GHG emissions for each source, project, or entity (e.g., through changes in behavior or technology), then aggregate

across all sources, projects, or entities to determine the total change in GHG emissions (e.g., using engineering models)

Bottom-up data are measured, monitored, or collected (e.g., using a measuring device such as a fuel meter) at the source-, entity-, or project-level (e.g., energy used at source level (by fuel type), output of production, etc.). **Top-down data** are macro-level statistics collected at the jurisdiction or sector level (e.g., energy use, population, GDP, fuel prices, etc.). Note that top-down data can be aggregated from bottom-up data sources.

For example, in terms of calculating the effects of energy efficiency policies, top down methods monitor the evolution of energy efficiency indicators whereas bottom up methods directly measure the savings at the project or entity level.

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

- Objectives of the assessment
- Level of accuracy required to meet stated objectives
- Type of policy and sector
- Number of interacting or overlapping policies and actions
- Number of actors influenced by the policy
- Data availability (e.g., type, quantity, quality, resolution of data available)Level of expertise required to carry out the assessment
- Capacity and resources

Table 11.1 lists a variety of different ex-post evaluation methods, including bottom-up methods, top down methods, and integrated methods.

Table 11.1: Classification of ex-post evaluation methods[14]

Method	Description
Bottom-up methods	
Direct measurement	The effect of the policy is measured through metering consumption and estimating GHG emissions or by direcly measuring emissions with continuous emissions monitoring systems.
Direct expenditure (billing) analysis	The effect of the policy is estimated using direct expenditures or billing data to determine changes in consumption that generate GHG emissions. This approach includes expenditures only when it is a direct purchase of what the user is estimating. The source of uncertainty in billing analysis may include the quality of data on the expenditures and other variables that affect consumption unrelated to the policy or action. The design of the the baseline and corrections can address this uncertainty.
Engineering estimates	The effect of the policy is estimated using a model of an individual unit. This type of estimate would consider the GHG emissions that would result from the use of a particular piece of equipment under certain assumptions about how the equipment, building, vehicle or other unit is used. A source of uncertainty in engineering analysis is a possible discrepancy between consumption and design. Depending on how a unit is used or put into practice may differ from how the user's assumptions.

[14] Source: Eichhammer et al. (2008)

Deemed estimate	The effect of a policy of action is estimated using the estimated effects from a series of measures associated with the policy implementation. Typically the user knows the number of measures taken or equipment installed and uses estimated savings per action. The estimated savings may be based on the specifications of the equipment, using testing and even surveys or audits of the results. In this case, the user does not have access to direct measurement or even direct expenditure data, but does know the types of measures adopted as a result of the policy or action.
Mixed deemed and ex-post estimate	The effect of the policy or action is captured using techniques such as analysis of sales data, inspection of samples, or monitoring of equipment purchased by participants.
Methods that can be bottom-up or top-down depending on the context	
Stock modelling	The effect of the policy or action is estimated using stock and market statistics and surveys monitoring to measure diffusion / uptake. This is typically used for equipment or other objects that are consumed or purchased over time. If the approach can identify the effect of the action or policy exclusive of other factors, it can be considered bottom-up. However, if other factors influence the stock and market statistics, it is considered top-down. When conducting a stock modeling analysis, the user may need to consider whether the uptake or purchasing indicators measure replacement of equipment, or whether the total use of a certain unit is increasing. The user may also need to consider the type of equipment that is being replaced. These final questions can be addressed in the evaluation baseline.
Diffusion indicators	The effect of the policy is action is estimated using indicators of the share of specific equipment or changes in activities in the market, often for end-use consumption that results in GHG emissions. If indicators are monitored and there are no other drivers, this is bottom-up. The user can also conduct a regression analysis to identify the effect of the policy, which is top-down. In contrast to stock modelling, the user may have limited data on the stock of new equipment or other units in the geographic boundaries of the analysis but does have indicators of use.
Top-down methods	
Monitoring of indicators	The effect of the policy or action could be estimated using sector or sub sector consumption changes. In this case the user has limited to no information on end use or stock statistics, but does have information on changes in a sector (tranportation or buildings) or subsector (space heating in buildings).
Econometric modelling	The effect of the policy or action among cross-cutting measures is isolated using modeling such as Input/Output analysis with price elasticities.
Integrated top-down and bottom-up methods	
Integrated top-down and bottom-up methods	Methods that combine elements of both bottom-up and top-down evaluations.

Table 11.2 provides an overview of appropriate ex-post evaluation methods for selected types of policies or actions.

Table 11.2: Ex-post evaluation methods appropriate for selected types of policies and actions

Type of policy or action	Bottom-up methods	Bottom-up or top-down methods	Top-down methods**
Regulations and standards		Stock modelling (equipment, buildings, etc.), diffusion indicators (monitoring units meeting	Monitoring specific consumption or activity indicators

		performance standard)	
Information instruments	Deemed estimates, surveys, monitoring, engineering estimates/direct measurement, billing analysis, monitoring of end-use actions	Diffusion indicators (of labeling, efficient equipment, technology, or buildings); stock modeling	Monitoring specific consumption or activity indicators
Economic and fiscal instruments	Mixed deemed and ex-post estimates; enhanced engineering estimates; deemed savings + monitoring; stock modelling + surveys	Diffusion indicators (where available)	Monitoring specific consumption or activity indicators For taxes: econometric modelling
Voluntary agreements	Benchmarking of targeted sectors or end-uses; Mixed deemed savings and ex-post estimates + monitoring; deemed savings; mixed deemed and ex-post + monitoring or surveys	Diffusion indicators	Monitoring specific consumption or activity indicators

* GHG effects can be allocated to these subcategories only if a direct or multiplier effect can be proven by specific monitoring efforts. Otherwise they must be evaluated as part of a package.

** Top-down methods can usually only measure the combined effect of packages of measures targeting one sector (specific energy consumption indicators, econometric methods) or end use (diffusion indicators).

11.2 Select a methodological tier

In order to decide which method to choose to quantify GHG effects ex-post, users should consider the availability and quality of data and the accessibility of the method itself to the organization. This section describes how the tiers presented in Chapter 3 apply to ex-post assessment. See Table 11.3 for a description of tiered approaches.

Resource constraints are an important consideration when developing suitable methodologies for ex-post policy evaluation. Methods may become increasingly complex with disproportionate increases in the quality of estimates. The availability and quality of data can vary from one country to the next, from policy to policy, and between sectors. Some methods may be too complex (and require a large amount of resources) or too simplistic. In general the data intensity, resolution of analysis, and accuracy of the estimates increase when moving from Tier 1 to Tier 2 to Tier 3.

A Tier 1 assessment is best suited for situations in which time and resources available are limited, and when the goal is to rapidly gain information on a specific target variable, but where precise insight into the detailed working of a specific policy is not required. Note that a Tier 1 assessment will typically not result in the isolation of GHG effects of a specific policy or action. In contract, a Tier 3 assessment should be used if the objective is to provide the most comprehensive understanding of the effects of the policy or action, including to fully isolate the GHG effects of the policy or action in question.

Table 11.3: Summary of tiered approaches for ex-post assessment[15]

Tier	General approach	Data and models used	Methodological issues addressed	Ability to isolate the GHG effects of the policy
Tier 1	Lowest level of accuracy and complexity	Top-down indicator-based approach, using existing aggregate statistical data	Few policy interactions or correction factors quantified	Not intended to isolate the policy effect, since it does not reflect the full complexity of the policy; instead, simply assesses changes in the indicators targeted by a policy
Tier 2	Intermediate level of analysis	Existing aggregate statistics with a higher resolution of data; country-specific data (e.g., national or grid average emission factors for electricity generation)	Some significant policy interactions and correction factors quantified	Depends on the availability and resolution of the data used
Tier 3	Most detailed and comprehensive assessment	Higher resolution of data; collection and analysis of new data; development of customized models or redevelopment of existing models	All significant policy interactions and correction factors quantified	Intended to fully isolate the GHG effects of the policy

11.3 Implement chosen ex-post GHG assessment method consistent with the chosen tier

Users should follow the same general steps and guidance provided in Chapter 9 (Quantifying GHG effects ex-ante) when quantifying GHG effects ex-post. However, rather than quantifying expected changes before policy implementation, the user will instead quantify historical changes after the policy or action is implemented.

Users should first assess whether the effects and outcomes identified in the causal chain (Chapter 6) actually occurred. This may include assessing the degree of policy implementation to ensure that the policy was implemented as planned. (More information on correcting for non-compliance is provided in section 11.5). Users should update the effects identified in the causal chain based on observed data before quantifying each GHG effect.

11.4 Address policy interactions and overlaps not previously considered in the baseline scenario

As outlined in Chapter 5, individual policies or actions often overlap or interact with other policies and actions, particularly if they affect emissions from the same source(s). Interactions may take a variety of forms: neutral, counteracting, or reinforcing (see Chapter 5).

