The Greenhouse Gas Protocol

The GHG Protocol for Project Accounting

World Business Council for
Sustainable Development

WORLD
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GHG Protocol Initiative Team

WORLD RESOURCES INSTITUTE	**WORLD BUSINESS COUNCIL FOR SUSTAINABLE DEVELOPMENT**
Suzie Greenhalgh	Mahua Acharya
Derik Broekhoff	Laurent Corbier
Florence Daviet	Kjell Oren
Janet Ranganathan	Heidi Sundin

Project Management Team (PMT)

This team was assigned to guide and oversee the development of the document until it was road tested in September 2003.

Mike McMahon, BP
Jennifer DuBose, Climate Neutral Network
P.R. Shukla, Indian Institute of Management
Melanie Eddis, KPMG
Bob Fledderman, MeadWestvaco
Clifford Schneider, MeadWestvaco
Jane Ellis, Organization for Economic Cooperation and Development
Richard Tipper, The Edinburgh Centre for Carbon Management
Yasuo Hosoya, Tokyo Electric Power Company (TEPCO)

Revision Management Team (RMT)

This team was instituted in December 2003, to guide the integration of feedback received from the road testing phase and advice towards the finalisation of the document.

Mike McMahon, BP
Arthur Lee, Chevron Corporation
Einar Telnes, Det Norske Veritas (also on the DNV review team)
Ken-Ichi Shinoda, Global Industrial and Social Progress Research Institute
Adam Costanza, International Paper
Melanie Eddis, KPMG (also on the KPMG review team)
Jed Jones, KPMG (also on the KPMG review team)
Fabian Gaioli, MGM International
Julia Martinez, Ministry of Environment and Natural Resources (SEMARNAT), Mexico
Lucy Naydenova, Ministry of Housing, Spatial Planning and the Environment, Netherlands
Tom Baumann, Natural Resources Canada (NRCan)
Patrick Hardy, NRCan
Jeff Fiedler, Natural Resources Defense Council (NRDC) (also Taskforce Leader)
Michelle Passero, Pacific Forest Trust
Ajay Mathur, Senergy Global
Sivan Kartha, Tellus Institute
Michael Lazarus, Tellus Institute
Yasushi Hieda, TEPCO
Martin Hession, United Kingdom Department for Environment Food and Rural Affairs (UK DEFRA)
Lisa Hanle, United States Environmental Protection Agency (USEPA)
Maurice LeFranc, USEPA (also Taskforce Leader)

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Lynn Betts, Natural Resources Conservation Service

Part I

BACKGROUND, CONCEPTS AND PRINCIPLES

1 Introduction

The Greenhouse Gas Protocol Initiative is a multi-stakeholder partnership of businesses, nongovernmental organisations (NGOs), governments, academics, and others convened by the World Business Council for Sustainable Development (WBCSD) and the World Resources Institute (WRI). Launched in 1998, the Initiative's mission is to develop internationally accepted greenhouse gas (GHG) accounting and reporting standards and/or protocols, and to promote their broad adoption.

The GHG Protocol Initiative is comprised of two separate but linked modules:

- the GHG Protocol Corporate Accounting and Reporting Standard (Corporate Accounting Standard), revised edition, published in March 2004; and
- the GHG Protocol for Project Accounting (this document).

1.1 The GHG Protocol for Project Accounting

The GHG Protocol for Project Accounting (Project Protocol) provides specific principles, concepts, and methods for quantifying and reporting GHG reductions—i.e., the decreases in GHG emissions, or increases in removals and/or storage—from climate change mitigation projects (GHG projects). The Project Protocol is the culmination of a four-year multi-stakeholder dialogue and consultation process, designed to draw knowledge and experience from a wide range of expertise. During its development, more than twenty developers of GHG projects from ten countries "road tested" a prototype version of the Protocol, and more than a hundred experts reviewed it.

The Project Protocol's objectives are to:

- Provide a credible and transparent approach for quantifying and reporting GHG reductions from GHG projects;
- Enhance the credibility of GHG project accounting through the application of common accounting concepts, procedures, and principles; and
- Provide a platform for harmonization among different project-based GHG initiatives and programs.

To clarify where specific actions are essential to meeting these objectives, the Project Protocol presents requirements for quantifying and reporting GHG reductions and provides guidance and principles for meeting those requirements. Though the requirements are extensive, there is considerable flexibility in meeting them. This flexibility arises because GHG project accounting necessarily involves making decisions that directly relate to policy choices faced by GHG programs—choices that involve tradeoffs between environmental integrity, program participation, program development costs, and administrative burdens. Because the Project Protocol is not intended to be biased toward any specific programs or policies, the accounting decisions related to these policy choices are left to the discretion of its users.

1.2 Who Can Use the Project Protocol?

The Project Protocol is written for project developers, but should also be of interest to administrators or designers of initiatives, systems, and programs that incorporate GHG projects, as well as third-party verifiers for such programs and projects. Any entity seeking to quantify GHG reductions resulting from projects may use the Project Protocol. However, it is not designed to be used as a mechanism to quantify corporate or entity-wide GHG reductions; the Corporate Accounting Standard should be used for that purpose.

GHG projects can be undertaken for a variety of reasons, including generating officially recognized GHG reduction "credits" for use in meeting mandatory emission targets, obtaining recognition for GHG reductions under voluntary programs, and offsetting GHG emissions to meet internal company targets for public recognition or other internal strategies. Though the Project Protocol is intended to be compatible with all of these purposes, using it does not guarantee a particular result with respect to quantified GHG reductions, or acceptance or recognition by GHG programs that have not explicitly adopted its provisions. Users are strongly encouraged to consult with relevant programs or other interested parties regarding the resolution of policy-relevant accounting decisions. In the absence of external guidance on these decisions, users should strive for maximum transparency when justifying the basis of such decisions and fulfilling the Project Protocol's requirements.

1.3 Overview of the Project Protocol

The Project Protocol has four parts. Part I presents GHG project accounting concepts and principles, as well as background information and a discussion of policy issues related to GHG project accounting. Part II contains the procedures and analyses that are required to quantify, monitor, and report GHG reductions. Part III provides two case study examples of how to quantify GHG reductions from GHG projects, and Part IV includes annexes to supplement the requirements and guidance contained in Parts I and II. Following are brief summaries of the information in Parts I and II.

PART I: BACKGROUND, CONCEPTS AND PRINCIPLES

- **Chapter 1: Introduction.** This chapter provides an introduction to the GHG Protocol Initiative and the Project Protocol, outlines its uses and limitations, and provides an overview of some tools that supplement the Project Protocol.

- **Chapter 2: Key GHG Project Accounting Concepts.** This chapter describes the terms and concepts used in project-based GHG accounting. This information is needed to properly understand and apply the Project Protocol and should be read carefully before moving on to the accounting chapters in Part II.
- **Chapter 3: Policy Aspects of GHG Project Accounting.** This chapter clarifies where and how certain decisions about GHG project accounting relate to the policy objectives of GHG programs.
- **Chapter 4: GHG Accounting Principles.** This chapter outlines general GHG accounting principles that underpin project-based GHG accounting. These principles are intended to guide accounting decisions when there is flexibility or uncertainty in applying the Project Protocol's requirements.

PART II: GHG REDUCTION ACCOUNTING AND REPORTING

The chapters in Part II are intended to guide project developers sequentially through the requirements for GHG project accounting, monitoring, and reporting. However, some of the requirements in different chapters are interrelated, and some back-and-forth consultation of chapters may be required. For instance, the full scope of the GHG assessment boundary (Chapter 5) may not be finalized until baseline emissions have been estimated (Chapter 8 or 9).

The chapters in Part II are divided into "requirements" and associated "guidance" intended to ensure that accounting for project-based GHG reductions is complete and transparent. To ensure that the GHG reductions have been quantified according to the Project Protocol, users should follow the guidance closely in completing the requirements.

- **Chapter 5: Defining the GHG Assessment Boundary.** This chapter provides requirements and guidance for identifying the GHG sources and sinks that will be taken into account in quantifying GHG reductions. It requires differentiating the GHG project into one or more "project activities." In addition to primary effects—specific changes in GHG emissions that a project activity is designed to achieve—project activities may result in unintended changes in GHG emissions elsewhere, or secondary effects. The GHG assessment boundary encompasses all these effects.
- **Chapter 6: Selecting a Baseline Procedure.** This chapter provides brief guidance on choosing between the project-specific and the performance standard procedures for estimating "baseline emissions"—i.e., the emissions to which project activity emissions will be compared in order to quantify GHG reductions.

- **Chapter 7: Identifying the Baseline Candidates.** This chapter provides requirements and guidance on how to identify baseline candidates, which are technologies or practices that should be considered and analysed to estimate baseline emissions.
- **Chapter 8: Estimating Baseline Emissions — Project-Specific Procedure.** This chapter contains the requirements and guidance for estimating baseline emissions using the "project-specific" procedure. This procedure employs a structured analysis of baseline candidates to identify a "baseline scenario" specific to a particular project activity.
- **Chapter 9: Estimating Baseline Emissions — Performance Standard Procedure.** This chapter contains the requirements and guidance for estimating baseline emissions using the "performance standard" procedure. This procedure estimates baseline emissions from a numerical analysis of all the baseline candidates identified in Chapter 7.
- **Chapter 10: Monitoring and Quantifying GHG Reductions.** This chapter describes the data that need to be monitored in order to credibly quantify GHG reductions.
- **Chapter 11: Reporting GHG Reductions.** This chapter defines the reporting requirements needed to transparently report GHG reductions.

1.4 Issues Not Addressed by the Project Protocol

The Project Protocol intentionally does not address several issues related to GHG projects, including sustainable development, stakeholder consultation, ownership of GHG reductions, uncertainty, confidentiality, and verification. These issues are not addressed because they are not directly related to GHG reduction accounting and quantification.

1.4.1 SUSTAINABLE DEVELOPMENT

Under the Kyoto Protocol's Clean Development Mechanism (CDM), a key provision is that GHG projects contribute to local sustainable development goals in addition to generating GHG reductions. Sustainable development criteria may also be important to other GHG programs. Because sustainable development is not directly related to GHG accounting, the Project Protocol does not address such provisions or criteria.

1.4.2 STAKEHOLDER CONSULTATION

For many GHG projects, successful implementation (and the furthering of sustainable development goals) will depend on successfully soliciting and responding to concerns from communities the GHG project affects. While such stakeholder consultation is an important part of project planning and implementation, the Project Protocol does not offer guidance on this issue.

1.4.3 OWNERSHIP OF GHG REDUCTIONS

GHG reductions may occur at sources not under the direct ownership or control of the project developer. Where legal ownership of project-based GHG reductions is sought, direct ownership or control is often an important consideration. The Project Protocol does not address ownership issues. Chapter 3 of the Corporate Accounting Standard contains a discussion of ownership and control of GHG emissions that may be relevant for project developers seeking more guidance in this area.

1.4.4 UNCERTAINTY

Project-based GHG accounting involves many forms of uncertainty, including uncertainty about the identification of secondary effects, the identification of baseline candidates, baseline emission estimates, and the measurement of GHG project emissions. Chapter 10 of this document provides brief guidance for dealing with uncertainty; however, the Project Protocol contains no explicit requirements for addressing uncertainty.

1.4.5 CONFIDENTIALITY

Quantifying GHG reductions can sometimes require extensive amounts of information, including information that a project developer, its partners, or business competitors may consider confidential. This may be a significant consideration for deciding whether the credible quantification of GHG reductions is realistic and possible. The Project Protocol does not address issues of confidentiality.

1.4.6 VERIFICATION

For many purposes, project developers may choose to have a third party verify their quantification of GHG reductions. Chapter 11 of the Project Protocol contains minimum requirements for reporting the quantification of GHG reductions in a manner that is transparent and allows for evaluation by interested parties. However, the Project Protocol does not offer guidance on how to solicit or conduct third-party verification. This is left to the discretion of its users.

1.5 Project Protocol Treatment of *Additionality*

The concept of *additionality* is often raised as a vital consideration for quantifying project-based GHG reductions. Additionality is a criterion that says GHG reductions should only be recognized for project activities that would not have "happened anyway." While there is general agreement that additionality is important, its meaning and application remain open to interpretation.

The Project Protocol does not require a demonstration of additionality *per se.* Instead, additionality is discussed conceptually in Chapter 2 and in terms of its policy dimensions in Chapter 3. Additionality is incorporated as an implicit part of the procedures used to estimate baseline emissions (Chapters 8 and 9), where its interpretation and stringency are subject to user discretion.

1.6 Linkages with the Corporate Accounting Standard

The Corporate Accounting Standard provides standards and guidance for companies and other types of organisations to prepare a GHG emissions inventory at the organisational level. Although the Corporate Accounting Standard and Project Protocol address different business goals, policy and regulatory contexts, and GHG accounting concepts and issues, they are linked through the use of common accounting principles. In both, the principles of relevance, completeness, consistency, transparency, and accuracy are applied in their appropriate contexts. The application of these principles is intended to ensure the credible accounting of both corporate GHG emissions and project-based GHG reductions.

A company can use both GHG Protocol Initiative modules in combination to meet different purposes and objectives. Where a company is developing an inventory of its corporate-wide GHG emissions, the Corporate Accounting Standard can be used. If the same company develops a GHG project, then the Project Protocol can be used to quantify its project-based GHG reductions. The Corporate Accounting Standard includes a GHG balance sheet showing how project-based GHG reductions can be accounted for in relation to a company's overall GHG emissions target.

1.7 Additional Tools

WRI and WBCSD are developing four sets of tools to help project developers use the Project Protocol. These tools will be available on the GHG Protocol website at www.ghgprotocol.org.

1.7.1 GHG PROJECT TYPOLOGY

The GHG Project Typology provides information to assist project developers in identifying and classifying different types of GHG project activities by their primary effect. The typology includes basic guidance specific to each type of project activity, such as how to identify baseline candidates and secondary effects, how to conduct monitoring, and how to address technology-specific calculation issues.

1.7.2 SECTOR-SPECIFIC GUIDANCE

Over time the Project Protocol, which is broadly applicable to all types of GHG projects, will be supplemented with sector-specific guidance. These guidance documents will provide more specific and in-depth procedures for particular types of GHG projects, such as those involving the displacement of grid electricity and biological carbon sequestration.

1.7.3 GHG CALCULATION TOOLS

A number of the GHG Protocol tools provide guidance on calculating GHG emissions from different GHG sources. Although developed for the Corporate Accounting Standard, these tools can be adapted to calculate GHG emissions from GHG projects. For example, the stationary combustion tool can be used to estimate GHG emissions from a project activity that involves fuel switching. The tools that are currently available include cross-sector and sector-specific tools.

Cross-sector tools include:

- Stationary combustion
- Mobile combustion
- Measurement and estimation of uncertainty
- Use of hydrofluorocarbons (HFCs) in refrigeration and air-conditioning equipment

Sector-specific tools include:

- Aluminium
- Iron and steel
- Nitric acid
- Ammonia
- Adipic acid
- Cement
- Lime
- Office-based organisations
- Pulp and paper mills
- HFC-23 from HCFC-22 production
- Semi-conductors
- Wood product manufacturing

1.7.4 RELATIONSHIP BETWEEN THE PROJECT PROTOCOL AND OTHER INTERNATIONAL PROJECT-BASED INITIATIVES

The Kyoto Protocol's CDM is currently the chief international initiative involving project-based GHG reductions. In principle, the methods and procedures provided in the Project Protocol can be used for the development of GHG projects for the CDM. Similarly, the International Organization for Standardization (ISO) provides ISO 14064, which includes an international standard on GHG accounting and reporting for GHG mitigation projects. The guidance provided by the Project Protocol can facilitate the application of the ISO requirements.

A mapping of key concepts between both initiatives and the Project Protocol will be provided on the GHG Protocol Initiative website. This will enable participants in these initiatives to understand how to use the Project Protocol alongside these initiatives.

2 Key GHG Project Accounting Concepts

A number of key concepts must be understood to account for GHG reductions from GHG projects. This chapter explains the importance of these concepts and describes how and where they are used in Part II of the Project Protocol. The concepts presented here are also defined in the glossary in Annex D.