Users should consider if these combined effects may have occurred during the implementation period and have not already been considered in the baseline scenario. If so, users shall quantify policy interactions to determine the GHG effects of the policy or action being assessed rather than other policies or actions. In that case it is necessary to identify the interaction strength between various policies and actions. See section 9.6 in Chapter 9 for guidance on quantifying policy interactions and overlaps.

[15] Source: AEA Technology/Fraunhofer ISI/Ecofys/ICCS, 2009

11.5 Correct for various effects not previously considered in the baseline scenario

After an ex-post evaluation, it is often necessary to correct the gross or total estimated GHG effect for various effects, outlined below. The types of effects that need to be corrected for depend on whether a bottom-up or top-down method is used. Note that many effects may already have been corrected for when identifying policy drivers and non-policy drivers to determine baseline emissions (Chapter 8).

Users shall correct for effects not previously considered in the baseline, within the context of the chosen tier.

Error! Reference source not found.<u>Effects that may need to be corrected for when using bottom-up methods</u>

- *Policy interactions* may not be adequately addressed within the methodology, which may lead to either an overestimation or an underestimation of the GHG effect, depending upon the nature of the interaction. (This correction may not be needed if multiple interacting policies (existing or planned) are evaluated as a package, as decided in Chapter 5. Note that additional policies may have been introduced during the policy implementation period that also have an interacting effect).
- *Multiplier effects:* actions that amplify the result, but are not directly driven by the policy or action of analysis, which may be lead to an underestimate of the net GHG effect.
- *Free-rider effects:* consumer actions that would have been taken anyway in the absence of the policy or action (e.g., grants or subsidies to encourage consumers to upgrade to more efficient equipment), which may overestimate GHG reductions from a policy (if not properly accounted for in the baseline scenario)
- *Direct rebound effects:* changes in behavior from energy efficiency policies (e.g., consumers increasing the internal temperatures of houses due to energy efficiency improvements that allow for higher indoor temperatures at lower costs), which would overestimate energy savings achieved from energy efficiency policies if not accounted for.
- *Non-compliance*: the degree to which the intended policy or action (e.g., a regulation) was implemented by the affected parties.
- *Exogenous factors* such as market energy prices will change the conditions for free riders, direct rebound effects, multiplier effects, and policy interactions.

<u>Effects that may need to be corrected for when using top-down methods</u>

- *Structural effects:* effects due to the disaggregation of a larger unit into subgroups. Hidden structural effects are those that are not resolved by disaggregation into subgroups. In the transport sector, structural effects can be identified partially with modal shift. In the industrial sector, influencing structures with facilitating policies might be more ambiguous (e.g., whether energy-intensive industries should be located in a country that has no affordable energy resources). Industries moving to another country is not the result of an energy efficiency policy, so changes in top-down indicators due to such structural effects have to be corrected for.
- *Economic rebound effects:* a larger number of effects that are similar to growth effects, where money saved through a policy or action is used for increased consumption of goods and services. Economic rebound can come from larger living area per household, higher home temperatures, increased number of households, larger and faster cars, longer journeys to work, etc. These growth effects are mainly wealth-related and are not directly related to concrete saving measures. These economic rebound effects reduce the additional GHG reductions from the policy or action assessed.
- *Earlier policies:* the impact of policies previous to the period considered (e.g., ongoing GHG reductions from previous GHG mitigation policies), which may lead to an overestimate of GHG reductions (if not properly accounted for in the baseline scenario)
- *Autonomous technology improvements:* GHG reductions that cannot be linked to the policy, e.g. GHG reductions due to market prices, ongoing trends in efficiency or technical progress, which

may overestimate GHG reductions from a policy (if not properly accounted for in the baseline scenario)

- *Exogenous factors* such as market energy prices change the conditions for autonomous technological improvments. When energy prices increase, autonomous technological improvements tend to increase and economic rebound effects to decrease.

Table 11.4 provides an example of using correction factors to take into account overlap with other policies and non-compliance. In this example, the correction factor for overlapping policies is a factor that reduces the overall size of the effect attributed to the specific policy or action. The compliance factor represents the percentage of compliance with a policy that may reduce its overall effect.

Table 11.4: Example of using correction factors

Policy or action	Initial estimated GHG effect (A)	Correction factor for overlapping policies (B)	Compliance factor (C)	Corrected GHG effect (=A*B*C)
Policy A	1,000 $MTCO_2e$	0.90	1.00	900 $MTCO_2e$
Policy B	1,000 $MTCO_2e$	0.45	0.80	360 $MTCO_2e$
Policy C	1,000 $MTCO_2e$	0.80	0.75	600 $MTCO_2e$
Policy D	1,000 $MTCO_2e$	0.50	0.95	475 $MTCO_2e$

11.6 Normalizing data (optional)

Users may normalize data within the ex-post evaluation, depending on the user's objectives. In this chapter, "normalization" is a process to make conditions comparable as opposed to "correction" (explained in section 11.5), which is a process used to identify and correct for various effects not previously considered, such as non-compliance, multiplier effects, or free-rider effects. Most of these effects are considered when determining the effect of various policy drivers and non-policy drivers in the baseline scenario (see Chapter 8).

If these effects have not been considered in the baseline scenario, data normalization may be used to create a comparable ex-post evaluation. For example, for a building insulation program, the following changes, if they occur during the implementation period, should be considered in data normalization:[16]

- Weather conditions (i.e., heating degree days, cooling degree days)
- Occupancy levels
- Structural changes
- Capacity use at the firm-level
- Impact of the economic or business cycle on industrial production
- Occupancy levels
- Opening hours for non-domestic buildings

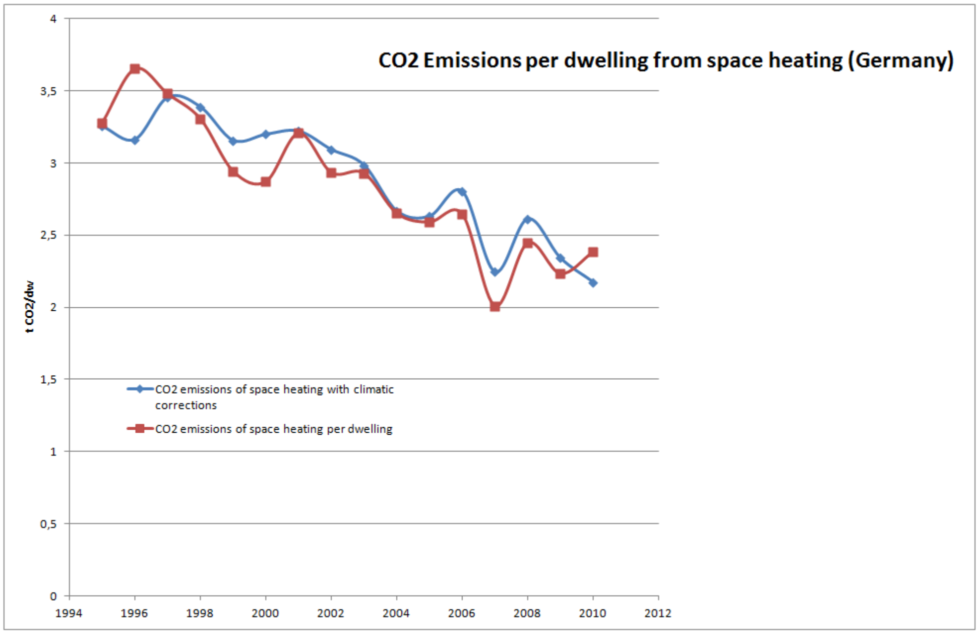
For example, for a building insulation program, if the end of the policy implementation period was warmer than the beginning of the policy implementation period, the GHG effect of the policy is reduced because less heating energy is used in such a year, while in a cold year the GHG effect will increase. The user should consider the GHG effects achievable under standard weather conditions in order to separate the GHG effect achieved "in principle" with the improvement of the building standard from the statistical fluctuations of annual climate variations.

Any normalization procedures used shall be transparently documented and reported.

[16] Source: European Directive for Energy Efficiency and Energy Services 2006/32/EC (ESD)

Figure 11.2 shows the difference of normalizing for weather conditions for an example from a German space heating policy.

Figure 11.2: Normalization with respect to weather conditions[17]



11.7 Aggregating GHG effects

Users may want to aggregate GHG effects across similar policies and actions to better communicate the overall effects of related policies. See Box 11.1 for an example of aggregating indicators for impacts to demonstrate the aggregated effect across policies.

Box 11.1: Example of aggregating indicators for impacts (ODEX)

The ODYSSEE-MURE project on energy efficiency indicators developed an energy efficiency index (ODEX) for communication and aggregation purposes. ODEX is used in the ODYSSEE-MURE project to measure the energy efficiency progress by main sectors (industry, transport, households) and for the whole economy (all final consumers). For each sector, the index is calculated as a weighted average of sub-sectoral indices of energy efficiency progress.

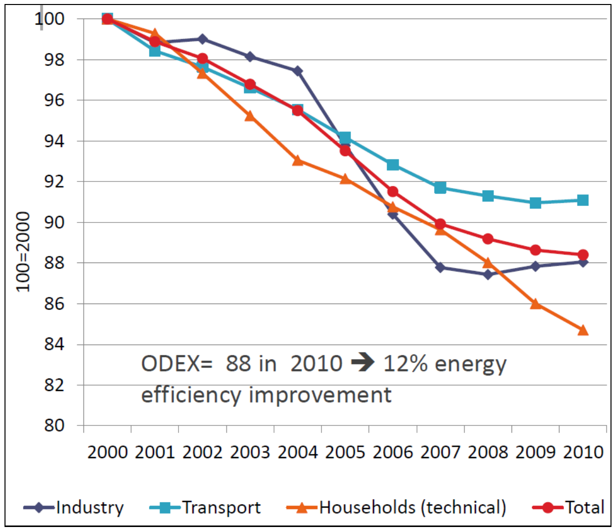
- The sub-sectoral indices are calculated from variations of unit energy consumption indicators, measured in physical units and selected so as to provide the best "proxy" of energy efficiency progress, from a policy evaluation viewpoint. Indices can combine different units for a given sector, for instance for households the user may consider kWh/appliance, koe/m2, and other units.
- The weight used to get the weighted aggregate is the share of each sub-sector in the total energy consumption of the sub-sectors considered in the calculation.
- A value of ODEX equal to 90 means a 10% energy efficiency gain.

The ODEX addresses the difficulty in communicating energy efficiency progress from 30 sub-indicators to an audience with limited time. ODEX top-down indicators represent a proxy for assessing energy efficiency trends at an aggregate level (e.g. overall economy, industry, households, transport, services)

[17] Source: Odyssee Database

than the traditional energy intensities, as they are cleaned from structural changes and from other factors not related to energy efficiency (more appliances, more cars).

Energy efficiency index (ODEX) for final consumers (EU-27)



Source: Odyssee Database (http://www.odyssee-indicators.org/registred/definition_odex.pdf)

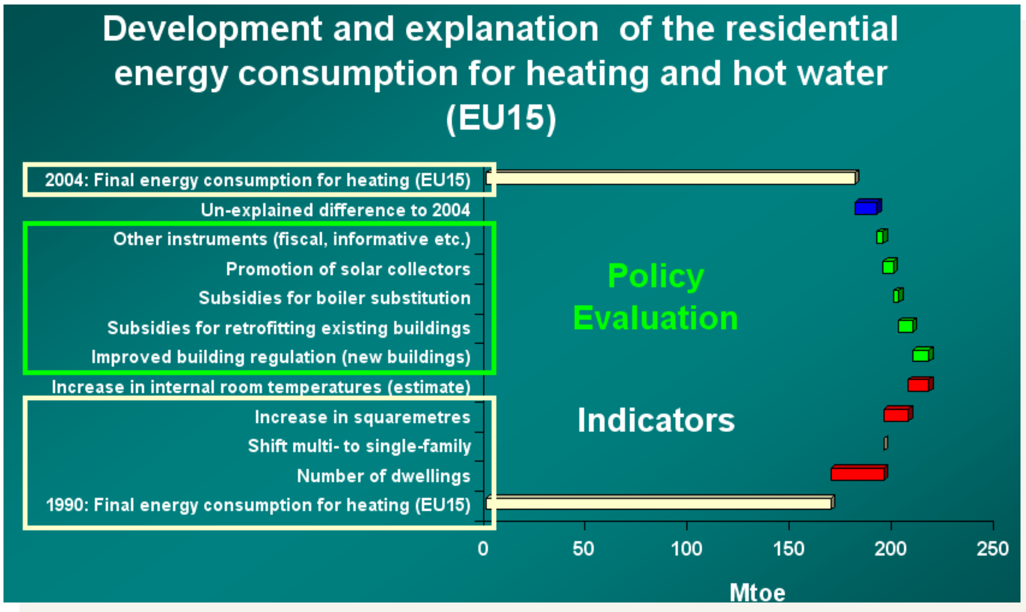
11.8 Harmonizing top-down and bottom-up evaluations and comparing GHG effects of policies to the GHG inventory

As explained in section 11.6, both top-down and bottom-up methods have limitations, and each approach results in specific types of effects that need to be corrected for. Typically, only either a top-down or bottom-up evaluation is carried out for an individual policy or a policy package. However, it is possible to carry out both methods in parallel. Harmonizing bottom-up and top-down accounting is useful to compare and control the differences between the different methods.

Users should also compare the results of the ex-post GHG assessment to the annual GHG emissions inventory for the relevant jurisdiction(s) to evaluate the quality of the GHG assessment and to understand the influence of counteracting factors that may lead to differences in the reported GHG effects based on a GHG assessment and the changes in GHG emissions that are reflected in the inventory.

Users should also apply a decomposition analysis, where relevant, to demonstrate the various factors that lead to changes in GHG emissions over time. Figure 11.3 provides an example on how to communicate the difference in residential energy consumption over time by what is a result of the evaluated policies and what is explained by other factors. Despite the policies implemented during the period, final energy consumption increased, but the policies reduced GHG emissions compared to the baseline scenario (which includes ongoing changes in housing preferences).

Figure 11.3: Example of decomposition analysis and linking top-down and bottom-up methods[18]



11.9 Link between ex-post and ex-ante monitoring ("rolling monitoring")

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 forecast is continuously overwritten with the results from ex-post evaluation, which allows for a comparison of the original expectations and the final result and also possible adjustments of targets or measures. Rolling monitoring can answer the questions:

- How much savings had been <u>achieved</u> up to a certain date?
- How much savings had been <u>initiated</u> up to a certain date?
- How much savings have been <u>achieved compared to the ex-ante projection</u>?

See Chapter 12 for guidance on uncertainty and sensitivity analysis, and Appendix A for guidance on evaluating data quality.

See Chapter 14 for reporting requirements related to quantifying GHG effects ex-post.

[Placeholder for sector-specific guidance and examples of monitoring performance over time]

[18] Source: EMEEES (2009)

Chapter 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 particularly relevant to determining baseline emissions (Chapter 8), quantifying GHG effects ex-ante (Chapter (9), monitoring performance over time (Chapter 10), and quantifying GHG effects ex-post (Chapter 11).

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 assist users in understanding the steps required to help improve the assessment quality and increase the level of confidence users have in the results. Because the audience of a GHG assessment report is diverse, users should make a thorough yet practical effort to communicate key sources of uncertainty in the results.

Understanding uncertainty also helps 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.

Requirements in this chapter

- Users shall carry out uncertainty assessments and sensitivity analyses for key parameters and assumptions in the GHG assessment

12.1 Guide to the uncertainty assessment process

Uncertainty assessment can be used within the GHG assessment process as a tool for guiding data quality improvements, as well as a tool for reporting uncertainty results. Users should identify and track key uncertainty sources throughout the assessment process and iteratively check whether the confidence level of the results is adequate for the stated objectives. Identifying, assessing, and managing uncertainty is most effective when done during the assessment process.

Users may choose a qualitative and/or quantitative approach to uncertainty assessment. Quantitative uncertainty assessment can provide more robust results than a qualitative assessment and better assist users in prioritizing data improvement efforts on the sources that contribute most to uncertainty. Including quantitative uncertainty results in the GHG assessment report also adds clarity and transparency to users of the report. Users should present both qualitative and quantitative (if completed) uncertainty information in the report. Users should also describe their efforts to reduce uncertainty in future revisions of the assessment (if applicable).

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 illustrates these types of uncertainties and corresponding sources.

Table 12.1: Types of uncertainties and corresponding sources

Types of uncertainty	Sources
Parameter uncertainty	Activity data
	Emission factors
	Global warming potential (GWP) values
Scenario uncertainty	Methodological choices
Model uncertainty	Model limitations

Parameter uncertainty

Parameter uncertainty is uncertainty regarding whether a value used in the assessment accurately represents the actual 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. In evaluating the uncertainty of a result, parameter uncertainties can be propagated to provide a quantitative measure (also as a probability distribution) of uncertainty in the final assessment.

Single parameter uncertainty

Single parameter uncertainty refers to incomplete knowledge about the true value of a parameter. Parameter uncertainty addresses how well data used to represent a parameter fits the actual activity. Single parameter uncertainty can arise in three data types: direct emissions data, activity data, and emission factors. Measurement errors, inaccurate approximation, and how the data was modeled to fit the conditions of the activity influence parameter uncertainty. For example, two data points of similar measurement precision may result in very different levels of uncertainty depending on how the points represent the activity's specific context (i.e. in temporal, technological, and geographical representativeness, and completeness terms).

Propagated parameter uncertainty

Propagated parameter uncertainty is the combined effect of each parameter's uncertainty on the total result. Methods are available to propagate parameter uncertainty from single data points. Two prominent methods are by random sampling (such as in the Monte Carlo method) and by analytical formulas (such as in the Taylor Series expansion method). These methods are described in the quantitative uncertainty guidance available at www.ghgprotocol.org.