2.1 GHG Project

A GHG project consists of a specific activity or set of activities intended to reduce GHG emissions, increase the storage of carbon, or enhance GHG removals from the atmosphere. A GHG project may be a stand-alone project or a component of a larger non-GHG project, and may be comprised of one or more *project activities.* Part II of the Project Protocol focuses on accounting for and reporting the GHG reductions that result from a single GHG project.

2.2 Project Activity

A project activity is a specific action or intervention targeted at changing GHG emissions, removals, or storage. It may include modifications to existing production, process, consumption, service, delivery or management systems, as well as the introduction of new systems.

Under the Project Protocol, properly identifying and defining project activities is crucial (see Chapter 5). *GHG reductions* are determined separately for each project activity associated with a *GHG project.* Chapters 6 through 9 of the Project Protocol deal specifically with determining GHG reductions from individual project activities. If a GHG project involves more than one activity, its total GHG reductions are quantified as the sum of the GHG reductions from each project activity (see Chapter 10).

2.3 GHG Source/Sink

A GHG source is any process that releases GHG emissions into the atmosphere. Under the Project Protocol, there are five general GHG source categories:

- combustion emissions from generating grid-connected electricity;
- combustion emissions from generating energy or off-grid electricity, or from flaring;
- industrial process emissions—e.g., carbon dioxide (CO_2) from the production of clinker for cement;
- fugitive emissions—e.g., GHG leaks from pipelines; and
- waste emissions—e.g., GHG emissions from landfills.

A GHG sink is any process that removes and stores GHG emissions from the atmosphere. The Project Protocol identifies one GHG sink category: increased storage or removals of CO_2 by biological processes.

The GHG sources and sinks affected by a *project activity* must be identified to determine the project activity's *GHG effects* (see Chapter 5), and to specify how emissions from GHG sources and sinks affected by the project activity will be monitored (see Chapter 10).

2.4 GHG Effects

GHG effects are changes in GHG emissions, removals, or storage caused by a *project activity*. There are two types of GHG effects: *primary effects* and *secondary effects.*

PRIMARY EFFECTS

A primary effect is the intended change caused by a project activity in GHG emissions, removals, or storage associated with a *GHG source* or *sink.* Each project activity will generally have only one primary effect. The primary effect is defined as a change relative to *baseline emissions* (see Figure 2.1), which are determined using either of the *baseline procedures* presented in Chapters 8 and 9. Primary effects are identified for each project activity in Chapter 5.

SECONDARY EFFECTS

A secondary effect is an unintended change caused by a *project activity* in GHG emissions, removals, or storage associated with a *GHG source* or *sink* (see Box 2.1). Secondary effects are typically small relative to a project activity's *primary effect.* In some cases, however, they may undermine or negate the primary effect. Secondary effects are classified into two categories:

- **One-time effects**—Changes in GHG emissions associated with the construction, installation, and establishment or the decommissioning and termination of the project activity.
- **Upstream and downstream effects**—Recurring changes in GHG emissions associated with inputs to the project activity (upstream) or products from

the project activity (downstream), relative to *baseline emissions.*

BOX 2.1 Secondary effects and leakage

Secondary effects are sometimes referred to as "leakage" in the GHG project literature and by some GHG programs. However, the definition of leakage varies from context to context (e.g., it is sometimes defined with respect to physical project boundaries or to ownership or control of GHG emission sources). Under the Project Protocol, the term *secondary effect* is used to avoid confusion with the varying interpretations of the term leakage.

Some upstream and downstream effects may involve market responses to the changes in supply and/or demand for project activity inputs or products. Only significant secondary effects, however, need to be monitored and quantified under the Project Protocol. Whether a secondary effect is considered significant depends on its magnitude relative to its associated primary effect and on circumstances surrounding the associated project activity.

Secondary effects for each project activity are identified in Chapter 5, which includes guidance on how to assess their significance and mitigate them.

2.5 GHG Assessment Boundary

The GHG assessment boundary encompasses all *primary effects* and significant *secondary effects* associated with the *GHG project.* Where the GHG project involves more than one *project activity*, the primary and significant secondary effects from all project activities are included in the GHG assessment boundary. The GHG assessment boundary is used to identify the *GHG sources and sinks* that must be examined to quantify a project's *GHG reductions.* It is not a physical or legal "project boundary." Primary and significant secondary effects are considered within the GHG assessment boundary, irrespective of whether they occur near the project, or at GHG sources or sinks owned or controlled by the project participants. Under the Project Protocol, it is not necessary to define a project boundary based on a GHG project's physical dimensions or according to what is owned or controlled.

2.6 GHG Reductions

Throughout the Project Protocol, the term *GHG reduction* refers to either a reduction in GHG emissions or an increase in removals or storage of GHGs from the atmosphere, relative to baseline emissions. *Primary effects* will result in GHG reductions, as will some *secondary effects.* A *project activity's* total GHG reductions are quantified as the sum of its associated primary effect(s) and any significant secondary effects (which may involve decreases or countervailing increases in GHG emissions). A *GHG project's* total GHG reductions are quantified as the sum of the GHG reductions from each project activity. Chapter 10 contains requirements and guidance on how to quantify the GHG reductions from each project activity and the GHG project.

2.7 Baseline Candidates

Baseline candidates are alternative technologies or practices, within a specified geographic area and temporal range, that could provide the same product or service as a *project activity.* The identification of baseline candidates is required to estimate the baseline emissions for the project activity. Baseline candidates are identified for each project activity in Chapter 7, which includes guidance on how to define an appropriate geographic area and temporal range.

2.8 Baseline Scenario

The baseline scenario is a reference case for the *project activity.* It is a hypothetical description of what would have most likely occurred in the absence of any considerations about climate change mitigation. The baseline scenario is used to estimate *baseline emissions* (see Figure 2.1). There are three generic possibilities for the baseline scenario:

- implementation of the same technologies or practices used in the project activity;
- implementation of a *baseline candidate*; or
- the continuation of current activities, technologies, or practices that, where relevant, provide the same type, quality, and quantity of product or service as the project activity.

FIGURE 2.1 Quantifying GHG reductions relative to a baseline scenario

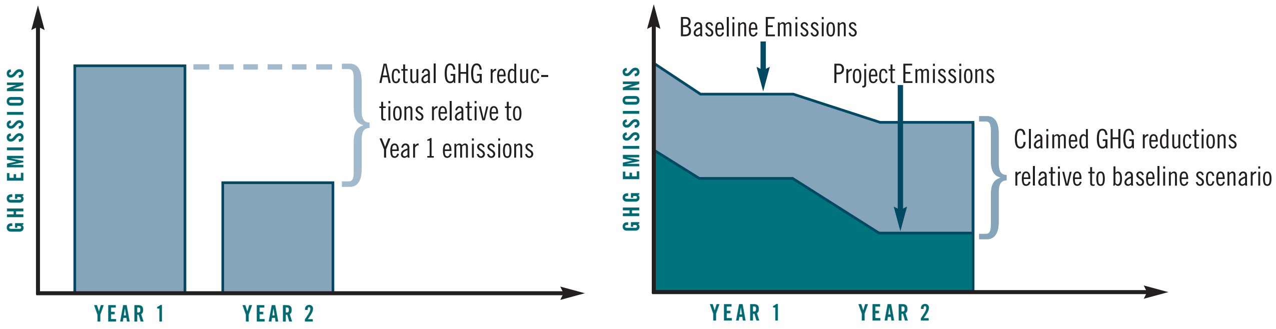


FIGURE 2.1a: Comparison against a base year for corporate/entity accounting

FIGURE 2.1b: Comparison against a baseline scenario for project accounting

GHG reductions must be quantified relative to a reference level of GHG emissions. Under national and corporate-level GHG accounting, reductions are typically quantified against actual GHG emissions in a historical base year (see Figure 2.1a). For project-based GHG accounting, however, GHG reductions are quantified against a forward-looking, counter-factual baseline scenario (see Figure 2.1b). The most important challenge for GHG project accounting is identifying and characterizing the baseline scenario.

An explicit baseline scenario for a project activity is identified only if the *project-specific* baseline procedure is used to estimate baseline emissions (Chapter 8). If the *performance standard* baseline procedure is used, baseline emissions are estimated without explicitly identifying a baseline scenario (see Chapter 9).

2.9 Baseline Emissions

GHG reductions from a *project activity* are quantified relative to *baseline emissions*, which refers broadly to baseline GHG emissions, removals, or storage. Baseline emissions associated with *primary effects* are derived from either a *baseline scenario* (Chapter 8) or a *performance standard* (Chapter 9). Baseline emissions associated with *secondary effects* are estimated in Chapter 5 and will be linked to the project-specific baseline scenario. If the performance standard procedure is used, baseline emissions associated with secondary effects are inferred from *baseline candidates* or are estimated conservatively.

2.10 Baseline Procedures

Baseline procedures are methods used to estimate *baseline emissions*. The Project Protocol describes two procedures:

- **Project-specific procedure**—This procedure produces an estimate of baseline emissions through the identification of a *baseline scenario* specific to the proposed *project activity*. The baseline scenario is identified through a structured analysis of the project activity and its alternatives. Baseline emissions are derived from the baseline scenario and are valid only for the project activity being examined. This procedure is described in Chapter 8.

- **Performance standard procedure**—This procedure produces an estimate of baseline emissions using a GHG emission rate derived from a numerical analysis of the GHG emission rates of all *baseline candidates*. A performance standard is sometimes referred to as a multi-project baseline or benchmark, because it can be used to estimate baseline emissions for multiple project activities of the same type. It serves the same function as a baseline scenario, but avoids the need to identify an explicit baseline scenario for each project activity. The performance standard procedure is described in Chapter 9.

2.11 Valid Time Length for the Baseline Scenario

Generally, the farther out into the future one tries to project "what would have happened," the more uncertain this projection becomes. For this reason, a particular *baseline scenario* or *performance standard* should be valid only for a finite period of time for the purpose of estimating baseline emissions. After a certain period, either no further *GHG reductions* are recognized for the project activity, or a new (revised) baseline scenario or performance standard is identified. The length of this period may vary, depending on technical and policy considerations,[1] and on whether baseline emission estimates are *dynamic* or *static* (see Figure 2.2). The valid time length for the baseline scenario of each project activity is determined in Chapter 10, as a prelude to quantifying GHG reductions.

2.12 Dynamic Versus Static Baseline Emission Estimates

Baseline emissions are often estimated using an emission rate, relating GHG emissions to the production of a product or service or to a certain period of time. Baseline emission rates may be dynamic or static. Static baseline emission rates do not change over time, while dynamic baseline emission rates change over time.

A static baseline emission rate is most appropriate for GHG projects that are substituting for existing plants or technologies where it can be reasonably assumed that basic operating parameters will not change over a certain time period (see Figure 2.2a). In contrast, dynamic baseline emission rates are better suited to GHG projects that are part of a system that changes significantly over time (see Figure 2.2b). Two types of GHG projects that may require dynamic baseline emission rates include:

- **Electricity supply projects**—The baseline emission rate may be based on displaced generation sources that are expected to change significantly over time.
- **LULUCF projects**—The baseline emission rate may change over time to reflect the changing growth patterns of carbon stocks in trees.

2.13 Equivalence of Products and Services

Nearly every project activity will provide products or services in the context of some broader market for them. Therefore, if the project activity were not implemented, it should be assumed that the market would have provided a quantity and quality of products or services equivalent to what the project activity would have produced.[2] This is particularly true when a GHG project is small relative to the market in which it operates (i.e., its presence or absence will not affect market prices). This concept of equivalence has broad application in the quantification of GHG reductions. For example:

- **Identifying secondary effects (Chapter 5)**—If a project activity reduces the production of a product or

FIGURE 2.2 Dynamic and static baseline emission rate estimates

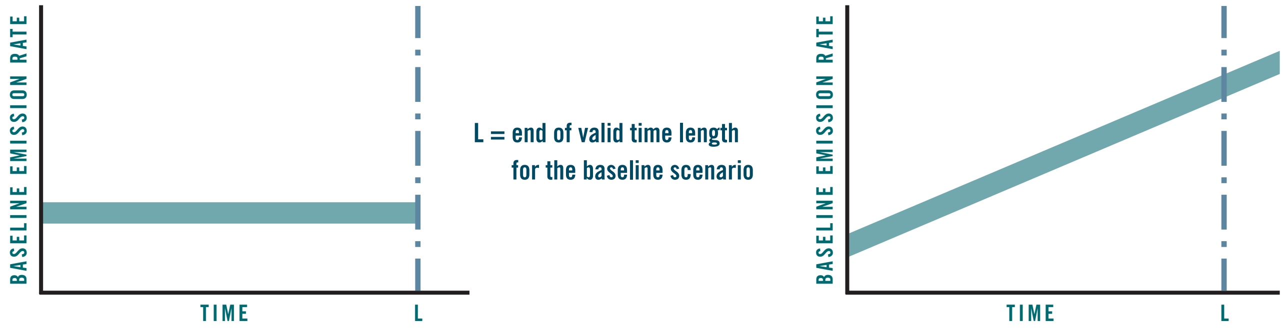


FIGURE 2.2a: Static emission rate

FIGURE 2.2b: Dynamic emission rate

Baseline emission rates may be dynamic or static. Static baseline emission rates do not change over time, while dynamic baseline emission rates change over time.

service, the market will compensate and provide a level of production equivalent to that in the baseline scenario. This response may give rise to a secondary effect.

- **Identifying baseline candidates (Chapter 7)**—Baseline candidates should be capable of providing the same quality of products or services as the project activity. Furthermore, if the project-specific baseline procedure is used, baseline candidates should be capable of providing the same quantity of products or services as the project activity.
- **Estimating baseline emissions (Chapters 8 and 9)**—Baseline emissions should be estimated by assuming equivalent quality and quantities of production in the baseline scenario as in the project activity.

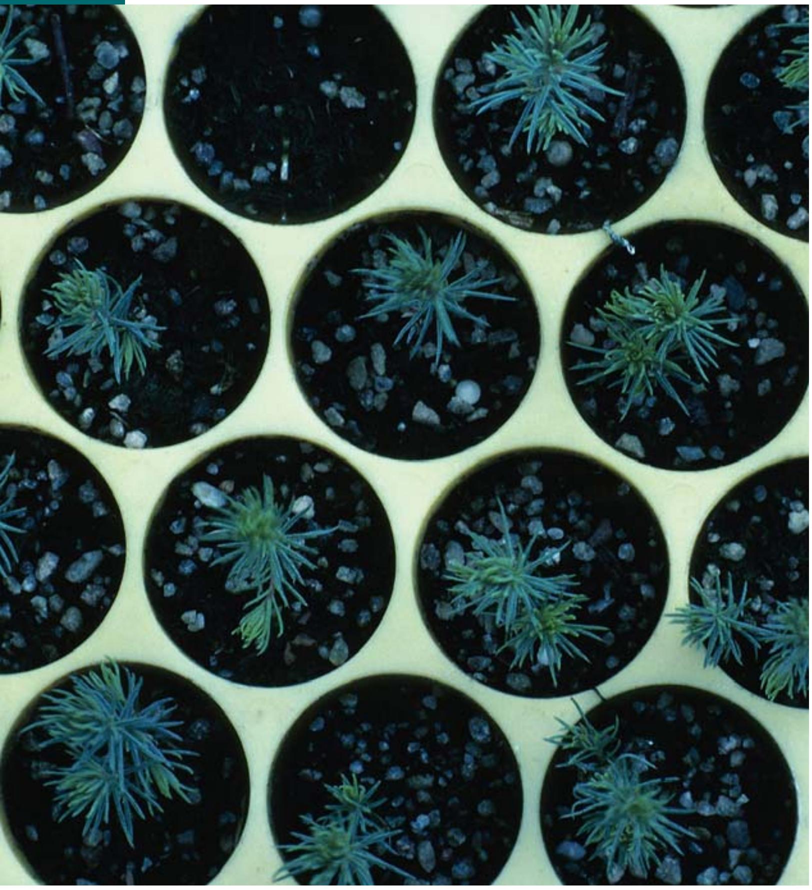
Some exceptions to equivalence will occur only when the market for the products or services provided by a project activity is poorly functioning or nonexistent, or where a project activity is so large that the market response would not have been proportional (e.g., because the project activity is large enough to change market prices relative to the baseline scenario, causing a change in the total quantity produced). In quantifying GHG reductions, project developers should fully explain any exceptions to the assumption of equivalence.