Scenario uncertainty

While parameter uncertainty is a measure of how close the data used to calculate emissions are to the true (though unknown) actual data and emissions, scenario uncertainty refers to variation in calculated emissions due to methodological choices. When there are multiple methodological choices available in the standard (e.g., the selection of baseline assumptions), scenario uncertainty is created. The use of standards results in a reduction in scenario uncertainty by constraining choices the user may make in their methodology. For example, the boundary setting requirements standardize the boundary setting approach for all users. To identify the influence of these choices on the results, users should undertake a sensitivity analysis (see section 12.3).

Model uncertainty

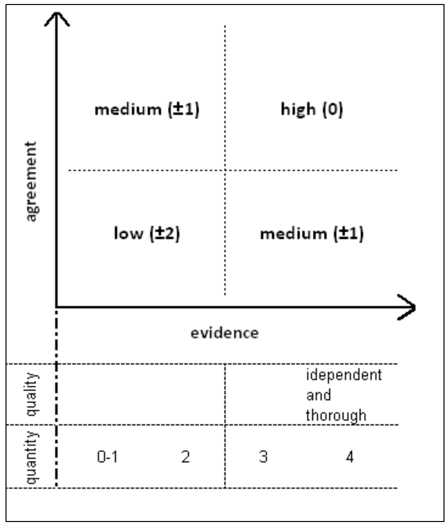
Model uncertainty arises from limitations in the ability of the modeling approaches used to reflect the real world. Simplifying the real world into a numeric model always introduces some inaccuracies. In many cases, model uncertainties can be represented, at least in part, through the parameter or scenario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

12.3 Uncertainty analysis

Uncertainty analysis should be undertaken to characterize parameter uncertainty (including single parameter uncertainty and propagated parameter uncertainty).

Figure 12.1 presents a matrix to guide users in assessing uncertainty. The uncertainty levels are expressed by the confidence of a finding. In the best case (high confidence) the evidence found should be sourced from a credible, independent institutions and at least four different sources support this finding (high agreement = e.g. all sources had the same conclusion). Depending on the method chosen for the quantification of impacts this uncertainty assessment can be used qualitatively or as an input into the calculations to deliver an uncertainty range (ideally with a 99% confidence interval).

Figure 12.1: Guiding matrix for uncertainty assessment for policy evaluators[19]



12.4 Sensitivity analysis

Sensitivity analysis should be used to understand differences in the GHG assessment results due to methodological choices and assumptions. A sensitivity analysis involves varying the parameters (or combinations of parameters) to understand the sensitivity of the overall results to changes in those parameters. These parameter adjustments may be plausible (e.g., changes are of a realistic magnitude) or implausible (e.g., interactions between the adjusted variables are ignored), but the main aim is to explore model sensitivity to inputs, and possibly uncertainty in outputs.[20]

When quantifying effects of policies on GHG emissions in Chapter 9 and Chapter 11, users shall identify those parameters that are most relevant for the determination of the result and conduct a sensitivity analysis by adjusting these to determine impact of such changes to the outcome, and specify whether the variation is conducted within a plausible or implausible range.

Two elements need to be considered separately in the sensitivity analysis:

- Sensitivity of results to policy and non-policy drivers (e.g., GDP, population, prices, other policies, and their effects on baseline and policy scenarios)
- Sensitivity of results to assumptions on drivers for the policy impact and the effect of variation of these on the policy scenario

The analysis should be conducted for all calculation methods (i.e., models or simplified methods).

12.5 Reporting uncertainty

Uncertainty can be reported in many ways, including qualitative descriptions of uncertainty sources, and quantitative representations, such as error bars, histograms, probability density functions, etc. It is useful to provide as complete a disclosure of uncertainty information as is possible. Users of the information may then weigh the total set of information provided in judging their confidence in the information.

[19] Source: Climate Action Tracker, Mexico Country report based on IPCC 2010.
[20] Definition taken from IPCC, AR4, WGII, Box 2.1.

Chapter 13: Verification

This chapter has not yet been developed but is expected to include information on:

- Benefits of verification/assurance
- Types of verification/assurance
- Levels of assurance
- Description of process and steps
- Timing of verification/assurance
- Materiality
- Challenges and considerations

Chapter 14: Reporting

This chapter provides reporting requirements explaining what information shall be reported in order for a GHG assessment report to be in conformance with the GHG Protocol *Policies and Actions Accounting and Reporting Standard*. This chapter also lists optional reporting information that users may should report if relevant.

Users shall report the following information related to the policy or action assessed and the quantified changes in GHG emissions and removals resulting from the policy or action:

- The policy or action (or package of policies/actions) assessed
- Whether the GHG assessment is an ex-ante assessment or an ex-post assessment
- The 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 metric tons of carbon dioxide equivalent
- Aggregate GHG effects for the package of policies/actions, separately reported from the individual GHG effects of each policy/action (if applicable)
- Annual GHG effects and cumulative GHG effects (over the GHG assessment period), separately reported
- The policy scenario and resulting emissions
- The baseline scenario and resulting emissions
- The net change in GHG emissions and the net change in GHG removals, separately reported in metric tons of individual greenhouse gases and in metric tons of carbon dioxide equivalent

Users shall report the following information on the methodology used to quantify changes in GHG emissions and removals resulting from the policy or action:

Defining the action of policy (Chapter 5)

- Detailed information describing the policy or action assessed
- Whether the assessment applies to an individual policy/action or a package of policies/actions, with justification for the choice.

Mapping the causal chain (Chapter 6)

- A map of the causal chain and a list of all potential effects considered in the analysis

Defining the GHG assessment boundary (Chapter 7)

- The policy implementation period, the policy monitoring period, and the GHG assessment period
- The GHGs included in the boundary
- GWP values and timeframe of GWP values used
- The significance threshold or criteria used to determine which GHG effects are included in the GHG assessment, with justification for their choice
- A list of the GHG effects included in the boundary
- A list of any GHG effects excluded from the boundary with justification for their exclusion

Determining baseline emissions (Chapter 8)

- The emissions estimation algorithm (including any models) used to quantify baseline emissions
- All policy drivers (e.g., policies, regulations, projects) that are included in the baseline scenario
- Any policy drivers (e.g., policies, regulations, projects) excluded from the baseline scenario, with justification for their exclusion

- All non-policy (e.g., socioeconomic) drivers that are included in the baseline scenario
- Any non-policy drivers excluded from the baseline scenario, with justification for their exclusion
- Any significance threshold or other justification used to determine which effects, parameters, policies, or drivers are included in the analysis
- All baseline values for parameters included in the baseline emissions estimation
- All data and assumptions related to drivers and parameters used to estimate baseline emissions (including relevant assumptions and data included in models), sources for those data and assumptions (e.g., peer-reviewed literature), and justification for the choice of data and assumptions used
- Indication of which elements of the baseline scenario and baseline emissions calculation are static and which are dynamic
- The tier(s) of analysis used for baseline estimation
- Justification for the choice of whether to develop new baseline data or use existing baseline data from peer-reviewed literature and the methodology used to develop any new data sets used in the assessment

Quantifying GHG effects ex-ante (Chapter 9)

- The emissions estimation algorithm used
- All policy drivers that are included in the policy scenario
- Any significance threshold or other justification used to determine which effects, parameters, policies, or drivers are included in the analysis
- All policy scenario values for parameters included in the ex-ante assessment
- All data and assumptions used to estimate GHG effects ex-ante (including relevant assumptions and data included in models), sources for those data and assumptions (e.g., peer-reviewed literature), and justification for the choice of data and assumptions used
- Indication of which elements of the policy scenario and emissions calculation are static and which are dynamic
- The tier(s) of analysis used
- The methodology used to develop any new data sets used in the assessment
- Methodology and assumptions used to determine the shape or scale of changes to parameters, including any adjustments made to results from previous studies or literature (if applicable)
- Emission factors and conversion factors used

Monitoring performance over time (Chapter 10)

- The indicators and the rationale for their selection
- Sources of indicator data
- The on-going performance of the policy or action, as measured by the respective indicators
- Whether the performance of the policy or action is on track
- Whether the assumptions on key parameters within the ex-ante assessment remain valid

Quantifying GHG effects ex-post (Chapter 11)

- The emissions estimation algorithm used
- The ex-post evaluation method used
- All policy drivers that are included in the policy scenario
- Any significance threshold or other justification used to determine which effects, parameters, policies, or drivers are included in the analysis
- All policy scenario values for parameters included in the ex-ante assessment
- All data and assumptions used to estimate GHG effects ex-post (including relevant assumptions and data included in models), sources for those data and assumptions (e.g., peer-reviewed literature), and justification for the choice of data and assumptions used

- Indication of which elements of the policy scenario and emissions calculation are static and which are dynamic
- The tier(s) of analysis used
- The methodology used to develop any new data sets used in the assessment
- Emission factors and conversion factors used
- Any effects that have been normalized and the methodology and normalization factors used
- Any effects that have been corrected (e.g., using policy interaction or non-compliance factors) and the methodology and correction factors used
- Description of differences between results from top-down and bottom-up methods (if applicable)

Assessing uncertainty (Chapter 12)

- A quantitative estimate or qualitative description of the uncertainty of the results
- Results from any sensitivity analysis used for key parameters

Optional reporting information

Users should report, where relevant:

- The objective and intended audience of the GHG assessment
- Net changes in GHG emissions and removals, separately by type of effect (i.e., intentional effects, unintentional effects, in-boundary effects, out-of-boundary effects, short-term effects, and long-term effects)
- Net changes in GHG emissions and removals that occur within the jurisdiction’s geographic boundary separately from net changes in GHG emissions and removals that occur outside of the jurisdiction’s geographic boundary
- Trends in the indicators used to monitor performance, such as the change in the indicators since the last reporting period
- The GHG inventory of the organization or jurisdiction implementing the policy or action
- Historical GHG emissions of the organization or jurisdiction implementing the policy or action
- GHG mitigation goal(s) of the organization or jurisdiction implementing the policy or action
- The contribution of the assessed policy or action toward the organization or jurisdiction’s GHG mitigation goal
- Non-GHG effects (i.e., co-benefits) of the policy or action
- Cost-effectiveness of the policy or action
- Other relevant information

Appendix A: Guidance on the collection, collation, and analysis of data

The accuracy of any estimates of the impacts of policies and actions on GHG emissions will be strongly influenced by the quality of the data used in making the estimates. The collection, collation and analysis of data are therefore a core activity that underpins the accounting of policies and actions.

GHG assessment of policies and actions is a data-intensive process. Some data might already be available from existing sources, but in many cases it requires additional data collection. The collection of data from multiple sources can lead to inconsistencies in levels of details, data formats and data quality. It also poses difficulties in achieving data integrity, data validity and completeness.

The purpose of the appendix is to provide some general guidance to help ensure data quality and to provide guidance on practical aspects of data collection, processing, compilation and reporting of data. The guidance is provided at a general level. More specific information on the data required for specific stages in the quantification of the GHG emissions of a policy or action, including defining the baseline emission, and quantifying emissions ex-ante and ex-post, is provided in the respective chapter.

Collection of data

The data collection requirements should be viewed in the context of the overall policy assessment process (see Figure 3.1). Certain data may be collected as part of the development of the policy, as part of the monitoring of its implementation, and as part of any ex-post evaluation.

The data collected in each of these steps may be similar; the data required for the on-going performance of the mitigation is likely to closely resemble the data required as part of an ex-post evaluation of the GHG emissions impacts. Likewise, the on-going monitoring data may mirror certain data collected prior to the implementation of the policy, for example to inform the assessment of the baseline scenario. An illustration is provided in Table A.1 for a hypothetical policy subsidizing renewable energy.

Table A.1: Example of data to be collected by stage

Stage	Usage	Data to be collected
Pre-policy	Informs the baseline scenario	Number and type of renewables devices implemented prior to the policy
Policy implementation	Indicates on-going performance of policy	Number and type of renewable devices installed during each year of policy implementation.
Post-policy	Informs the estimate of the policy impact	Number and type of renewable devices installed over lifetime of the policy

The precise data that will need to be collected will depend upon the policy in question, the stage in the process (e.g. defining the baseline, quantifying the emissions) and also the complexity (or Tier) or method that is being followed. These considerations were discussed further in the respective chapters.

However, it is also useful to consider the data required across all steps in the guidelines. By understanding the data that is required for each of the steps it is possible to define plans which ensure a consistent approach to the data, and make best use of existing data sources and data collection mechanisms.

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 an 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 document, along with a brief justification.

Quality assurance of data

For key data sources, or for key processes data sets it is important to 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.

Processes that have been followed in checking the data should be clearly followed.

Sources of activity data

Use of macro data sources at national and international level

Official data sources associated with public institutions and official statistics sources at the country level are generally accessible via the internet. These typically cover all types of official data from energy consumption (e.g., petroleum products, natural gas, electricity, and other combustion sources for industry or buildings), infrastructure development (e.g., roads, freight, rail, marine, and aviation), imports of consumables, current GHG emissions, evolution of land use, deforestation, livestock data, and domestic wood consumption. Usually trends can be derived from time series of annual data. International organizations (UN and others) provide international databases covering several specific areas, which may complete some gaps in national statistics.

Use of other expert data sources

A variety of research organizations, NGOs, and other technical agencies offer a range of complementary data sources such as GHG emission factors, policy drivers and research results that may be more appropriate to a specific field or economic sector (e.g., improved techniques, new processing material, industry units, improved production systems). Additionally, specific local or regional information sources (e.g., local research centers, local economic actors, regional universities and technical centers, decentralized public services and municipalities) may offer geographically specific data sources and inventories of economic or emissions-related activity.

Data gathering at source level

Rapid appraisal among individual agents (e.g., farmers, small industries, alternative energy producers, other economic agents) is often necessary to fill data gaps or particularities with respect to input consumption or output use coefficients. Targeted survey work with questionnaires may be considered as a final option for developing necessary input data.

Iterative approach in data collection and validation process

When data are not available, the users will have to gather experts involved in the project formulation, implementation, or evaluation. They may have a better understanding of the project zone and environment, or expertise in the specific location. Their experience and knowledge may be useful to assess what would have happen without the project considering e.g. the socio-economic and the agro-climatic contexts. While appraising the project, the user shall clearly state and justify any assumptions made to adjust the baseline, if required. Where data discrepancies occur, once again, the user shall state which source has been used and why it has been selected over any alternatives.

Sources of emission factors

Sources of emission factors include:

- IPCC *Guidelines for National Greenhouse Gas Inventories* (2006)
- Emission factors contained in the GHG Protocol calculation tools and guidance, available at www.ghgprotocol.org
- The *GHG Protocol for Project Accounting* and related *GHG Protocol Guidelines for Quantifying GHG Reductions from Grid-Connected Electricity Projects* (if applicable)

Sources of global warming potential (GWP) values

Global warming potential (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. GWP values convert GHG emissions data for non-CO2 gases into units of carbon dioxide equivalent (CO2e). Users should apply GWP values provided by the Intergovernmental Panel on Climate Change (IPCC) based on a 100-year time horizon. Users may either apply the IPCC GWP values agreed to by United Nations Framework Convention on Climate Change (UNFCCC) or the most recent GWP values published by the IPCC. Users should apply consistent GWP values across GHG assessments and their GHG inventory and should maintain consistency in the source of GWP values used over time (by consistently following guidance provided by either the UNFCCC or IPCC, once selected). Users are required to disclose the source of GWP values used to quantify emissions (see Chapter 14).

Using proxy data to fill data gaps

If data of sufficient quality are not available, proxy data could be used to fill data gaps. Where this is the case all proxy data should be clearly defined, and its use justified. Proxy data may include similar data from other geographic regions. Proxy data should be strongly correlated with the relevant parameter.

Improving data quality over time

Collecting data, assessing data quality, and improving data quality is an iterative process. Over time, lower quality data should be replaced with data of higher quality.

Assessing uncertainty

Where uncertainty is significant, lower and upper bounds or confidence intervals for all measurements should be identified. The user should be conservative and use data for quantification that reflect uncertainties that will tend to underestimate performance. For more information on assessing uncertainty, see Chapter 12.

Appendix B: Assessing cost-effectiveness of policies and actions

This appendix has not yet been developed but is expected to include:

- Brief guidance
- Suggested resources for more information

Additional appendices may also be added, such as:

- Additional sector-specific or policy/action-specific issues if not addressed in the other chapters
- Additional guidance on aggregating GHG effects across policies if not addressed in the other chapters

Worked example: Biofuels policy

This is a simplified, illustrative example to demonstrate how to apply the guidance in each chapter to an example of a biofuels policy. It does not represent an actual GHG assessment for an actual policy.

Chapter 5: Defining the policy or action

The following information describes the policy which is evaluated:

Category	Information	Example/explanation
Title	The title of the action or policy.	The European Biofuel Obligation
Implementation	The status of the action/policy.	On-going.
	Date of commencement.	The policy came into effect on 1 January 2008 (i.e. the first obligation year was calendar year 2008).
	Date of completion.	NA – the policy is on-going and does not have a defined end date.
Descriptors	Type of action/policy.	The policy is a regulation on fuel suppliers.
	Primary emission sources targeted.	Emissions from transport.
	Key indicators.	The target indicators for the policy are gCO_2e/MJ of biofuel supplied; and the total volume of biofuel supplied.
	Greenhouse gases covered.	The policy is intended to reduce CO_2 emissions from fossil fuel combustion in vehicles. In addition, all greenhouse gases controlled under the Kyoto Protocol will be included in the life cycle assessment of the biofuels supplied.
	Geographical coverage.	EU. The policy applies to all transport fuel supplier in the EU.
	Description of the specific interventions included in the action or policy.	The regulation creates an obligation on transport fuel suppliers to ensure that 5% (on an energy content basis) of the total fuel supplied is biofuels. In addition, the biofuels supplied must have a carbon intensity that is 50% lower than conventional fossil fuels (on a life cycle basis).
	Intended or target level of total mitigation to be achieved.	2 million tCO_2e/yr.
	Title of legislation or regulations associated with the action or policy.	The European Biofuel Directive.
	Title and reference/url of guidance documents relating to the action or policy.	NA
Other information	The broader historical context/significance of the action or policy.	There are relatively few other options available for mitigating the emissions from road transport, and this is expected to be a growing source of emissions caused by increased trade and economic activity within the EU.
	Outline of non-GHG co-benefits of the action/policy	It is anticipated that the policy will create co-benefits in terms of increasing rural incomes and improving European fuel security.