2.14 Additionality

As previously described in section 2.9, project-based *GHG reductions* are quantified relative to *baseline emissions*, which are derived either from an identified *baseline scenario* (see Figure 2.1) or by using a *performance standard* that serves the same function as a baseline scenario. Though the presumption is generally that a *project activity* differs from its baseline scenario, in some cases, a project activity (or the same technologies or practices it employs) may have been implemented "anyway." In these cases, the project activity and its baseline scenario are effectively identical.

While such a project activity may appear to reduce GHG emissions relative to historical emission levels, compared to its baseline scenario the project activity does not reduce GHG emissions. In the context of GHG programs, it is important to count only GHG reductions from project activities that differ from—or are additional to—their baseline scenarios (see Box 2.2). Distinguishing a project activity from its baseline scenario is often referred to as determining *additionality.*

While the basic concept of additionality may be easy to understand, there is no common agreement about how to prove that a project activity and its baseline scenario are different. The two baseline procedures (project-specific and performance standard) presented in Chapters 8 and 9 of the Project Protocol reflect two different methodological approaches to additionality.



THE PROJECT-SPECIFIC APPROACH TO ADDITIONALITY

The project-specific approach to additionality aims to identify a distinct baseline scenario specific to the project activity, in spite of subjective uncertainties involved in doing so. The reasoning behind this approach is that a rigorously identified baseline scenario is all that is necessary to establish additionality: if the project activity is different from its baseline scenario, it is additional. However, because identifying a baseline scenario always involves some uncertainty, many observers argue that this approach should be combined with explicit additionality tests. (Some of these tests are described in Chapter 3, which discusses the policy dimensions of additionality.)

THE PERFORMANCE STANDARD APPROACH TO ADDITIONALITY

The second approach is to avoid project-specific determinations of additionality and instead try to ensure the overall additionality of quantified GHG reductions from multiple project activities. This is done by developing a performance standard, which provides an estimate of baseline emissions that would otherwise be derived from baseline scenarios for each project activity. Under this approach, the presumption is that any project activity will produce additional GHG reductions if it has a lower GHG emission rate than the performance standard.[3] A performance standard can provide a consistent way to address additionality for a number of similar project activities and avoids having to identify individual baseline scenarios. The challenge is to set the performance standard at a sufficiently stringent level to ensure that, on balance, only additional GHG reductions are quantified.

NOTES

[1] See Chapter 3 for a discussion of the policy considerations.

[2] Alternatively, if the project activity involves reducing the production of a product or service, the market will generally respond by making up for this lost production when the project activity is implemented.

[3] Or a higher GHG removal rate in the case of project activities involving GHG sinks.

BOX 2.2 Why additionality is important

GHG emission trading programs operate by capping the emissions of a fixed number of individual facilities or sources. Under these programs, tradable "offset credits" are issued for project-based GHG reductions that occur at sources not covered by the program. Each offset credit allows facilities whose emissions are capped to emit more, in direct proportion to the GHG reductions represented by the credit. The idea is to achieve a zero net increase in GHG emissions, because each tonne of increased emissions is "offset" by project-based GHG reductions.

The difficulty is that many projects that reduce GHG emissions (relative to historical levels) would happen regardless of the existence of a GHG program and without any concern for climate change mitigation. If a project "would have happened anyway," then issuing offset credits for its GHG reductions will actually allow a positive net increase in GHG emissions, undermining the emissions target of the GHG program. **Additionality is thus critical to the success and integrity of GHG programs that recognize project-based GHG reductions.** The following table (Table 2.1) illustrates this concept.

TABLE 2.1 Illustration of GHG emission balances with and without "additional" reductions

TYPES OF GHG EMISSIONS	CAPPED SOURCES	UNCAPPED SOURCES	TOTAL
GHG emissions that would have occurred without a GHG program[1]	20,000 tonnes	50,000 tonnes	**70,000 tonnes**
GHG emissions under a GHG program cap of 15,000 tonnes, without offset credits[2]	15,000 tonnes	50,000 tonnes	**65,000 tonnes**
GHG emissions under a GHG program cap of 15,000 tonnes, with 2,500 tonnes in offset credits based on "additional" reductions[3]	17,500 tonnes	47,500 tonnes	**65,000 tonnes**
GHG emissions under a GHG program cap of 15,000 tonnes, with 2,500 tonnes in offset credits for reductions that "would have happened anyway"[4]	17,500 tonnes	50,000 tonnes	**67,500 tonnes**

NOTES:

[1] The GHG emissions from "capped sources" are what would have occurred at the plants and facilities the GHG program is intending to cap, if there had been no GHG program. The uncapped source emissions are net of any GHG reductions that "would have happened anyway".

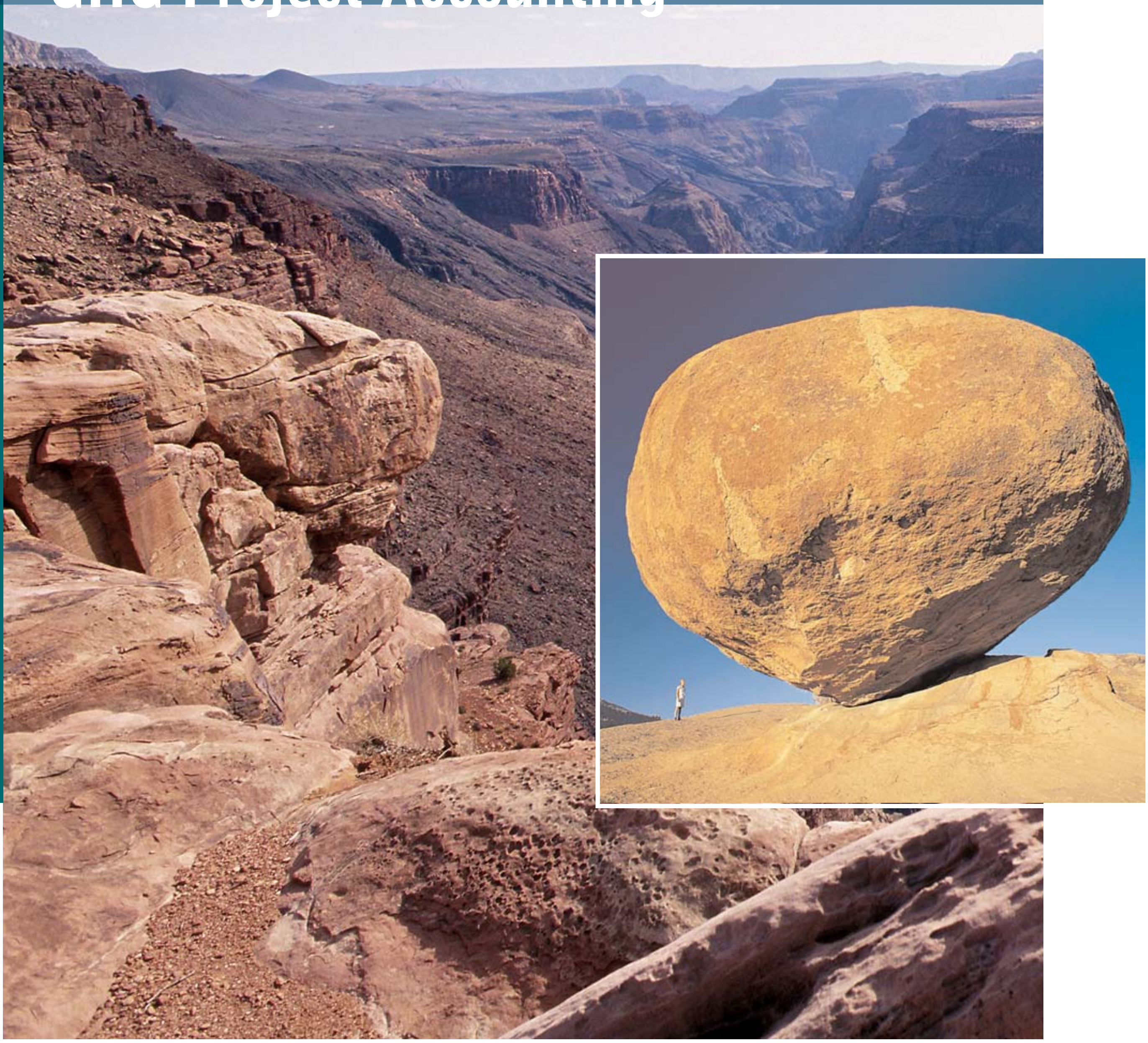
[2] In this case, a GHG program is in place with a cap of 15,000 tonnes, causing a net reduction of 5,000 tonnes in overall GHG emissions. Uncapped sources remain unaffected.

[3] In this case, 2,500 tonnes of additional GHG reductions are achieved at uncapped sources, resulting in a net 2,500 tonne decrease in GHG emissions from these sources to 47,500 tonnes. The credits used to achieve these reductions allow the capped sources to emit an additional 2,500 tonnes beyond the 15,000 tonnes they were originally limited to, so GHG emissions from capped sources rise to 17,500 tonnes. Total GHG emissions, however, remain the same, as if there were a cap with no offset credits.

[4] In this case, credits are issued for GHG reductions that "would have happened anyway." In other words, GHG emissions at uncapped sources are the same as they would have been without the presence of any GHG program (i.e., 50,000 tonnes). Total emissions increase because capped sources are allowed to emit more due to the credits (in this case, an increase of 2,500 tonnes).

3

Policy Aspects of GHG Project Accounting



GHG project accounting necessarily involves making decisions that directly relate to policy choices faced by GHG programs. These policy choices involve tradeoffs between environmental integrity, program participation, program development costs, and administrative burdens. This chapter seeks to clarify the major areas where decisions about GHG project accounting relate to the policy objectives of GHG programs. It is explanatory in nature and contains no requirements, but will be helpful to consider regardless of whether a specific GHG program is involved. The chapter covers five major areas where GHG accounting decisions are relevant to policy objectives:

- 3.1 Additionality
- 3.2 Selection of Baseline Procedures
- 3.3 Secondary Effects Accounting
- 3.4 Valid Time Length for Baseline Scenarios
- 3.5 Static Versus Dynamic Baseline Emission Estimates

3.1 Additionality

As noted in Chapter 2, section 2.14, additionality is a critical concern for GHG programs. Whatever methods are used to address additionality, a GHG program must decide how stringent to make its additionality rules and criteria based on its policy objectives. Under the project-specific approach, stringency is determined by the weight of evidence required to identify a particular baseline scenario (and possibly to pass any required additionality tests—see Box 3.1). Under the performance standard approach, stringency is determined by how low the performance standard GHG emission rate is relative to the average GHG emission rate of similar practices or technologies.[1]

Setting the stringency of additionality rules involves a balancing act. Additionality criteria that are too lenient and grant recognition for "non-additional" GHG reductions will undermine the GHG program's effectiveness. On the other hand, making the criteria for additionality too stringent could unnecessarily limit the number of recognized GHG reductions, in some cases excluding project activities that are truly additional and highly desirable. In practice, no approach to additionality can completely avoid these kinds of errors. Generally, reducing one type of error will result in an increase of the other.

Ultimately, there is no technically correct level of stringency for additionality rules. GHG programs may decide based on their policy objectives that it is better to avoid one type of error than the other. For example, a focus on environmental integrity may necessitate stringent additionality rules. On the other hand, GHG programs that are initially concerned with maximizing participation and ensuring a vibrant market for GHG reduction credits may try to reduce "false negatives"—i.e., rejecting project activities that are additional—by using only moderately stringent rules.

3.2 Selection of Baseline Procedures

Under the Project Protocol, there are two possible procedures for estimating baseline emissions: the project-specific procedure and performance standard procedure. The choice of a baseline procedure will affect the outcome of any GHG project accounting effort, since the two procedures can lead to different levels of quantified GHG reductions, even for the same project activity. As their names imply, however, these procedures are conceptually linked to the project-specific and performance standard approaches for dealing with additionality, as outlined in Chapter 2 (section 2.14). Any choice about which procedure to use is thus relevant to GHG program concerns about additionality. Moreover, as a practical matter, GHG programs may decide that one or the other procedure is preferred on administrative grounds. Requiring the project-specific procedure, for example, may involve less preparatory work in starting a GHG program (in exchange for more administrative work later on), whereas developing performance standards may require significant upfront investment of resources, but may lower transaction costs once the GHG program is underway. From a GHG program perspective, such policy considerations are important in deciding which baseline procedure project developers should use.

3.3 Secondary Effects Accounting

If a secondary effect involves a significant increase in GHG emissions, it can undermine or even negate a project activity's primary effect (see Chapter 2, section 2.4). Therefore, accurately accounting for the GHG reductions caused by a project activity requires some examination of secondary effects. The practical challenge is deciding how far to go in this examination.

One question concerns breadth. In a full "life cycle analysis" of GHG emissions[2] for a particular product, for example, one could in principle examine GHG emissions associated not just with inputs to the product, but also the inputs to those inputs, and so on up the product's "value chain." Generally, the cost and time requirements for this kind of analysis are prohibitive. Another question concerns significance. The secondary effects for many types of GHG projects can be relatively small, particularly for small projects. Yet time and money are still required to estimate, monitor, and quantify these effects.

GHG project accounting requires decisions about the tradeoff between accounting for secondary effects and the time and effort required to do so. From the perspective of GHG programs, requiring an extensive and detailed accounting of secondary effects will help to ensure environmental integrity, but could limit program participation, since these requirements may be too burdensome for some project developers. Strict requirements could also increase administrative costs incurred to evaluate or verify second-

BOX 3.1 Policy and the use of additionality "tests"

As noted in Chapter 2, many observers argue that the identification of a project activity's baseline scenario should be accompanied by an explicit demonstration of additionality using various additionality "tests." Some illustrative additionality tests are presented in Table 3.1. Generally, these tests try to isolate the reasons for implementing a GHG project—particularly whether achieving GHG reductions was a decisive reason for implementing it (even if only one among many). They involve evaluating objective conditions that are assumed to indicate reasons for initiating a project. They are intended only to help establish that the GHG project and baseline scenario are different, and are applied separately from the actual identification of a baseline scenario.

However, there is no agreement about the validity of any particular additionality test, or about which tests project developers should use. GHG programs must decide on policy grounds whether to require additionality tests, and which tests to require. Because their use is a matter of policy, the Project Protocol does not require any of these tests.

TABLE 3.1 Examples of possible "tests" for additionality

TEST	GENERAL DESCRIPTION OF THE TEST AS IT IS COMMONLY FORMULATED
Legal, Regulatory, or Institutional Test	The GHG project must reduce GHG emissions below the level required (or effectively required) by any official policies, regulations, guidance, or industry standards. If these reductions are not achieved, the assumption is that the only real reason for doing the project is to comply with regulations, and any claimed GHG reductions are not additional.
Technology Test	The GHG project and its associated GHG reductions are considered additional if the GHG project involves a technology that is not likely to be employed for reasons other than reducing GHG emissions. The default assumption is that for these technologies, GHG reductions are a decisive reason (if not the only reason) for implementing them. GHG projects involving other technologies could still be considered additional, but must demonstrate additionality through some other means.
Investment Test	Under the most common version of this test, a GHG project is assumed to be additional if it can be demonstrated (e.g., through the divulgence of project financial data) that it would have a low rate of return without revenue from GHG reductions. The underlying assumption is that GHG reductions must be a decisive reason for implementing a project that is not an attractive investment in the absence of any revenue associated with its GHG reductions. A GHG project with a high or competitive rate of return could still be additional, but must demonstrate additionality through some other means.
Common Practice Test	The GHG project must reduce GHG emissions below levels produced by "common practice" technologies that produce the same products and services as the GHG project. If it does not, the assumption is that GHG reductions are not a decisive reason for pursuing the project (or conversely, that the only real reason is to conform to common practice for the same reasons as other actors in the same market). Therefore, the GHG project is not considered to be additional.
Timing Test	The GHG project must have been initiated after a certain date to be considered additional. The implicit assumption is that any project started before the required date (e.g., before the start of a GHG program) could not have been motivated by GHG reductions. Under most versions of this test, though, GHG projects started after the required date must still further establish additionality through some other test.

ary effects. The extent and detail of secondary effects analysis are, therefore, essentially policy decisions from the perspective of GHG programs.