Consider assessing a package of related policies/actions

Consideration should be given to assessing a package of related policies/actions in order to capture the effects of interacting policies, or to avoid difficulties with disaggregating effects. The first step is to identify measures which may interact with the initial policy, for example by considering policies which target the same emission source. Examples include the European Vehicle Efficiency Improvement Standard, which aims to increase the average efficiency of road vehicles, and the European Speed Limit Regulations which aims to reduce the maximum speed limit on major roads.

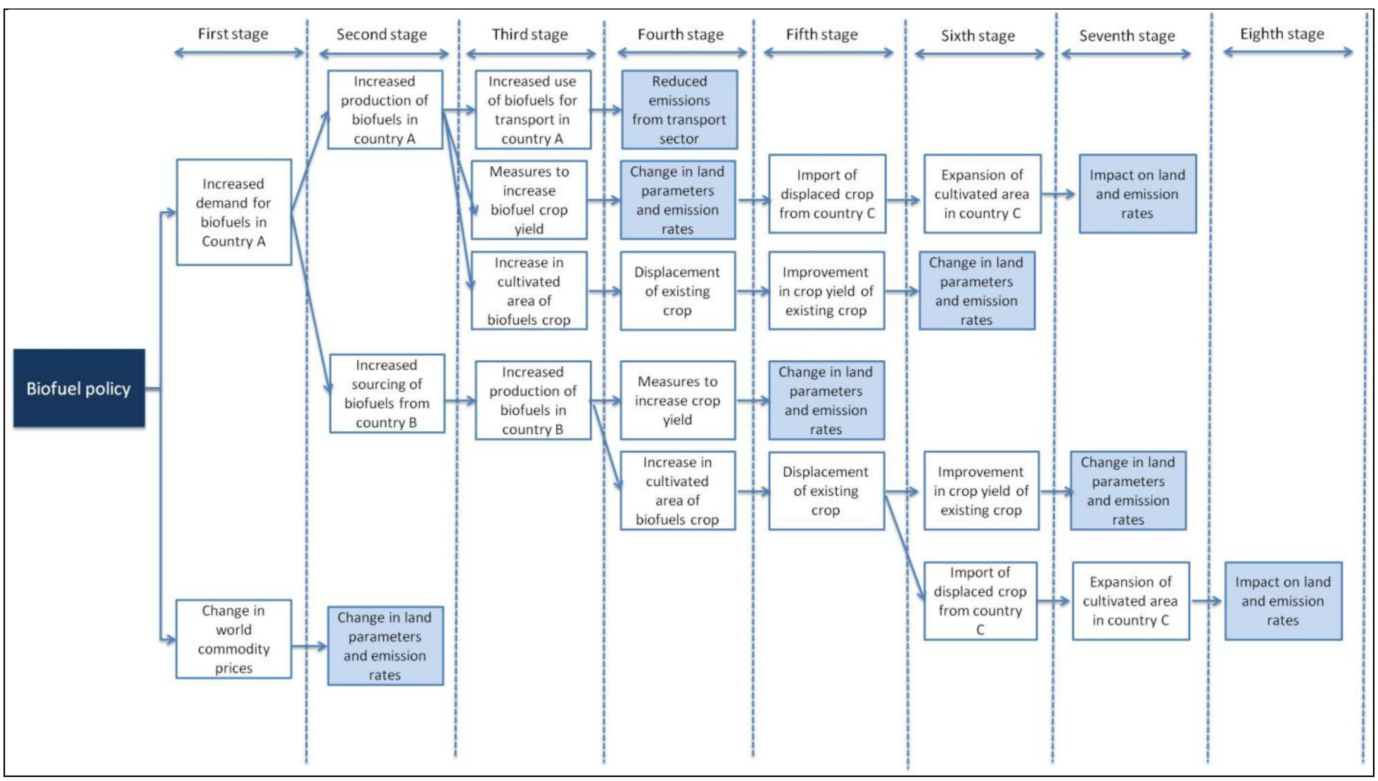
Because these two other policies are expected to reduce total fuel consumption in the EU by a large amount, they are therefore likely to reduce the volume of biofuel supplied under the EU Biofuel Obligation, and therefore have a large counteracting effect on the level of mitigation. Consideration should then be given to whether to assess a package that includes these policies. For the purposes of this example it is decided not to do so, because :

1. The commissioning agency requires an estimate of the effectiveness of the European Biofuel Policy, as an individual policy.
2. There are no methodological difficulties with disaggregating the effects of these interacting policies.

The interacting policies will be considered in the baseline and policy scenario for the assessment of the European Biofuel Policy.

Chapter 6: Mapping the causal chain

Final biofuel policy causal chain (Diagram of first through eighth stage effects)



Chapter 7: Defining the GHG assessment boundary

The causal chain mapping in Chapter 6 identified all potential effects and their associated GHG impacts for a biofuels policy. The process described in this chapter will define the GHG assessment boundary for quantification in subsequent chapters. An example of the process of establishing the GHG assessment boundary is outlined and described below.

GHGs covered

All seven Kyoto gases are covered in the assessment as required by the Protocol. To prevent double counting of GHG emissions, combustion of biogenic CO_2 is not included. Instead, biogenic CO_2 emissions (and uptake) are accounted by assessing land use change, both direct and indirect, consistent with IPCC guidelines for national GHG inventories. Non-GHG emissions are equated to CO_2 emissions using the 100-year Global Warming Potentials from the IPCC 4th Assessment Report. Assessment of black carbon and gas-aerosol interactions are not addressed in the assessment.

Temporal boundary

Temporal boundary	Example
Policy implementation period	10 years: 1 January 2010 - 1 January 2020
Policy monitoring period	20 years: The relevant sources are monitored on an annual basis from 2005 to 2025 (including pre-implementation, during implementation, and post-implementation)
GHG assessment period	25 years after the policy implementation period ends. Emissions associated with fuel production and combustion in motor vehicles are assumed to occur within the year. Biofuels are expected to be produced with short rotation non-woody (e.g., agricultural) crops; however, the timing of land-use change may be delayed by up to five years. Changes in soil carbon storage associated with land-use change are expected to occur within 20 years of land conversion.

Selection of significance criteria

Tier 2 significance criteria have been selected. There is currently no plan to generate credits from the policy, or verify the emissions reductions normally associated with Tier 3 significance criteria. However, the policy intends to impact a sector (transportation) with a large (~33%) of the GHG emissions inventory in a meaningful way, so it was determined that Tier 1 did not provide the appropriate level of rigor. Order of magnitude assessments generally were a comparison against the current carbon intensity of liquid fossil fuels. Potential international impacts evaluated on the basis of current value of agricultural trade.

Evaluation of significance

Effect	Expected Direction of GHG Impact	Likelihood of Occurrence	Order of Magnitude Analysis				Signifi-cant GHG effect?
			0	-1	-2	Explanation / Comment	
Combustion of biofuels for transportation	Decrease	Very Likely	X			In lifecycle analysis of traditional fossil fuels, combustion emissions are largest source of GHGs.	Yes
Domestic Fuel Production	Increase	Very Likely	X			Many forms of likely biofuel production more energy intensive. Existing published LCAs show fuel production emissions to be on same order of magnitude as fossil tailpipe emissions.	Yes
International Fuel Production	Increase	Likely	X			See above. Underutilized biofuel capacity available in neighboring countries	Yes
Fuel transport	Increase	Very Likely			X	Mostly domestic production expected.	No

Effect	Expected Direction of GHG Impact	Likelihood of Occurrence	Order of Magnitude Analysis				Signifi-cant GHG effect?
			0	-1	-2	Explanation / Comment	
Domestic Land-Use Change	Increase	Likely		X		Ministry of Agriculture estimates additional farmland availability at 10-20%.	Yes
Domestic Soil Carbon	Increase	Very Likely			X	Increased land for biofuels production expected to come from existing marginal grassland. Change in carbon storage expected to be less than 10%.	No
Domestic Farm inputs / fertilizer use	Increase	Very Likely			X	Nitrogen fertilizer consumption expected to increase; however, only a fraction would be lost as N_2O.	Yes
Changes in domestic livestock production	Decrease	Likely		X		Increased commodity pricing is likely to reduce domestic production at the margin. Previous biofuel assessments have documented impact at roughly 5-10% of fossil fuel baseline emissions	Yes
Changes in domestic rice production	Decrease	Unlikely		X		Domestic rice production currently high margin crop.	No
Increased crop yield	Decrease	Likely		X		Increased crop yields may mitigate both domestic and international land-use change. Some varieties promise increased crop yields of 10-20%.	Yes
Tailpipe non-CO_2 Emissions	Increase	Very Likely			X	Biofuels have N_2O and CH_4 emissions 1 – 10% greater than traditional fossil fuels	Yes
International land use change	Increase	Very Likely	X			Region currently net importer of agricultural commodities. Other biofuel LCAs performed by U.S. EPA and CA Air Resources Board determined magnitude to be same order of magnitude as fossil tail pipe emissions. Those countries, ranked in order of agricultural trade value, which cumulatively represented 90% of total trade value were included.	Partial – Country specific

Chapter 8: Determining baseline emissions

Given that this example represents a national level policy that will have direct economic consequences on the member nations of the EU, the highest-level quality is suggested and a Tier 3 analysis selected. Induced land-use change is an important consideration for establishing appropriate emission factors for several potential imported biofuel sources; however, given that there is currently insufficient evidence to enable these impacts to be quantified with a reasonable level of accuracy, this important consideration has been excluded from the analysis. In addition, given that there were limited imported biofuels to the EU at the time of this policies implementation (the time period of this analysis is 1995-2007), the impact of land-use change is expected to be small with respect to this ex-post analysis.

The following table provides a simplified example of steps that might be undertaken to establish a baseline emissions estimate for the biofuel directive .

Step	Example	Comments
Define emissions estimation algorithm	Quantify energy and emission impacts of fuel substitution of various biofuel options for projected/observed diesel and	Interaction of this program with other transportation sector programs is also conducted using PRIMES model.

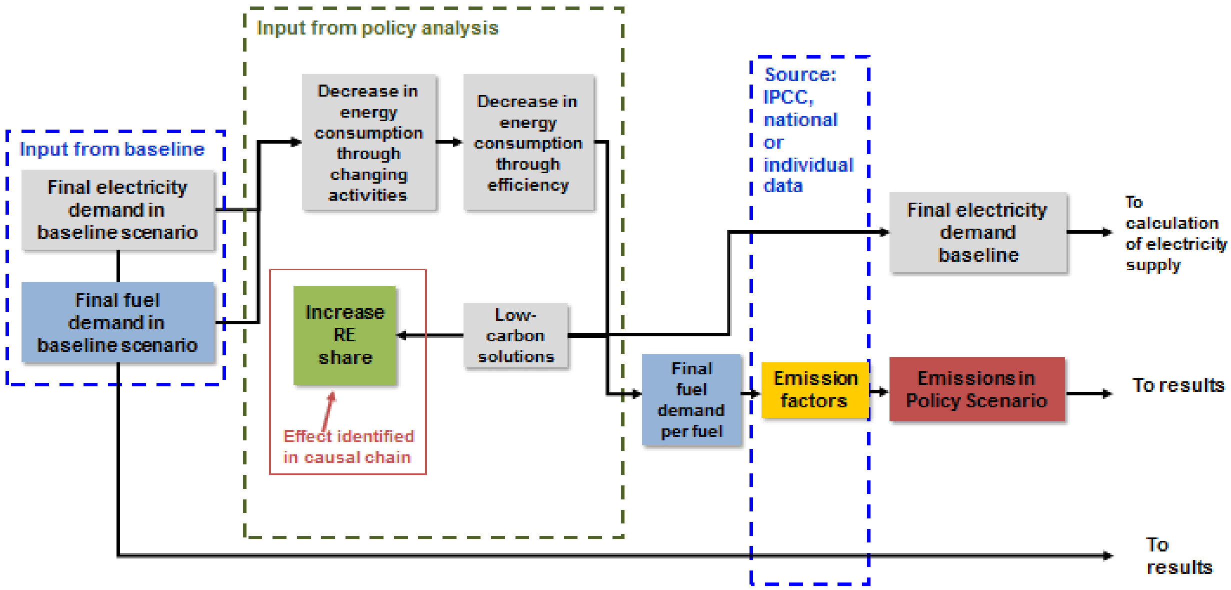
	gasoline in transportation.	
Define parameters	• Quantity of biofuels produced, consumed and imported in EU; • Emission factor of biofuels including LCA across full supply chain	Accurate production, consumption, and import data on biofuel feedstock exists for the EU prior to 2005 directive. Research has identified appropriate emission factors and uncertainties.
Define policy and non-policy drivers and assumptions	Non-policy drivers: • Structural changes in EU transportation sector (fuel consumption consistent with increasing private cars, trucks, and aviation) • Dieselization of EU Fleet (consistent with historical trends: 1995-2005) • Interaction between food prices and biofuel prices Policy drivers: • EU fuel efficiency requirements and voluntary agreements (continued increase in LD transportation fleet efficiency) • Individual EU member state tax incentives and subsidies for biofuel production *prior* to adoption of EU biofuel directive	
Estimate baseline emissions	Quantify volume and GHG impact of biofuel under assumptions consistent with pre-directive historical trends and policies in place at time of directive	Utilize emission factors consistent with full LCA for each supply chain excluding land-use change

Chapter 9: Quantifying GHG effects ex-ante

Identifying parameters affected by policy

Based on the previous example for a biofuels policy, [21] the relationships between parameters within a defined algorithm are identified. The example assumes a simplified model approach based on fuel consumption. In this model the biofuels policy effect number 1: 'Reduced emissions from transport in country A' would affect the parameter 'share of renewables' in the calculation.

[21] Adapated from Höhne et al. (2011) , available at www.climateactiontracker.org/assets/publications/publications/WP1_MethodologyCountryAssessment_website_2011.pdf



The share of renewables would then in fact be broken down further to the different fuel types. The policy would then influence the share of biofuels, which would then cause changes to the shares of the other fuels used (see example further below).

Another example with a more detailed level of calculation could require a number of different parameters to look at. An incentive scheme to replace inefficient appliances (compare examples in chapter 8) could require more parameter changes:

- Number of appliances replaced
- Average energy saving per appliance replaced
- Age structure of appliances replaced
- Lifecycle emissions of different types of appliances

<u>Identifying and reporting expected changes in parameters</u>

The table below provides more detail on expected changes using the same biofuels policy example used to identify the parameters.

	Share baseline	Share new biofuel	Assumptions on division of rest across other fuels	Shares new
Coal	-			
Oil	90%		biofuel replaces oil products only	84%
Gas	5%		stays constant	5%
Nuclear	-			
Hydro	-			
Geothermal	-			
Solar/wind/other	-			
Biomass/waste	4%	10%		10%
Electricity	1%		stays constant	1%

In a more detailed model, the transport fuels could be broken down to another level, differentiating different transport fuel types (gasoline, diesel, etc.), various gas fuels (LPG, CNG, etc.) and the different biofuel types (ethanol, biodiesel, etc.).

Example of reporting parameter changes

Parameter	Baseline value	Policy scenario value(s)	Time line of effect	Shape of effect	Source(s) used	Comments / explanations
Share of biofuels	4%	10%	Full analysis period	Linear increase	Policy specification, national transport institute	Biofuel only replaces oil-based fuels, not electricity or gas, because…

Chapter 10: Monitoring performance over time

Define the indicators, or metrics, to track the on-going performance of the policy or action

The performance of an obligation on the biofuels content of road transport fuels can be monitored using a range of input, activity, output and outcome metrics. The main input depends upon the instrument that is assumed to deliver the obligation. In this instance a regulatory obligation is assumed to be the primary measure. However, there may also be supporting instruments such as a tax exemption or subsidy scheme. The value of this tax exemption or subsidy, in terms of total revenues, can be monitored. The policy will stimulate certain activities, including changes in the domestic supply of biofuels as well as imports. Indicators of the outputs may include the biofuel content of fuels. An indicator relating to the biofuels meeting certain sustainability criteria would provide an indication on the wider GHG impacts. Outcome related indicators would take into account the increase in consumption of biofuels and therefore the associated reduction in the consumption of fossil fuels, with an associated emissions saving.

Inputs	• Value of tax exemptions offered • Value of subsidy • Cost of administrative/monitoring the regulations
Activity	• Annual biofuel production, by feedstock type • Annual imports of biofuel, by feedstock type and supply location
Outputs	• % of biofuel in transport fuel • % of biofuel meeting sustainability criteria
Outcomes	• Volume of biofuels consumed • Savings of direct GHG emissions from fuel combustion

Define the monitoring plan

The indicators can be prepared largely from existing data sources. To facilitate the data collection, the regulatory obligation may include requirements for manufacturers and retailers to provide certain data to facilitate the effective monitoring.