3.4 Valid Time Length for Baseline Scenarios

Technical considerations can inform a decision about what the valid time length should be for a baseline scenario or performance standard. For example, technology and economic trends may suggest an appropriate time length for specific project types within a particular geographic area. For GHG programs, however, deciding on different valid time lengths for the baseline scenarios of individual project activities is likely to be too cumbersome. Instead, it is often easier for administrative reasons—and to provide consistent expectations for project developers—to simply adopt a common valid time length for all baseline scenarios or performance standards (usually several years). In the context of GHG programs, such administrative and policy considerations are likely to be the key deciding factors in how long baseline scenarios or performance standards will be valid.

3.5 Static Versus Dynamic Baseline Emission Estimates

From a GHG program policy perspective, the key issue in choosing between static or dynamic baseline emission estimates once again involves a tradeoff between environmental integrity and program participation. Generally, dynamic baseline emission estimates ensure a greater degree of environmental integrity by keeping estimates accurate and in line with changing circumstances. The tradeoff is that dynamic baseline estimates may increase transaction costs under a GHG program and will increase uncertainty for project developers. This could discourage investment and limit participation in the GHG program.

NOTES

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[1] Or how high the performance standard GHG removal rate is relative to average GHG removal rates.

[2] In some cases, the Project Protocol refers to “GHG emissions” to encompass both the emissions that are a direct product of a GHG source and the removals that are a direct product of a GHG sink.

4 GHG Accounting Principles

Six principles are intended to underpin all aspects of the accounting, quantification, and reporting of project-based GHG reductions. Their purpose is to guide decisions where the Project Protocol affords flexibility or discretion, or where the requirements and guidance are ambiguous with respect to a particular situation. The application of these principles will help ensure the credibility and consistency of efforts to quantify and report project-based GHG reductions according to the Project Protocol.

The principles are derived in part from accepted financial accounting and reporting principles and are largely the same as those that guide the Corporate Accounting and Reporting Standard.

4.1 Relevance

Use data, methods, criteria, and assumptions that are appropriate for the intended use of reported information

The quantification and reporting of GHG reductions should include only information that users—both internal and external to the GHG project—need for their decision-making. This information should thus fit the intended purpose of the GHG project and meet the expectations or requirements of its users. Data, methods, criteria, and assumptions that are misleading or that do not conform to Project Protocol requirements are not relevant and should not be included.

4.2 Completeness

Consider all relevant information that may affect the accounting and quantification of GHG reductions, and complete all requirements

All relevant information should be included in the quantification of GHG reductions. Among other things, this means that all the GHG effects of a GHG project should be considered and assessed (Chapter 5), all relevant technologies or practices should be considered as baseline candidates (Chapter 7), and all relevant baseline candidates should be considered when estimating baseline emissions (Chapters 8 and 9). The GHG project's monitoring plan should also specify how all data relevant to quantifying GHG reductions will be collected (Chapter 10). Finally, notwithstanding areas where there is flexibility and discretion, all requirements within relevant chapters should be completed to quantify and report GHG reductions.

4.3 Consistency

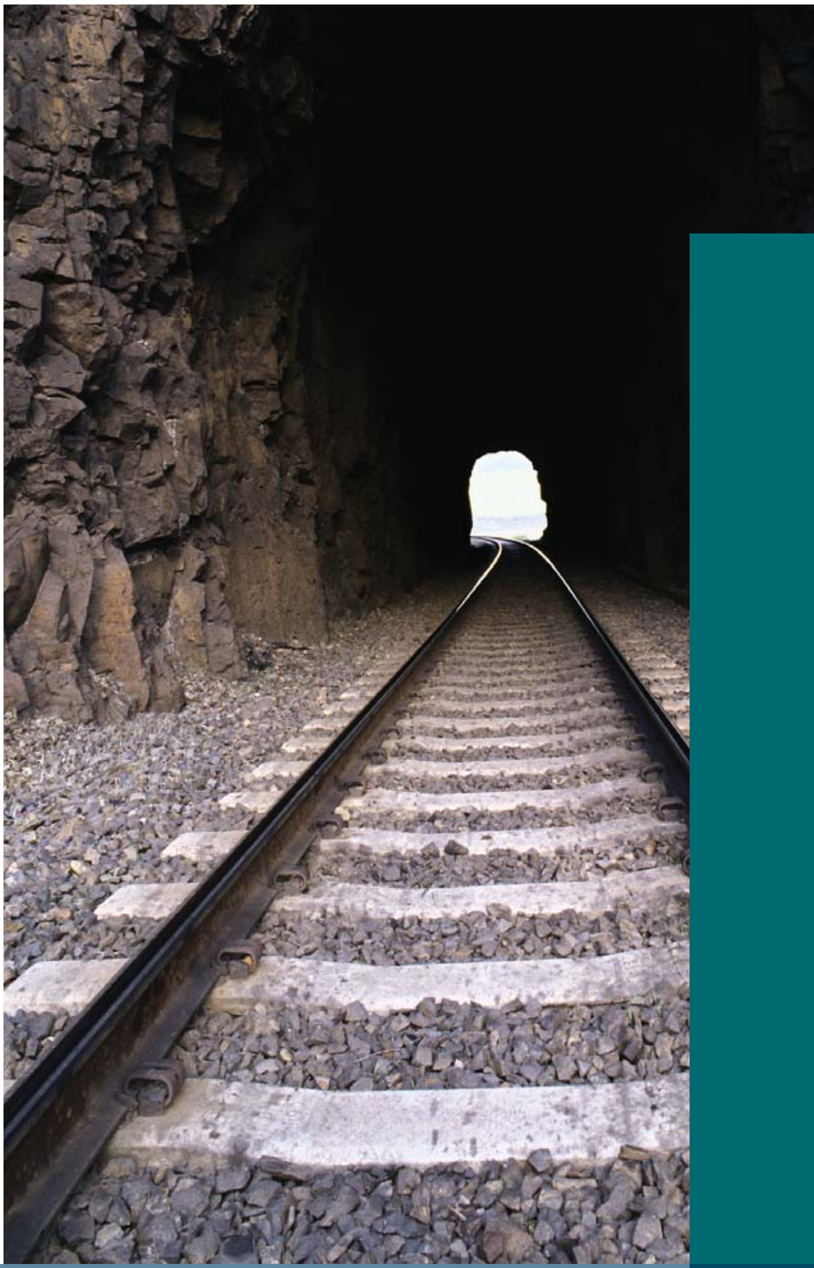
Use data, methods, criteria, and assumptions that allow meaningful and valid comparisons

The credible quantification of GHG reductions requires that methods and procedures are always applied to a GHG project and its components in the same manner, that the same criteria and assumptions are used to evaluate significance and relevance, and that any data collected and reported will be compatible enough to allow meaningful comparisons over time.

4.4 Transparency

Provide clear and sufficient information for reviewers to assess the credibility and reliability of GHG reduction claims

Transparency is critical for quantifying and reporting GHG reductions, particularly given the flexibility and policy-relevance of many GHG accounting decisions (see Chapter 3). GHG project information should be compiled, analysed, and documented clearly and coherently so that reviewers may evaluate its credibility. Specific exclusions or inclusions should be clearly identified, assumptions should be explained, and appropriate references should be provided for both data and



assumptions. Information relating to the GHG assessment boundary, the identification of baseline candidates, and the estimation of baseline emissions should be sufficient to enable reviewers to understand how all conclusions were reached. A transparent report will provide a clear understanding of all assessments supporting GHG reduction accounting and quantification. This should be supported by comprehensive documentation of any underlying evidence to confirm and substantiate the data, methods, criteria, and assumptions used.

4.5 Accuracy

Reduce uncertainties as much as is practical

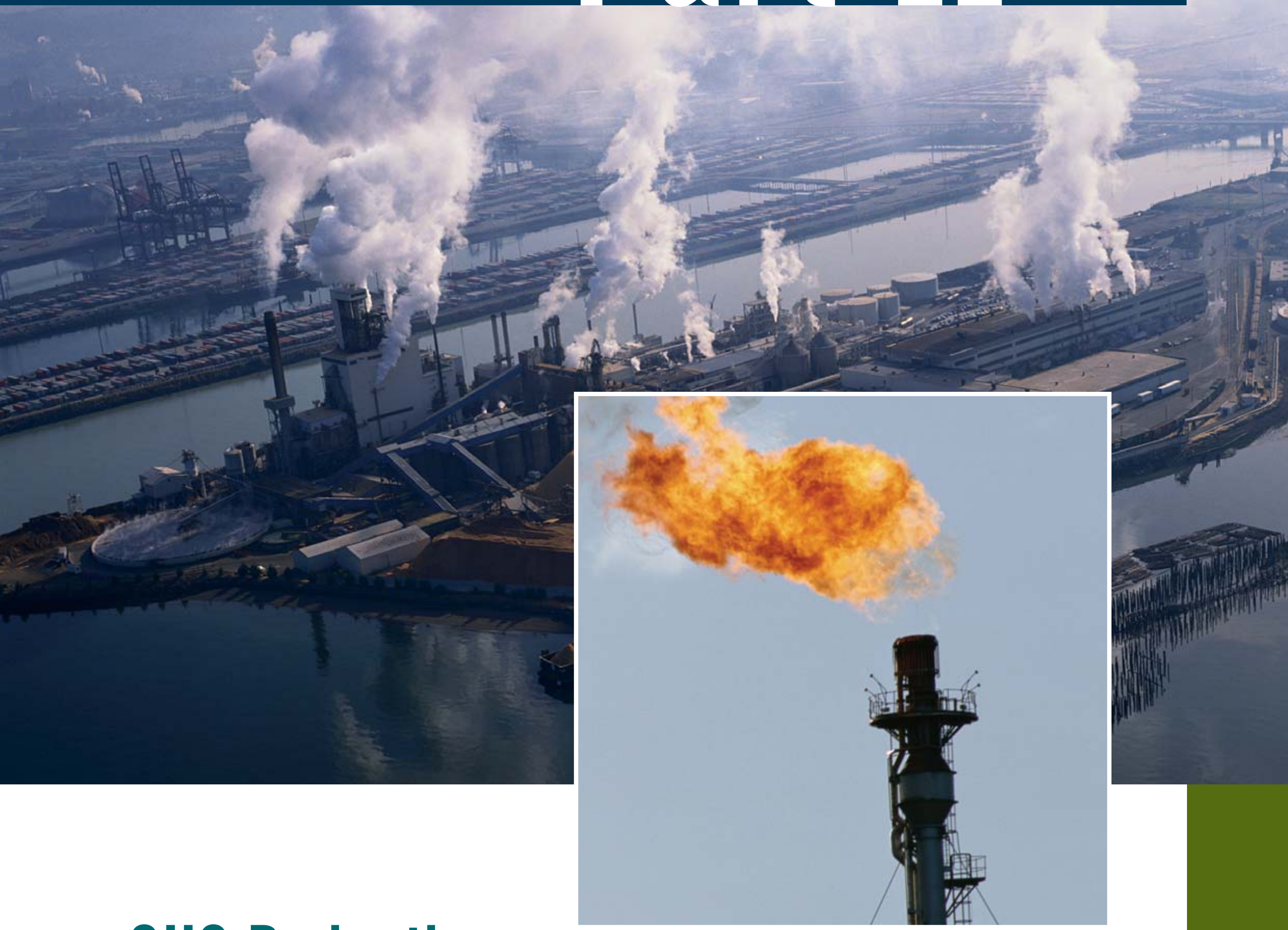
Uncertainties with respect to GHG measurements, estimates, or calculations should be reduced as much as is practical, and measurement and estimation methods should avoid bias. Acceptable levels of uncertainty will depend on the objectives for implementing a GHG project and the intended use of quantified GHG reductions. Greater accuracy will generally ensure greater credibility for any GHG reduction claim. Where accuracy is sacrificed, data and estimates used to quantify GHG reductions should be conservative.

4.6 Conservativeness

Use conservative assumptions, values, and procedures when uncertainty is high

GHG reductions should not be overestimated. Where data and assumptions are uncertain and where the cost of measures to reduce uncertainty is not worth the increase in accuracy, conservative values and assumptions should be used. Conservative values and assumptions are those that are more likely to underestimate than overestimate GHG reductions.