The value of any tax exemptions and subsidy payments are available for government records. Annual biofuel production and sales statistics may be available from manufacturers or retailers, although additional surveys may be required to determine the mix of feedstocks. Data on biofuel imports is available from trade data. Requiring fuel manufacturers to calculate and report the respective biofuel content of the fuel supplied would ensure this data is available for reporting. Statistical on fuel sales is available from existing monitoring of tax revenues.

In terms of the frequency of monitoring then this will be to some extent determined by the availability of relevant statistics. A number of the data sources will be updated on an annual basis, although there will be a delay associated with the compilation and validation of the statistics.

Abbreviations

AFOLU	Agriculture, Forestry, and Other Land Use
CDM	Clean Development Mechanism
CH_4	Methane
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
g	Grams
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GWP	Global Warming Potential
HFCs	Hydrofluorocarbons
IPCC	Intergovernmental Panel on Climate Change
kg	Kilogram
km	Kilometer
kWh	Kilowatt-hour
LULUCF	Land Use, Land Use Change, and Forestry
MSW	Municipal Solid Waste
$MTCO_2e$	Metric Tons of Carbon Dioxide Equivalent
MWh	Megawatt-hour
NF_3	Nitrogen Trifluoride
NGO	Non-Governmental Organization
N_2O	Nitrous Oxide
PFCs	Perfluorocarbons
QA	Quality Assurance
QC	Quality Control
SF_6	Sulphur Hexafluoride
t	Metric Ton
T&D	Transmission and Distribution
UNFCCC	United Nations Framework Convention on Climate Change
WBCSD	World Business Council for Sustainable Development
WRI	World Resources Institute

Glossary

Absolute value: 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.

Action: An organized activity intended to achieve an objective. Actions include deployment of new products or technologies, financing and investment, among others.

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.

Baseline emissions: An estimate of GHG emissions, removals, or storage associated with a baseline scenario. Elements that are required to calculate the baseline emissions include the baseline emissions factors and baseline activity data.

Baseline scenario: A set of assumptions and data describing the most likely events or conditions that would have occurred in the absence of the policy intervention, based on available information. Elements that are required to define a baseline scenario include baseline assumptions (e.g., related to policies, technologies, management methods, cost, etc.)

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 (e.g., using a measuring device such as a fuel meter) at the source-, entity-, or project-level (e.g., energy used at source level (by fuel type), output of production, etc.).

Bottom-up methods: Methods that use bottom-up data to calculate or model the change in GHG emissions for each source, project, or entity (e.g., through changes in behavior or technology), then aggregate across all sources, projects, or entities to determine the total change in GHG emissions (e.g., using engineering models).

Causal chain: A conceptual diagram tracing the process by which the policy or action leads to GHG effects through a number of interlinked logical and sequential stages and outcomes of causes and effects.

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 releasing (or avoiding releasing) different greenhouse gases against a common basis.

Driver:. Something that creates or causes an activity or change in the level of activity. E.g. Economic growth may be a driver of increased energy consumption.

Dynamic: A descriptor for an element of a baseline scenario or baseline emissions calculation (e.g., emission factor) that changes over time***.***

Effect. A result of the policy or action (or package of policies or actions) being assessed (e.g., reduced energy use in households is an effect of an insulation promotion scheme).

***Emission factor*:** A factor that converts activity data into GHG emissions data (e.g., kg CO2e emitted per liter of fuel consumed).

***Emissions*:** The release of greenhouse gases into the atmosphere.

Emission estimation algorithm: An equation, approach, methodology, or model that utilizes indicators and parameters to quantitatively estimate GHG emissions reduction. E.g. A typical emission estimation algorithm is the following equation: Emissions = Emission Factor x Activity Rate

Emission source:. A point of origin for emissions. E.g. stationary fuel combustion is an emission source.

Ex-ante baseline scenario: A baseline scenario that is established prior to implementation of the policy or policies based on trends in historical data and on forecasts of external drivers (e.g., projected population, economic activity, or other conditions that affect emissions).

Ex-ante assessment: Quantifying expected future GHG effects of policies and actions before implementation.

Ex-post baseline scenario: A baseline scenario that is established during or after implementation of the policy or policies and may include adjustments to the ex-ante forecasts of external drivers based on observed historic data (e.g., changes in population, economic activity, or other conditions that affect emissions).

Ex-post estimation: Quantifying historical GHG effects of policies and actions after implementation.

GHG: See greenhouse gas.

GHG assessment: The quantification of changes in GHG emissions resulting from a policy or action. Typically “GHG appraisal” has been used to describe ex-ante GHG estimation, while “GHG evaluation” has been used to describe ex-post GHG quantification. This standard uses “GHG assessment” to refer to both cases.

GHG assessment boundary: Defines the scope of the GHG assessment in terms of the GHGs included; the geographies and sectors covered; the time period covered; and the GHG effects for which GHG impacts are quantified.

GHG assessment period: The time period over which GHG effects associated with the policy and its effects are assessed.

GHG effect: The net change in GHG emissions by sources and removals by sinks associated with an effect.

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 (CH4); nitrous oxide (N2O); hydrofluorocarbons (HFCs); perfluorocarbons (PFCs); sulphur hexafluoride (SF6); and nitrogen trifluoride (NF_3).

Impact: See effect and GHG effect.

In-boundary effects: Effects that occur inside a defined geographic and sectoral boundary.

Indicator: A parameter that corresponds to the desired effect of a policy or action. E.g. GW of wind power generated in a county is a useful indicator for tracking the effects of a production tax credit for wind power in that country.

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

Leakage: Out-of-boundary effects that increase emissions outside the boundary.

Long-term effects: Effects that are more distant in the causal chain and more distant in time (based on the number of stages in the causal chain and amount of time between the policy and the effect)

Non-policy driver: A driver of activity that results from socioeconomic conditions that is independent of regulatory and legal frameworks in place. E.g. fuel prices and weather conditions are non-policy drivers of demand for air conditioning or heating.

Out-of-boundary effects: Effects that occur outside of a defined geographic and sectoral boundary.

Parameter: One of a set of variables used in a calculation. E.g. "emissions per kWh of electricity", and "quantity of electricity supplied" are both parameters in the calculation "0.5 kg CO_2e/kWh of electricity * 100 kWh of electricity supplied = 50 kgCO_2e".

Parameter value: The value of a parameter. E.g. "0.5" is the parameter value for the parameter "emissions per kWh of electricity".

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

Policy: A plan of action adopted or pursued by an individual, government, business, or other party. Government policies include laws, regulations, programs, and other instruments implemented and/or mandated by a government agency or authority. Types of government policies include regulations and standards, taxes and charges, subsidies and incentives, voluntary agreements, and information instruments.

Policy driver: A driver of activity that results from a policy or regulation other than the policy being assessed. E.g. a renewable portfolio standard that is in place is a policy driver for an electric-vehicle program that might increase electric demand.

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 (i.e., including a base period) and post-policy monitoring (over which the permanence of the policy is assessed), in addition to monitoring during the policy implementation period.

Post-measure effects*:* some measures may only be active for a defined time frame (e.g. incentive schemes or capacity building initiatives). Effects of these measures can potentially continue beyond this defined time frame with same or changed intensity.

Proxy data: Data from a similar process or activity that is used as a stand-in for the given process or activity. Proxy data should be strongly correlated with the relevant parameter.

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).

Removal: Removal of GHG emissions from the atmosphere through sequestration or absorption (e.g., when CO_2 is absorbed by biogenic materials during photosynthesis).

Sensitivity analysis: Sensitivity analyses employ characterisations that involve arbitrary or graduated adjustments of one or several variables relative to a reference case. These adjustments may be plausible (e.g., changes are of a realistic magnitude) or implausible (e.g., interactions between the adjusted variables are ignored), but the main aim is to explore model sensitivity to inputs, and possibly uncertainty in outputs. (IPCC, AR4, WGII, Box 2.1)

Short-term effects: Effects that are nearer in the causal chain and nearer in time (based on the number of stages in the causal chain and amount of time between the policy and the effect)

Spillover effect: Out-of-boundary effects that reduce emissions outside the boundary.

Static: A descriptor for an element of a baseline scenario or baseline emissions calculation (e.g., emission factor) that does not change over time.

Top-down data: Macro-level statistics collected at the jurisdiction or sector level (e.g., energy use, population, GDP, fuel prices, etc.).

Top-down methods: Methods that use top-down data to calculate or model changes in GHG emissions based on changes in macro-level statistical time series indicators (e.g., using econometric models or regression analysis). Note that top-down data can be aggregated from bottom-up data sources.

Uncertainty: 1. Quantitative definition: Measurement that characterizes the dispersion of values that could reasonably be attributed to a parameter. 2. Qualitative definition: A general and imprecise 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, lack of transparency etc.

Uncertainty analysis: In uncertainty analysis, inputs relevant for the impact of policies are varied depending on the confidence in the made assumptions. The uncertainty levels are expressed by the confidence of a finding.

Unintended effects: Effects that are unintentional based on the original objectives of the policy or action.

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To be completed

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