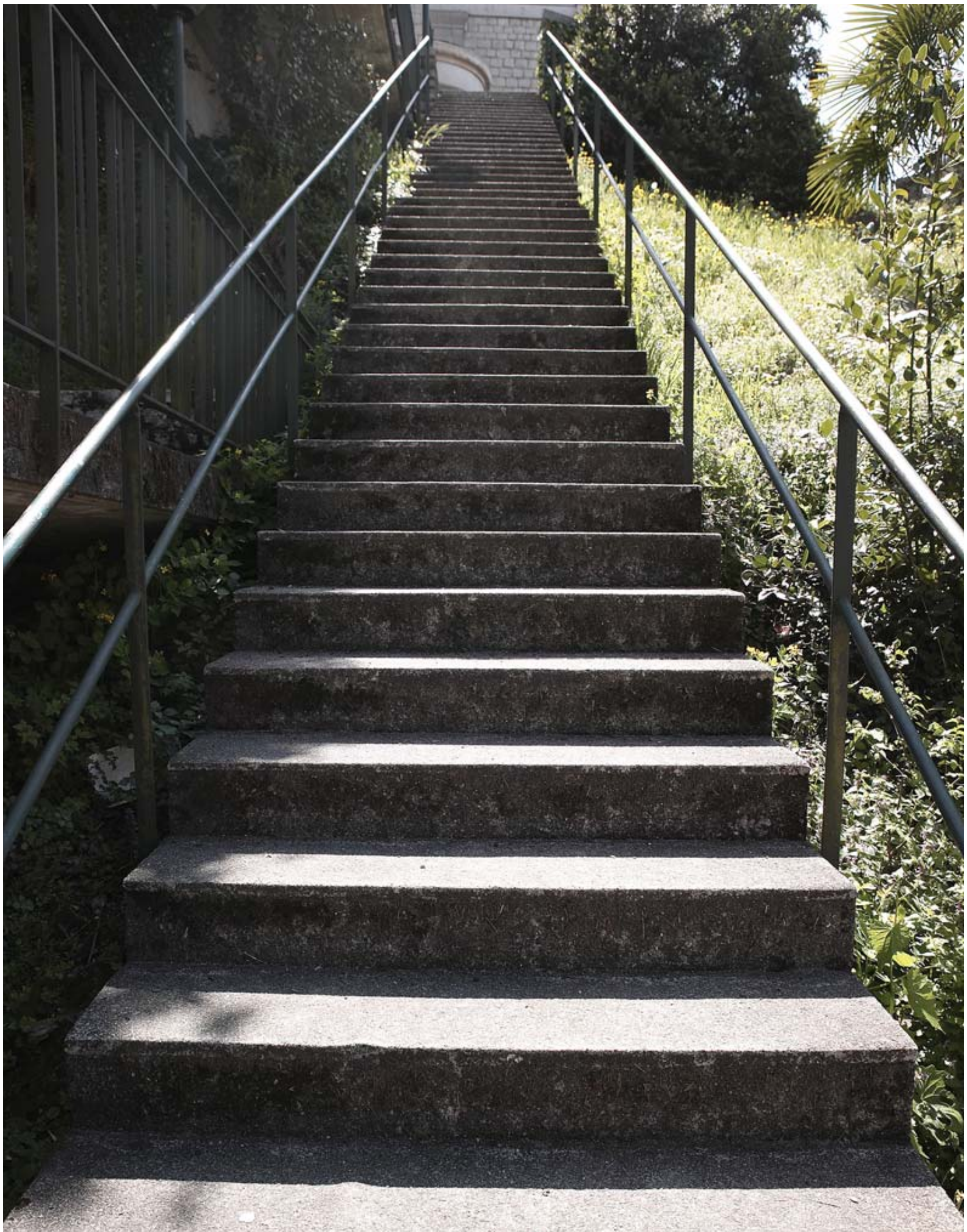
Part II



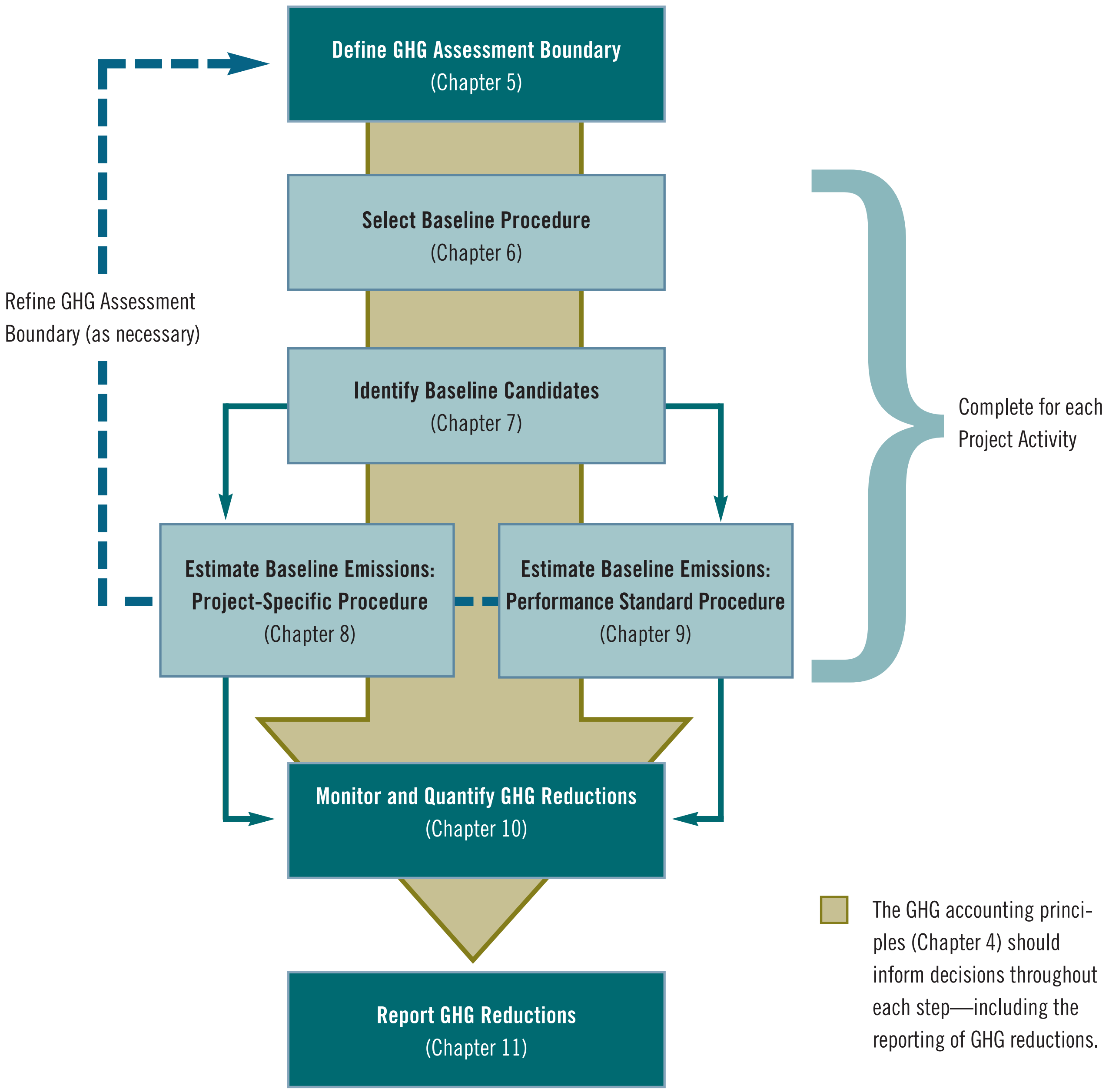
GHG Reduction Accounting and Reporting

GHG Reduction Accounting and Reporting

The chapters in Part II are intended to guide project developers sequentially through the requirements for GHG project accounting, monitoring, and reporting. Chapters 6 through 9 are completed for each project activity comprising the GHG project. Some of the requirements in different chapters are interrelated, and some back-and-forth consultation of chapters may be required. In particular, the definition of the GHG assessment boundary (Chapter 5) may require modification depending on the final identification of each project activity's baseline emissions (Chapters 8 or 9). The following diagram provides a "road map" for how the Part II chapters should be followed. The GHG accounting principles (Chapter 4) should inform decisions throughout each of these chapters.



Steps for accounting and reporting GHG reductions from a GHG project



▨ The GHG accounting principles (Chapter 4) should inform decisions throughout each step—including the reporting of GHG reductions.

5 Defining the GHG Assessment Boundary

For a comprehensive accounting of GHG reductions, it is necessary to set a GHG assessment boundary that includes all the primary effects and significant secondary effects of a GHG project.

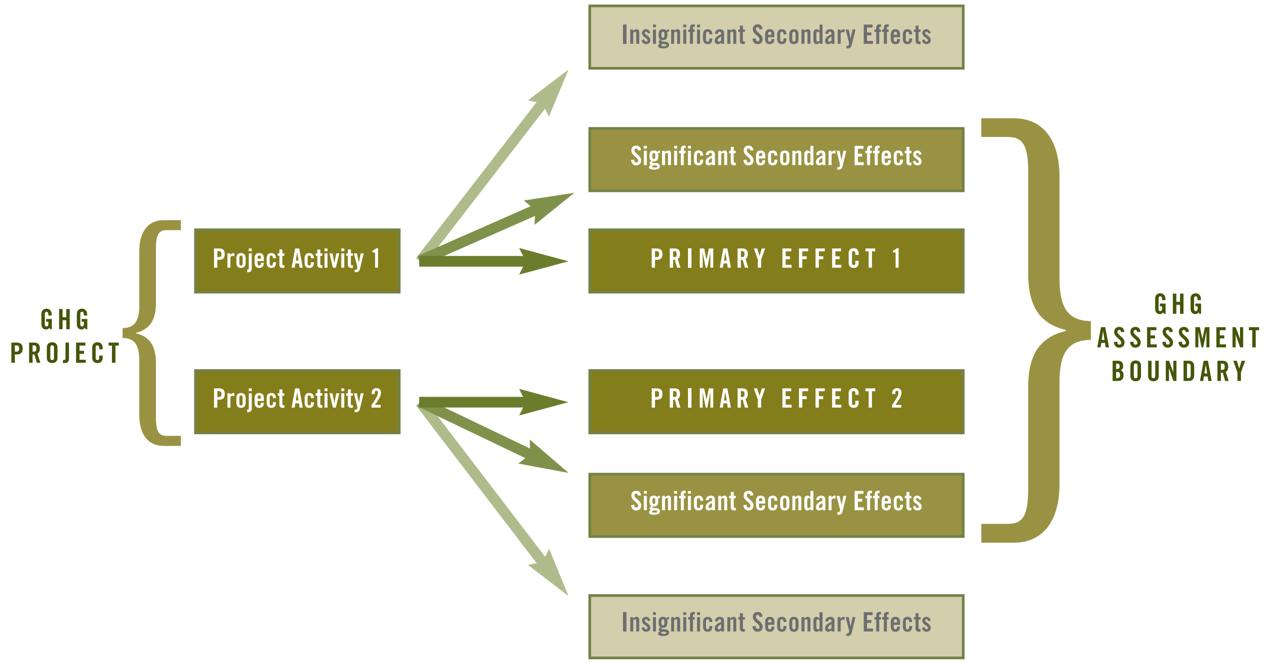
Defining a GHG assessment boundary involves:

- identifying the project activity (or activities) that comprise the GHG project;
- identifying the primary and secondary effects associated with each project activity; and
- thoroughly analyzing the secondary effects to determine which are significant for the purpose of estimating and quantifying GHG reductions.

The GHG assessment boundary encompasses GHG effects, regardless of where they occur and who has control over the GHG sources or sinks associated with them. This inclusive GHG assessment boundary is intended to encourage a more comprehensive assessment of the GHG project's effect on GHG emissions and to minimize the possibility of overlooking any significant GHG effects that may occur outside the project's physical location or beyond the control of the project developer. However, what constitutes *significant* is left to the discretion of the project developer.

Fulfilling the requirements of this chapter will depend in part on fulfilling the requirements of Chapter 8 or 9—which concern the estimation of baseline emissions—since identifying primary and secondary effects depends on the baseline scenario identified.

FIGURE 5.1 The GHG assessment boundary



The GHG assessment boundary includes all the primary effects and significant secondary effects associated with the GHG project, which can consist of multiple project activities (two project activities are depicted). Insignificant secondary effects are not included in the GHG assessment boundary.

Defining the GHG Assessment Boundary

Requirements

For complete, accurate, and transparent quantification of project-based GHG reductions, the GHG assessment boundary (Figure 5.1) shall be clearly defined and reported. The GHG assessment boundary shall include the primary and significant secondary effects of all project activities. The following steps are required for defining the GHG assessment boundary:

5.1 Identify each project activity associated with the GHG project.

5.2 Identify all primary effects related to each project activity.

5.3 Consider all secondary effects related to each project activity.

5.4 Estimate the relative magnitude of all secondary effects.

5.5 Assess the significance of all secondary effects.

Exclude insignificant secondary effects from the GHG assessment boundary. Justify any exclusions.

Courtesy of the World Bank

Guidance

5.1 Identifying Project Activities

A project activity is a single intervention designed to cause GHG reductions (see Chapter 2 and Table 5.1 for examples), and a GHG project may be comprised of more than one project activity. GHG reductions are estimated and quantified[1] for each project activity.

5.2 Identifying Primary Effects

The Project Protocol classifies six generic types of primary effects:

- Reduction in combustion emissions from generating grid-connected electricity.
- Reduction in combustion emissions from generating energy or off-grid electricity, or from flaring.
- Reductions in industrial process emissions from a change in industrial activities or management practices.
- Reductions in fugitive emissions.
- Reductions in waste emissions.
- Increased storage or removals of CO_2 by biological processes.

5.3 Considering All Secondary Effects

Project activities often produce changes in GHG emissions aside from their primary effects—and these are termed secondary effects. As with primary effects, these secondary effects are defined as a difference in GHG emissions between the baseline scenario and the project activity. The baseline scenario used for estimating the secondary effects is the same as that identified for the related primary effect.

Secondary effects may be "positive" (e.g., involving a reduction in GHG emissions) or "negative" (e.g., involving an increase in GHG emissions). Typically, secondary effects are small in comparison to the primary effect, but occasionally they may be large and negative enough to render the project activity unviable as a GHG reduction effort. Therefore, it is wise to consider the type and magnitude of secondary effects before proceeding with rest of the Project Protocol.

TABLE 5.1 **Examples of the relationship between GHG projects, project activities, and primary effects**

GHG PROJECT	PROJECT ACTIVITY	PRIMARY EFFECT
Wind Power Project	Generate grid-connected electricity from wind turbines	Reduction in combustion emissions from generating grid-connected electricity
Energy Efficiency Project	Improve energy efficiency of lighting by using energy-efficient light bulbs	Reduction in combustion emissions from generating grid-connected electricity
Transportation Fuel Switch Project	Change from fossil fuel to biofuel in buses	Reduction in combustion emissions from generating energy or off-grid electricity, or from flaring
Industrial Fuel Switch Project	Fuel switch to natural gas at an off-grid stationary combustion plant	Reduction in combustion emissions from generating energy or off-grid electricity, or from flaring
Afforestation Project	Change land-use to enhance carbon storage	Increased storage or removals of CO_2 by biological processes
Forest Management Project	Change forest management to enhance carbon storage	Increased storage or removals of CO_2 by biological processes
Agricultural Tillage Project	Change tillage practices to enhance carbon storage	Increased storage or removals of CO_2 by biological processes
Landfill Gas Project	a) Install equipment to capture methane b) Generate grid-connected electricity from captured methane	a) Reduction in waste emissions b) Reduction in combustion emissions from generating grid-connected electricity

The guidance provided in this chapter will help project developers think comprehensively about secondary effects. However, it is not necessary to undertake a complete life-cycle analysis when considering secondary effects. For some project activities, reducing the uncertainty around the quantification of the primary effect may be more important than exhaustively examining secondary effects. The principle of relevance can be used to guide decisions about the extent of the secondary effects to consider. This principle takes into account the purpose of the GHG project and the decision-making needs of the project developers and may help them decide the extent to which secondary effects should be considered.

5.3.1 ONE-TIME EFFECTS

One-time effects are secondary effects related to GHG emissions that occur during the construction, installation, and establishment or the decommissioning and termination of the project activity. One-time effects are identified by considering whether the project activity will require any practices, processes, or consumption or production of energy or materials during its establishment and termination that will cause a change in GHG emissions unrelated to the primary effect.

For some types of projects, large one-time effects may arise during construction or establishment from the transportation of equipment, or manufacturing and use of cement used in construction. During the decommissioning or termination phase, the one-time effects to consider may be associated with off-site waste disposal and dismantling equipment.

One-time effects during the establishment phase can also be large for some land-use projects. For example, reforestation and afforestation projects often require the clearing of vegetation to prepare a site for planting. This results in GHG emissions from the machinery used to clear the site, as well as the release of stored carbon from the cleared vegetation and disturbed soils.

5.3.2 UPSTREAM AND DOWNSTREAM EFFECTS

Upstream and downstream effects are recurring secondary effects associated with the operating phase of a project activity and relate to either the inputs used (upstream) or the products produced (downstream) by a project activity. Upstream and downstream effects are identified by considering whether there are any inputs consumed or products/by-products produced by the project activity that will cause a change in GHG emissions unrelated to the primary effect during the project activity's operating phase.

Some examples of where upstream and downstream effects may arise include:

- Project activities that use fossil or biomass fuels to generate electricity, heat, or steam. Upstream effects may result from changes in the extraction of fossil fuels, the harvest of biomass, and the transportation of either type of fuel—e.g., changes in the release of methane (CH_4) during coal mining, the release of CO_2 from fuel combustion during harvesting, and the release of CO_2 from transporting coal or biomass.
- Project activities that cause a change in the use of materials or products that give rise to GHG emissions as a result of physical or chemical processing during their manufacture, use, or disposal.
- Project activities that cause a change in the use of materials or products whose application gives rise to GHG emissions—e.g., changes in nitrous oxide (N_2O) emissions associated with the application of nitrogen fertilizer; changes in HFC leakage from refrigeration equipment, or changes in the use of lime in sulphur dioxide scrubbers in a coal fired boiler.
- Project activities that involve the transportation of materials, employees, products, and waste. Changes in GHG emissions may arise from changes in the combustion of fuels in vehicles, trains, ships, and aircraft.
- Project activities that affect levels of fugitive or vented emissions. For example, a project activity may incidentally cause changes in GHG emissions from leaking joints, seals, packing, and gaskets; CH_4 emissions vented from coal mines; or CH_4 leaks from gas transport and storage.
- Project activities that cause changes in GHG emissions from disposed waste—e.g., changes in CH_4 emissions from landfilled waste, even if these changes occur much later than the implementation of the project activity.

UPSTREAM AND DOWNSTREAM EFFECTS INVOLVING MARKET RESPONSES

In theory, nearly all upstream and downstream effects will involve, or be associated with, some kind of market response. Market responses occur when alternative providers or users of an input or product react to a change in market supply or demand caused by the project activity.

For example, a downstream market response occurs when a forest protection project activity that reduces the supply of fibre causes logging to shift to other adjacent forests to meet unchanged fibre demand. An upstream market response could occur where the project activity involves switching fuel from coal to biomass; the switch to biomass may reduce the availability of this biomass to existing users, who may then substitute a more GHG-intensive fuel to meet their needs, increasing GHG emissions. These are both examples of negative market responses. An example of a positive market response is where a forest plantation increases the supply of fibre, which in turn reduces logging at other sites.

The extent to which an upstream or downstream effect involves a market response depends on:

- the extent to which products and services consumed or produced by the project activity can be replaced by substitutes;
- the ability of alternative producers to change their supply of a product or service;
- the ability of alternative consumers to change their demand for a product or service; and
- the cumulative impact of similar projects.

If a product or service consumed or produced by the project activity has many substitutes, many alternative suppliers, or many consumers, then market responses are likely to occur and the effects of these market responses on GHG emissions should be considered. For each input used or product produced by the project activity, project developers should describe whether the input or product is highly substitutable and indicate the extent to which they believe a market response will or will not occur.

Market responses can often be small and difficult to discern, especially if the quantity of inputs consumed or products produced by a project activity is small relative to the overall market. If an upstream or downstream effect involving a market response is identified, the market involved should be carefully described and defined along with the project activity's size relative to the market. Where negative market responses cannot be eliminated or mitigated by project design (Box 5.1), every reasonable attempt should be made to estimate their possible significance. Where estimating the market response is infeasible, the reasons for this should be clearly documented and explained. If estimated, the market response should be factored into the estimation and final quantification of secondary effects.

BOX 5.1 Mitigating market responses

GHG projects can sometimes mitigate market responses by incorporating unique design elements. Project developers should describe and explain any such design elements. Some examples of these design elements include:

- Providing alternative income streams to displaced workers. For example, land-use projects can accommodate displaced workers by developing other employment opportunities, such as ecotourism.
- Providing an alternative supply of the products or services reduced by the project activity. For example, an avoided deforestation project could meet the baseline scenario's market demand for fibre by including a forest plantation as an additional GHG project activity.
- Using inputs for the project activity that have no alternative use. For example, GHG projects that employ alternative inputs to GHG-intensive materials or fuels might use waste biomass, such as rice husks, as the alternative input.

Design solutions are likely to be more feasible for market responses caused by a nearby shift of physical activities, because it is easier to identify and manage changes that take place close to the GHG project's physical site.

5.4 Estimating the Relative Magnitude of Secondary Effects

Project developers should attempt to estimate the magnitude of secondary effects as a prelude to determining whether they are significant. Following are some basic approaches for estimating the magnitude of secondary effects.

USING DEFAULT OR EXISTING DATA

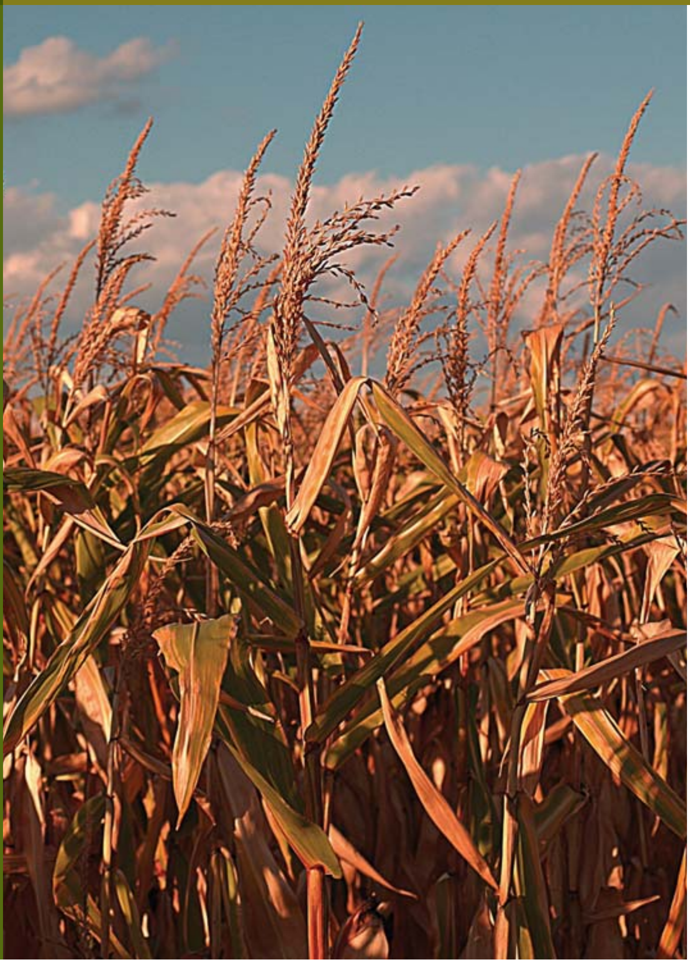
Available default data or rough estimates often provide a reasonable basis for quantifying secondary effects, and are usually the most cost-effective route to take. Default or existing data are useful for all secondary effects that do not involve a market response, including one-time effects. Default data are also appropriate for estimating the magnitude of small secondary effects, which can in principle be aggregated together. In some cases, it may be possible to use default data from existing market assessments for upstream and downstream effects involving market responses.

USING EMISSION FACTORS

Many secondary effects can be estimated as the product of an emission rate and the level of input used or product produced that is related to the change in GHG emissions. This approach works well for upstream and downstream secondary effects. The key to this approach is to determine how input or product levels differ between the project activity and baseline scenario. For example, a change in methane emissions associated with the extraction of coal can be estimated as the product of an emission rate for methane (e.g., tonnes of CO_2eq/tonnes of coal used) and the difference between the amount of coal used in the project activity and baseline scenario. If market responses are involved, however, it may sometimes be difficult to determine the change in quantities of inputs or products between the baseline scenario and the project activity. Estimating this change may require some kind of market assessment.

UNDERTAKING A MARKET ASSESSMENT

A market assessment involves the economic modelling (e.g., equilibrium or econometric modelling) of the relevant market's response to the project activity's impact on supply or demand for an input or product. Many markets will not respond with a one-for-one substitution



and/or may substitute other products or supply sources with very different GHG profiles. While this approach will provide estimates of how a project activity affects supply and demand of products, it presents some challenges. For instance:

- Developing an economic model for a specific market may be unrealistically costly if a model does not already exist.
- Even conducting an analysis with existing models may be costly.
- Different models and assumptions often yield different results.
- Currently there are no off-the-shelf guidelines or approaches to determine what models and assumptions to use.
- Uncertainty associated with the modelling effort may still be very high.

In most cases, market assessments are only necessary where the changes in supply or demand caused by a project activity are significant relative to the overall size of the market. Very small changes in supply or demand will not appreciably affect the behaviour of other actors in the market.

APPLYING THE CONSERVATIVENESS PRINCIPLE

Any method used to estimate secondary effects is prone to uncertainty. Because of this, the conservativeness principle should guide any effort to estimate their magnitude. For instance, it is advisable to use upper-bound estimates for project activity GHG emissions and lower-bound or zero estimates for baseline emissions.[2] Use of a conservative estimate for baseline emissions is appropriate whenever it is difficult to determine the baseline scenario conditions related to a secondary effect. This is particularly relevant when the performance standard procedure is used to estimate baseline emissions for a project activity. In this case, it may be simplest to assume that the baseline emissions for secondary effects are zero, as the baseline scenario conditions may be ambiguous.

5.5 Assessing the Significance of Secondary Effects

Only significant secondary effects are included in the GHG assessment boundary. However, the significance of a secondary effect can be subjective and can depend on the project activity's context. The following criteria may be used to help determine whether a secondary effect is significant or not:

- **The secondary effect involves a positive difference between baseline emissions and project activity emissions.** From an environmental standpoint, the purpose of considering secondary effects is to identify those that would negate the project activity's primary effect. If a specific secondary effect can be shown to be positive (i.e., it would increase the estimate of GHG reductions if included), but would be costly to monitor and quantify, it may be more practical to exclude it from the GHG assessment boundary. Such exclusions should result in a conservative estimate of GHG reductions for the overall GHG project.
- **The secondary effect is small relative to the associated primary effect.** If a secondary effect is small in absolute terms and in relation to the primary effect and all other secondary effects, it may be excluded from the GHG assessment boundary. However, it is important to take into account the cumulative effect of

excluding "small" secondary effects. In some cases, it may be advisable to develop a single proxy estimate for the changes in GHG emissions associated with multiple "small" secondary effects. Any criteria used to determine that a secondary effect is "small" in magnitude should be explained.

- **The secondary effect involves a negligible market response.** If a secondary effect is expected to arise from a market response to the project activity and this market response will be small or negligible, the secondary effect may be insignificant. This will most often be the case where the project activity's production or consumption of products or services is insignificantly small relative to the total markets for those products or services. The only exception to this would be where the absolute change in GHG emissions associated with even a small market response would be significant relative to the project activity's primary effect. This is most likely where the primary effect is linked to reducing the supply of a GHG-emitting product or service, in which case the market response will usually be to meet demand using other suppliers, negating the primary effect.

Any exclusion of a secondary effect should be justified, and the justification should include an assessment of whether the effect could become significant in the future due to changing circumstances.

SIGNIFICANT SECONDARY EFFECTS THAT CANCEL EACH OTHER OUT

In some instances, two significant secondary effects—one positive and one negative—associated with related GHG sources or sinks may effectively counterbalance each other. For example, a project activity that switches the fuel used for stationary combustion from coal to biomass may give rise to two secondary effects: (1) a reduction in rail transportation GHG emissions associated with transporting coal (positive), and (2) an increase in rail transportation GHG emissions associated with transporting biomass (negative). If these two secondary effects were of the same magnitude, they would cancel each other out. If it can be demonstrated that two related significant secondary effects will counterbalance each other, their net effect could be considered insignificant and they could be excluded from the GHG assessment boundary. However, the expected magnitude of both secondary effects should be clearly substantiated.

Warren Gretz, National Renewable Energy Lab

NOTES

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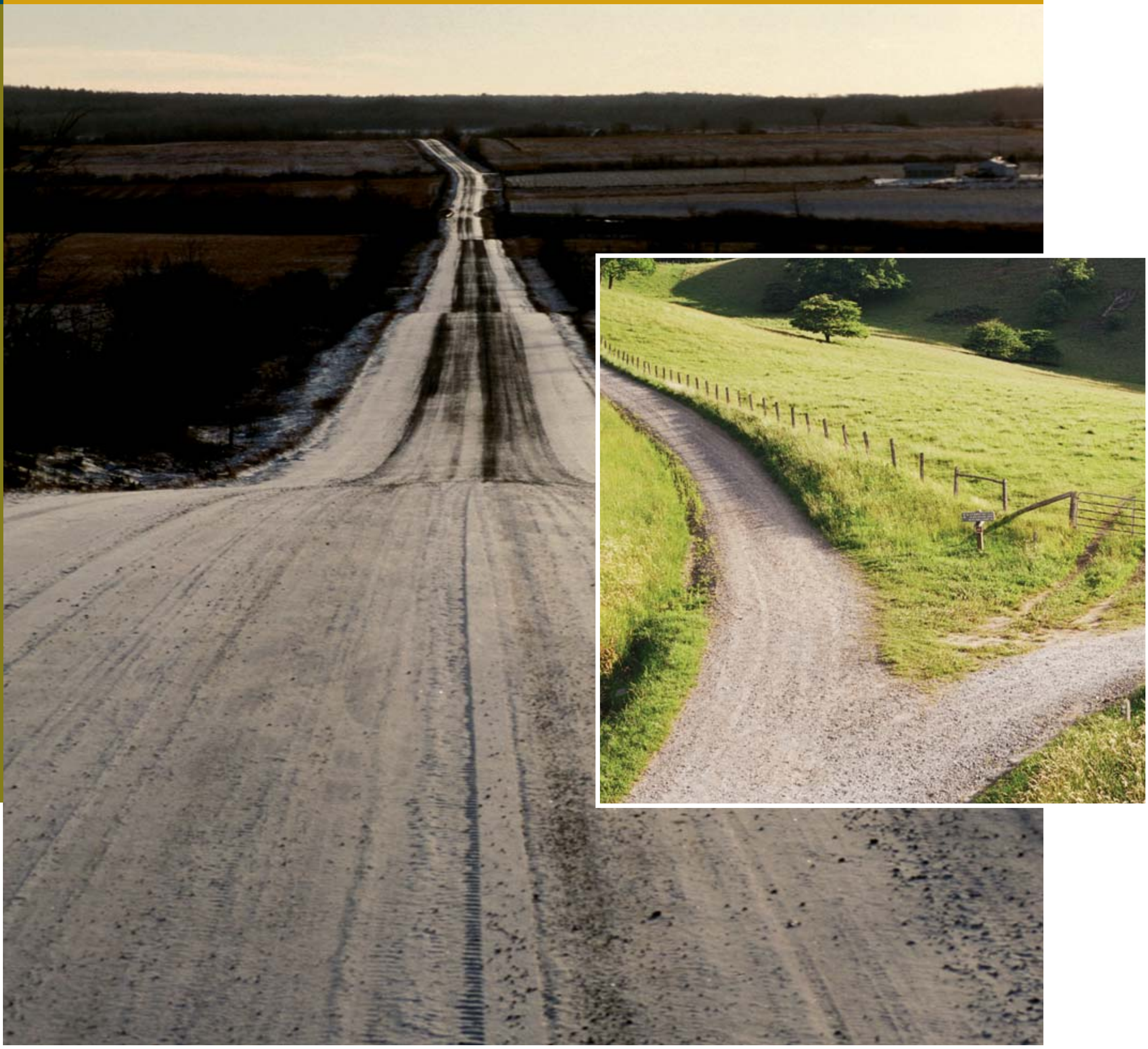
[1] GHG reductions are estimated with *ex ante* information, and are quantified *ex post* with information compiled during monitoring. See Chapter 10 for more information on quantification and monitoring.

[2] If the secondary effect involves GHG removals and storage, conservative estimates would be reversed: lower-bound or zero estimates for the project activity and upper-bound estimates for baseline emissions.

6 Selecting a Baseline Procedure



In Chapters 8 and 9, the Project Protocol presents two procedures for estimating baseline emissions associated with a project activity's primary effect: the project-specific and performance standard procedures. This chapter provides brief guidance on when one procedure may be preferable to the other.

Requirement

For each primary effect associated with a project activity the project developer shall select and justify the choice of baseline procedure used to estimate baseline emissions.

Guidance

Selecting and Justifying a Baseline Procedure

The performance standard procedure may be preferred when:

1. **A number of similar project activities are being implemented.** Where a number of similar project activities in the same geographic area are being undertaken, developing a performance standard may be the most cost-effective route. If a GHG program approves a performance standard for one project activity, it may be used for numerous similar project activities in the same area (assuming they are all developed within the time period for which the performance standard is valid).
2. **Obtaining verifiable data on project activity alternatives is difficult.** The project-specific procedure requires a structured analysis of the barriers and possibly the benefits associated with the project activity and its alternatives. This requires access to verifiable data on the barriers faced by these alternatives, as well as the expected benefits of these alternatives, including in some cases economic or financial performance data. While identifying barriers and expected benefits for the project activity may be relatively straightforward, undertaking the same analysis for its alternatives may be more challenging and time consuming. The performance standard procedure requires verifiable data on the GHG emission rates of individual alternatives, but not on their potential barriers or benefits. Thus, when access to information on the barriers and benefits for alternatives is limited, the performance standard procedure may be preferred.
3. **Confidentiality concerns arise with respect to the project activity.** Under the project-specific procedure, any data relating to barriers and possibly net benefits should be reported. In some cases, these data may include financial or other information that project developers wish to keep confidential. If the credible identification of the baseline scenario under the project-specific procedure is not possible without the use of confidential data, project developers may prefer to use the performance standard procedure. However, in some cases gathering sufficient data from competitors to determine a performance standard may also be complicated due to confidentiality issues.

The project-specific procedure may be preferred when:

4. **The number of baseline candidates is limited, or GHG emission rate data for baseline candidates are difficult to obtain.** The performance standard procedure requires verifiable GHG emission rate data on each individual facility or site within a given geographic area and temporal range, or a large enough sample of data to represent each facility or site statistically. The project-specific procedure, on the other hand, requires verifiable information relating to each representative type of technology or practice in the chosen geographic area and temporal range. In cases where the data set of facilities or sites may be too small—or access to GHG emission rate data is too limited—developing a robust performance standard may be difficult. In these situations, the project-specific procedure may be more appropriate.

USING A COMBINATION OF BASELINE PROCEDURES

In some cases, it may be possible to combine the project-specific and performance standard procedures to estimate baseline emissions. This would involve using a performance standard to characterize one of the alternatives (e.g., the continuation of current activities) in the project-specific procedure. Using a combination of the baseline procedures may be useful when the baseline scenario could be represented by a blend of alternative technologies, management or production practices, or delivery systems (e.g., grid-connected electricity generation). If a combination of baseline procedures is used, both procedures should be performed in their entirety.

7 Identifying the Baseline Candidates

Both the project-specific and performance standard baseline procedures presented in Chapters 8 and 9 rely on the identification of baseline candidates. Baseline candidates are alternative technologies or practices within a specified geographic area and temporal range that could provide the same product or service as the project activity. They can involve both existing and potential technologies and practices. This chapter describes how to formulate a complete list of baseline candidates appropriate for either baseline procedure.

Requirements

For each project activity, the project developer shall develop a complete list of baseline candidates that will be used in the baseline procedures to represent possible alternatives to the project activity. The following steps are required:

7.1 Define the product or service provided by the project activity.

7.2 Identify possible types of baseline candidates.

7.3 Define and justify the geographic area and the temporal range used to identify baseline candidates.

7.4 Define and justify any other criteria used to identify baseline candidates.

7.5 Identify a final list of baseline candidates.

7.6 Identify baseline candidates that are representative of common practice (for the project-specific baseline procedure).

Guidance

Although the requirements for this chapter follow a sequential order, identifying a final list of baseline candidates is not a strictly linear process. Some iteration between the steps outlined in the requirements will usually be necessary to arrive at a final definition of the geographic area and temporal range, and a final list of baseline candidates.

Identifying an exhaustive list of baseline candidates can be both costly and time consuming. It is often necessary to try to balance time and cost with the need to identify a representative list of baseline candidates. Where trade-offs are necessary, it is best to be transparent about any decisions relating to the final list of baseline candidates. The accounting principles in Chapter 4 provide helpful guidance when making these decisions.

Baseline candidates may be defined somewhat differently, depending on which baseline procedure is used (Chapter 8 or 9). Project developers should carefully review the guidance for identifying the final list of baseline candidates (section 7.5) for an understanding of the key differences.

7.1 Defining the Product or Service Provided by the Project Activity

Baseline candidates provide a product or service identical (or nearly identical) to that of the project activity. To identify baseline candidates, it is therefore important to first clearly define the product or service provided by the project activity. The product or service can take many forms, depending on the type of project activity, and in some cases may not be intuitively obvious. In most cases, the product or service should be defined narrowly to include only the immediate or direct outputs associated with the project activity. Project developers should be careful not to identify a product or service that is provided by a larger facility or system of which the project activity is only a component. For example, for a project activity that substitutes a low-GHG-emitting fuel for a high-GHG-emitting fuel in vehicles, the service provided would be energy used for transportation, not transportation itself. Thus, alternative fuels would be considered as baseline candidates, but alternative modes of transportation would not.

TABLE 7.1 Examples of the product or service and baseline candidates for some types of project activities

GHG PROJECT	PROJECT ACTIVITY	PRODUCT AND/OR SERVICE	PRIMARY EFFECT
Wind Power Project	Generate grid-connected electricity from wind turbines	Kilowatt-hours of electricity	Reduction in combustion emissions from generating grid-connected electricity
Energy Efficiency Project	Improve energy efficiency of lighting by using energy-efficient light bulbs	Lighting (e.g., amount of illumination per square meter of floor space)	Reduction in combustion emissions from generating grid-connected electricity
Transportation Fuel Switch Project	Change from fossil fuel to biofuel in buses	Kilojoules of energy to power transportation	Reduction in combustion emissions from generating energy or off-grid electricity, or from flaring
Industrial Fuel Switch Project	Fuel switch to natural gas at an off-grid stationary combustion plant	Tonnes of steam required for industrial processes	Reduction in combustion emissions from generating energy or off-grid electricity, or from flaring
Afforestation Project	Change land-use to enhance carbon storage	Product/service changes depending on the land-use but the area of land is equivalent*	Increased storage or removals of CO_2 by biological processes
Forest Management Project	Change forest management to enhance carbon storage	Forestry commodities from a given area of land**	Increased storage or removals of CO_2 by biological processes
Agricultural Tillage Project	Change tillage practices to enhance carbon storage	Agricultural commodities from a given area of land	Increased storage or removals of CO_2 by biological processes
Landfill Gas (LFG) Project	a) Install equipment to capture methane b) Generate grid-connected electricity from captured methane	a) Collection and disposal of waste gases* b) Kilowatt-hours of electricity	a) Reduction in waste emissions b) Reduction in combustion emissions from generating grid-connected electricity

*For these project activities, there may or may not be equivalence in the type of product or service provided by the project activity and the baseline candidates.

**For these project activities, there may or may not be equivalence in the quantity or quality of product or service provided by the project activity and the baseline candidates.

7.2 Identifying Possible Types of Baseline Candidates

Possible baseline candidates can be identified by thinking broadly about the different alternatives that have a comparable product or service to the project activity (Table 7.1). The following questions can help in this effort:

- What alternative new or existing technologies, management or production practices, or delivery systems would provide products or services similar to the project activity?
- What alternative management, production, or delivery systems do others use to provide the same product(s) and/or service(s) as the project activity?

EXAMPLES OF BASELINE CANDIDATE TYPES
Other electricity-generating technologies on the grid, such as fossil fuel or other renewable energy technologies
• Incandescent light bulbs • Compact fluorescent light bulbs • Halogen light bulbs
• Diesel • Gasoline • Ethanol • Biodiesel • LNG
• Other fossil fuels, such as coal or oil • Renewable energy sources
• Continuation of current land-use • Cropland growing different food crops • Pastureland
• Continuing current forest management • Variations in forest management, such as increasing thinning or fertilisation
• Continuing current tillage practices • No-till / zero tillage • Mouldboard ploughing • Conventional tillage • Ridge tillage
a) • Continuation of current activities • Flaring of LFG • Use of LFG for fuel b) Other electricity-generating technologies on the grid, such as fossil fuel or renewable energy technologies

- What is the production, management, or delivery system most commonly used to serve the same market as the project activity?
- If any, what is/are the status-quo technologies, management or production practices, or delivery systems?

For both the project-specific and the performance standard procedures, baseline candidates should provide the same product or service as the project activity. Exceptions may occur in certain limited situations. In some cases, for example, baseline candidates may provide a product or service that is comparable but not identical to the project activity's product or service—e.g., different lighting technologies with different characteristics. Generally, the availability and nature of substitute products or services for the project activity should be considered in identifying baseline candidates with the "same" product or service. For transparency, project developers should outline when and why the product or service provided by baseline candidates will not be the same as the project activity.

7.3 Defining the Geographic Area and Temporal Range

In developing a final list of baseline candidates, it is important to identify specific types of baseline candidates within a geographic area and temporal range relevant to the project activity.

The most important criterion in defining the geographic area and temporal range is that they should contain a sufficient number and diversity of baseline candidates to allow a credible analysis and estimate of baseline emissions. If the following guidelines result in an area or range yielding too few baseline candidates, the area or range should be expanded. For example, the temporal range may need to be expanded from recent historical plants, technologies, equipment, or practices to include new or under-construction plants, equipment being installed, or technologies or practices being implemented. Similarly, the geographic area could be expanded to include other areas that exhibit circumstances similar to those surrounding the project activity (e.g., technological, resource, socioeconomic, or political circumstances). Defining the appropriate geographic area and temporal range may be an iterative process.

7.3.1 DEFINING THE GEOGRAPHIC AREA

The geographic area determines the locations of plants, equipment, or practices that are included in the final list of baseline candidates. Generally it will make sense to start with national political boundaries to define the geographic area, and to modify this area as appropriate (see Figure 7.1). Depending on circumstances surrounding the project activity and various aspects of the baseline candidates, the appropriate geographic area may be narrower (e.g., an area within a country or an electricity grid), or wider (e.g., an international region or global area).

Some general rules of thumb for defining the geographic area include:

1. Where the baseline candidates reflect a mature technology or practice that is similar across regions or is rapidly converging, a regional or global geographic area may be the most appropriate geographic area.
2. Where the baseline candidates vary because of human-influenced factors, some form of jurisdictional/administrative boundary may be the most appropriate geographic area. Human-influenced factors may include legal factors (e.g., government policies, laws or regulations); socio-cultural factors (e.g., social norms, traditions, individual habits, attitudes, values, vested interests, human capital); or economic factors (e.g., household incomes, energy and other factor prices, employment, imperfect markets, financing, demand for specific services). For instance, if legislation affects a certain sector in a given state/province of a country, that state/province may be more representative than the country.
3. Where the baseline candidates are constrained by the availability of physical infrastructure, such as supply networks for electricity and fuels, an area that represents the extent of infrastructure may be the most appropriate geographic area. For instance, the power grid is appropriate for grid-connected electricity projects. Similarly, market boundaries are appropriate if baseline candidates are constrained or isolated by a clearly defined market region.
4. Where the baseline candidates vary according to biophysical characteristics, such as climatic variation (e.g., temperature or precipitation) or geological variation (e.g., soils, topography, or altitude), some form of representative ecological zone may be the most appropriate geographic area. Land-use and forestry projects are often defined by the homogeneity in soil, vegetation, and/or climatic conditions.

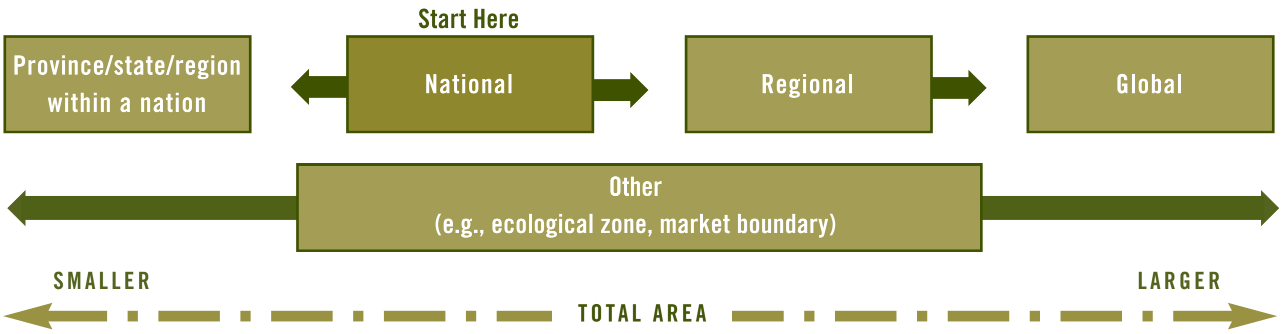
A number of factors may influence the choice of geographic area. The principles of transparency and relevance should be used to weigh the importance of these factors.

7.3.2 DEFINING THE TEMPORAL RANGE

The temporal range defines the appropriate time period from which to select the relevant baseline candidates, and is based on installation, implementation, or establishment dates of the various technologies, equipment, or practices. For instance, if a 5-year temporal range were selected, only those technologies, pieces of equipment, or practices that became operational or were implemented in the last 5 years would be used. The temporal range is usually based on one or more of the following:

- **Recent plants, technologies, equipment, or recently established practices (e.g., during the last 5 to 7 years).**

FIGURE 7.1 **Defining the geographic area**



Start with national political boundaries to define the geographic area, and modify this area as appropriate to obtain a reasonable list of baseline candidates reflecting technological, jurisdictional, infrastructural, and physical/territorial considerations.

These data are observable and verifiable, whereas the data for under-construction, near-future, or future equipment or practices can only be estimated or projected. Where possible, recently built plants and newly established practices are the best baseline candidates to use.

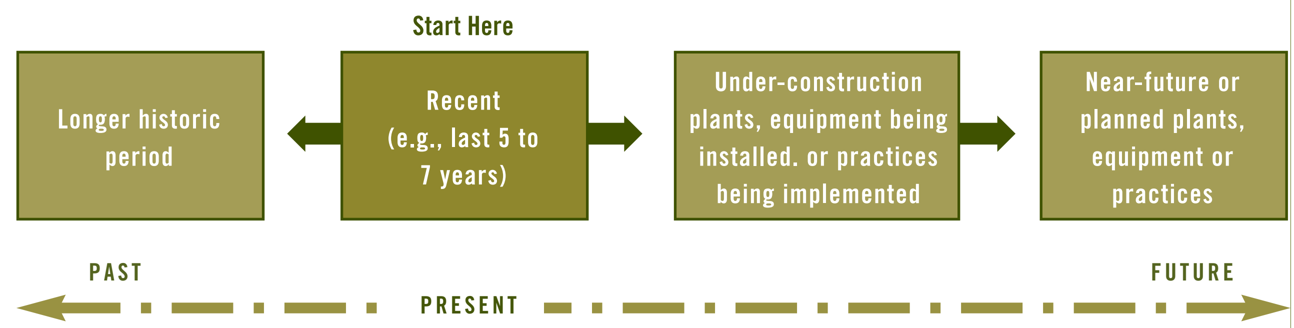
- **Under-construction plants, equipment being installed, or technologies or practices being implemented.** Although these baseline candidates may be more difficult to find data for and fully characterize, they may provide a better indication of trends in technology, practices, or fuel mix than existing baseline candidates.
- **Planned future plants, technologies, equipment, or proposed practices.** Data on planned baseline candidates tend to be relatively uncertain, since plans can be modified before or during the implementation or construction phase. If these data are used, they should be based on published government or company plans. For larger plants or operations, information may also be available from environmental impact assessments, operating permits, or similar documents.

Project developers should start with a temporal range that includes the recently built plants and equipment, or recently established practices (e.g., the last 5 years). Where necessary, the temporal range may be expanded to include under-construction plants, equipment being installed or practices being implemented and/or planned future plants, equipment, or practices to capture any trends in the sector that are indicative of future technology, management, or regulatory paths (see Figure 7.2).

Some general rules of thumb to use for defining the temporal range include:

1. If a single technology or practice dominates a sector or region where no significant changes have taken place—e.g., one fuel source, such as coal (with no change in combustion efficiencies over time) or hydro, dominates a power grid—a longer temporal range can be used, since there has been little change over time.
2. If there is a large and varied number of alternative technologies or practices providing similar products or services in a sector or region, a longer temporal range should be used to ensure that the baseline candidates are representative of the range of resource

FIGURE 7.2 Defining the temporal range



Start with a temporal range that includes the recently built plants, equipment, or recently established practices. Where necessary, choose a longer historical period or expand the temporal range to include under-construction plants, equipment being installed or practices being implemented, and/or planned future plants, equipment, or practices.

options available. This may include under-construction plants, equipment being installed or practices being implemented or planned future plants, equipment, or practices.

3. If technology is changing very rapidly and the sector is relatively homogeneous in its use of the technology, the temporal range may need to be shorter in order to capture the trend in the sector.
4. If a sector experiences a discrete policy or legal change or autonomous change in technology, practices, or resource mix, a temporal range that corresponds to the point of change should be used. This range may include under-construction plants, equipment being installed or practices being implemented.

If information on emission rates is available, the temporal range can also be defined by assessing the trends in emission rates. Stable trends can use a longer temporal range; upward or downward trends can use a shorter temporal range; scattered trends can use a longer temporal range; and if a break point (or a distinct change in GHG emission rates) exists, the year in which the break point occurred can be used to define the first year of the temporal range.

Once again the circumstances surrounding the project activity influence the choice of temporal range, and the principles of relevance and transparency should be used when making decisions regarding the temporal range.

7.4 Defining Other Criteria Used to Identify Baseline Candidates

Other factors, such as legal requirements and common practice, may be helpful in identifying the baseline candidates, or may guide the definition of the geographic area and temporal range.

7.4.1 BASELINE CANDIDATES AND LEGAL REQUIREMENTS

The presence of enforced laws or regulations that affect baseline candidates can be a basis for defining the geographic area and temporal range. The geographic area should align with, or lie within, the jurisdiction to which the law or regulation applies, and the temporal range should not extend prior to any date covered by the law or regulation. The result will be that any baseline candidates that do not comply with the regulations may be eliminated from the final list.

Where legal requirements are not enforced, it may not be appropriate to use legal jurisdictions or dates of enactment to constrain the geographic area or temporal range. If laws and regulations are not enforced, this lack of enforcement should be documented.

Relevant legal requirements will include any applicable national/state/provincial/local regulations or laws that directly or indirectly affect GHG emissions and that require technical, performance, or management actions. These may involve the use of a specific technology (e.g., gas turbines instead of diesel generators), meeting a certain standard of performance (e.g., fuel efficiency standards for vehicles), or managing operations according to a certain set of criteria or practices (e.g., forest management practices).

These legal requirements should be laws that have been passed by a legislative body, have been enacted, and are being enforced at a national, state/provincial, or local level. Generally, they should not include voluntary agreements with no enforcement mechanism, laws or regulations under discussion, and general government policies—none of which are considered mandatory.

Baseline candidates comply with legal requirements when either:

- there are no applicable mandatory laws or regulations concerning the baseline candidates in the defined geographic area and temporal range (or concerning the GHG source in the country/area where the affected source is located); or
- the technology or practices employed by the baseline candidates perform as well as any standard and meet all the conditions prescribed by existing and enforced mandatory laws and regulations.

A number of challenges arise with defining legal requirements, including:

- unclear and/or contradictory written law(s) or regulation(s);
- questions regarding how to treat pending legislation;
- varying levels of enforcement of particular laws and regulations; and
- laws or regulations applying to project activities where the sites, facilities, production, or delivery systems affected and the GHG sources or sinks affected are located in different regulatory jurisdictions.

If legal requirements are used to constrain the geographic area and temporal range, or to constrain the final list of baseline candidates, project developers should be transparent about how they decided which legal requirements to consider. Additional discussion and further guidance on legal requirements can be found in Annex A.

7.4.2 BASELINE CANDIDATES AND COMMON PRACTICE

In some cases it may be advisable to eliminate from the list of relevant baseline candidates those whose GHG emissions are higher than those of "common practice" technologies or practices. This will generally be the case only if the project-specific procedure is used to estimate baseline emissions.

Common practice refers to the predominant technologies or practices in a given market, as determined by the degree to which those technologies or practices have penetrated the market (defined by a specified geographic area). Collecting data on all baseline candidates within the geographic area and calculating a relative percentage for each different technology or practice will give the level of penetration for each technology or practice. This percentage could be based on the number of plants or sites using each technology or practice, or could be weighted by the proportion of the total output for the market that is attributed to each technology or practice.

The level of penetration that represents common practice may differ between sectors and geographic areas, and may depend on the diversity of different baseline candidates within a geographic area. For example, in one area a certain technology may have a 60 percent market share, while in another area it may only have a 15 percent market share. In both instances, the technology may be common practice. Low rates of penetration or market shares that represent common practice usually occur in areas where there is a large diversity of baseline candidates. If there are few alternative technologies or practices, the common practice penetration rate may be quite high.

Common practice technologies or practices may or may not correspond to what is legally required.

7.5 Identifying the Final List of Baseline Candidates

7.5.1 RELATIONSHIP BETWEEN BASELINE CANDIDATES AND BASELINE PROCEDURES

The number of baseline candidates to be identified and how baseline candidates are defined may differ, depending on the procedure used to identify baseline emissions. For the performance standard, the baseline candidates include all individual plants, instances of a technology, or practices that provide the same product or service as the project activity. For the project-specific procedure, baseline candidates usually include a more limited number of individual instances and/or representative types of plants, technologies, or practices.

For example, there may be six plants producing the same product as the project activity—three plants utilizing technology X (plants A, B and C), two plants using technology Y (plants D and E) and one plant using technology Z (plant F). The baseline candidates for the performance standard would include the six individual plants (plants A, B, C, D, E and F). For the project-specific procedure, the baseline candidates could be the representative technologies—X, Y and Z (see Figure 7.3).

For the project-specific procedure, representative types of technologies or practices should be carefully defined and explained. In some cases, an individual plant or instance of a technology or practice may be chosen as representative. In other cases, it may make sense to define a representative type using average performance characteristics or GHG emissions from a number of individual plants. For example, the GHG emission rate of technology X may be characterized as the average GHG emission rate of plants A, B, and C. Sometimes there are wide variations in performance for a certain type of technology—e.g., coal-fired boilers with a wide range of fuel-use efficiencies. For these technologies, it will often make sense to define baseline candidates corresponding to different performance levels—or for specific makes and models—of the technology. Representative types of technologies or practices should always be present in some form within the appropriate geographic area and temporal range.

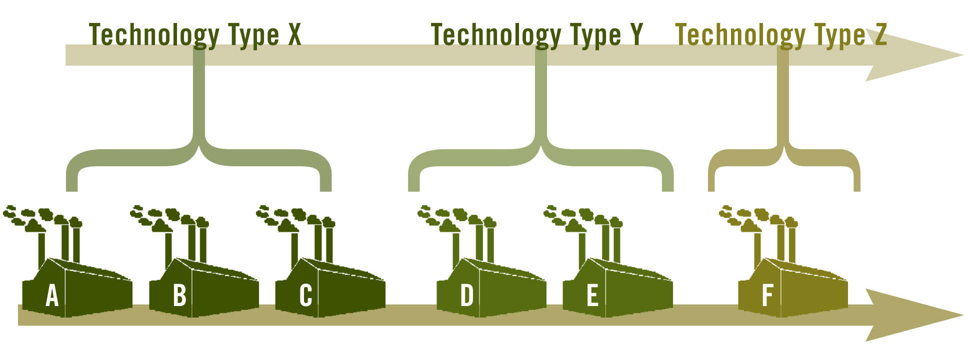
Finally, for the project-specific procedure, each baseline candidate should also be capable of providing an equivalent quantity of product or service as the project activity. In certain situations, this may mean that a single baseline candidate is defined as a number of similar smaller plant technologies or practices that in aggregate provide an equivalent quantity of product or service as the project activity.

7.5.2 SELECTING A FINAL LIST

The final baseline candidates used to estimate baseline emissions are those that fall within the defined geographic area and temporal range and provide the same product or service as the project activity. Completeness, relevance, and transparency are the most important principles to use when identifying the baseline candidates. The final list of baseline candidates, their characteristics, and a description of how they were identified within the geographic area and temporal range should be documented before undertaking one of the baseline procedures.

In some cases, the number of specific baseline candidates within the geographic area and temporal range may be quite large. In these cases, a statistical sampling may be used to define the final list of baseline candidates used in the baseline procedures. Methods used to identify a sample of baseline candidates should be fully described and explained.

FIGURE 7.3 **Relationship between baseline candidates and baseline procedures**



Project-Specific Procedure Baseline Candidates: Representative Types of Plants/ Technologies/Practices

Performance Standard Procedure Baseline Candidates: Individual Plants/Instances of a Technology or Practice

For the performance standard baseline procedure, the baseline candidates include all individual plants, instances of a technology, or practices that provide the same product or service as the project activity. For the project-specific procedure, baseline candidates include a more limited number of representative types of plants, technologies, or practices.

7.6 Identifying the Baseline Candidates that Represent Common Practice

If the project-specific procedure is used to estimate baseline emissions, project developers should identify any baseline candidates that represent what could be considered common practice. The guidance provided above in section 7.4.2 can assist in defining common practice technologies or practices. Instances where common practice cannot be meaningfully defined should be explained.

If the performance standard procedure is used to estimate baseline emissions, identifying common practice baseline candidates is not necessary. This is because rates of market penetration for different baseline candidates (and thus what constitutes common practice) will be directly reflected in the baseline emission rate derived using that procedure.


Hisham Zerriffi, Program on Energy and Sustainable Development

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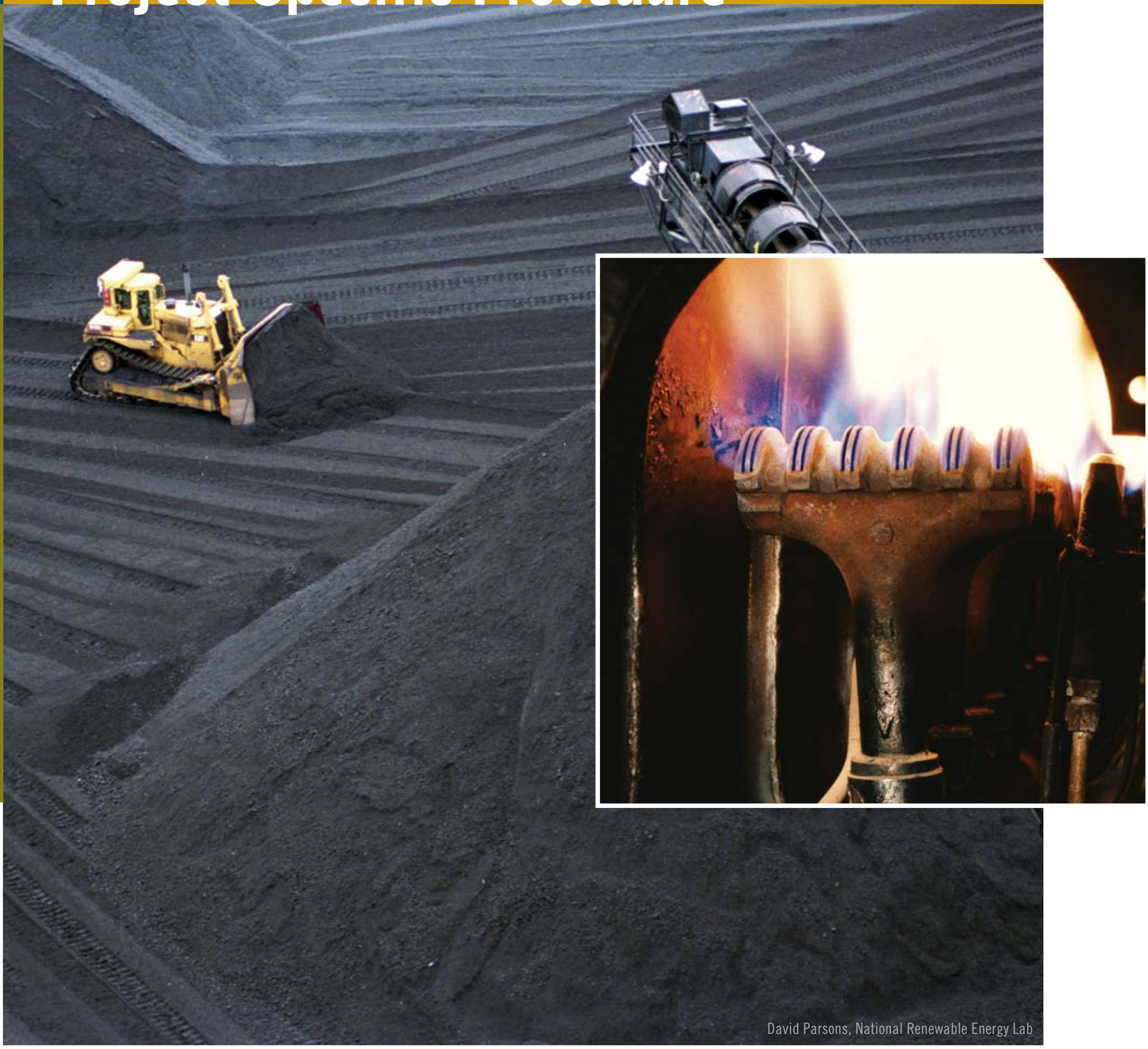
Estimating Baseline Emissions—Project-Specific Procedure



David Parsons, National Renewable Energy Lab

The project-specific procedure produces an estimate of baseline emissions for a project activity's primary effect through the identification of a baseline scenario linked to the specific circumstances surrounding the project activity. The baseline scenario is identified through a structured analysis of the project activity and the baseline candidates identified in Chapter 7. This procedure has two components. The first component involves identifying the baseline scenario. The second component involves estimating the GHG emissions associated with the baseline scenario.

Requirements

For each project activity, the following steps shall be performed to identify the baseline scenario and estimate baseline emissions:

8.1 Perform a comparative assessment of barriers.

8.1.1 **Identify all barriers that would affect decisions to implement the project activity or any of the baseline candidates.**

8.1.2 **Identify barriers to the continuation of current activities.**

8.1.3 **Assess the relative importance of the identified barriers for each alternative.**

8.2 Identify and justify the baseline scenario.

8.2.1 **Explain the significance of any barriers that affect the project activity and how these barriers will be overcome.**

8.2.2 **Identify the baseline scenario using the results of the comparative assessment of barriers.** Where it is not possible to identify the baseline scenario using the results of the comparative assessment of barriers, either:

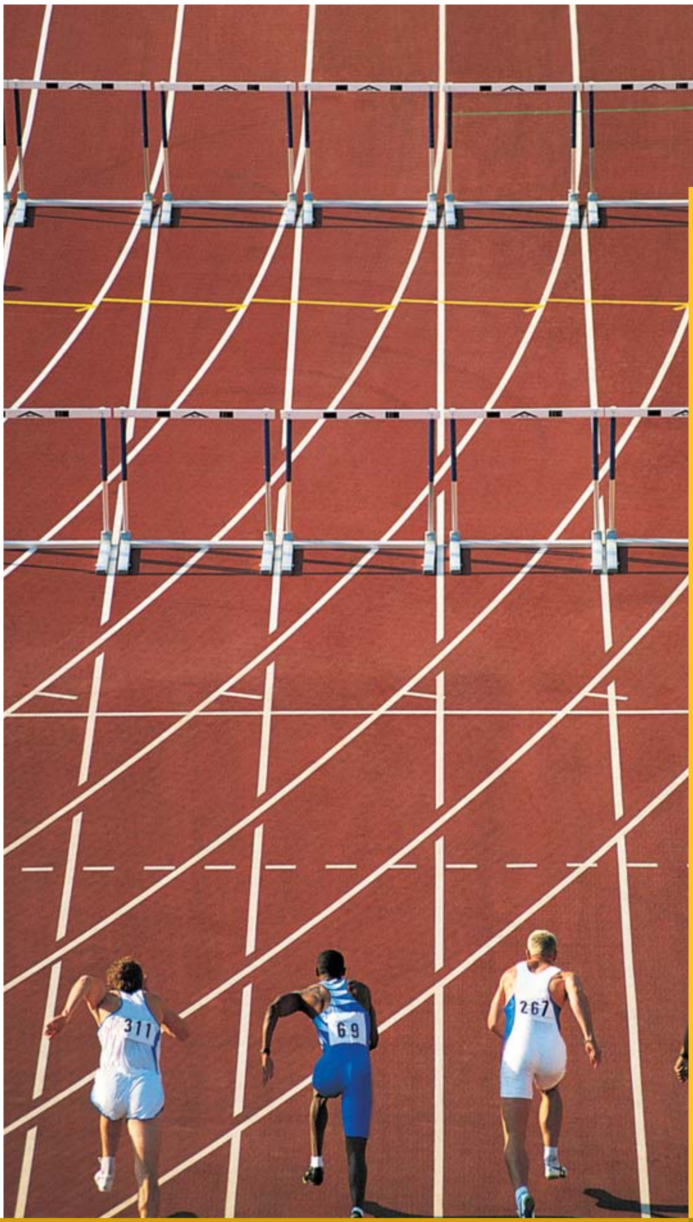
a) identify the baseline scenario as the most conservative viable alternative, which will have the lowest GHG emissions or the highest GHG removals compared to other viable alternatives; or

b) identify the baseline scenario using a net benefits assessment. The baseline scenario will be the alternative with the greatest net benefits—excluding any benefits resulting from GHG reductions—relative to assessed barriers.

8.2.3 **Justify the identified baseline scenario.**

8.3 Estimate baseline emissions.

Use assumptions, calculations, and emission factors specific to the identified baseline scenario.



Guidance

The baseline scenario is a reference case for the project activity. It describes an activity or a set of activities that result in GHG emissions (referred to as "baseline emissions"), against which project activity emissions can be compared for the purpose of quantifying GHG reductions. Broadly speaking, there are three types of possible alternatives for a baseline scenario:

- The baseline scenario involves implementation of the same technologies or practices involved in the project activity.
- The baseline scenario involves the configuration, deployment, implementation, operation, and decommissioning of new technologies or practices described by one of the baseline candidates from Chapter 7.
- The baseline scenario involves the continuation of current activities that, where relevant, provide the same type, quality, and quantity of product(s) or service(s) as the project activity.

CONTINUATION OF CURRENT ACTIVITIES

The "continuation of current activities" can be thought of as the "do nothing" alternative. It will mean slightly different things depending on the type of project activity. Examples include:

- Provision of grid-connected electricity from existing power plants, where the project activity involves construction of new generation equipment that would displace grid-connected electricity.
- Continued operation of existing equipment, where the project activity involves retrofitting the equipment to improve its efficiency.
- Continued emissions of methane from a landfill, where the project activity involves capturing and destroying this methane.
- Continued operation of working forests, where the project activity involves additional carbon sequestration through enhanced forest management.

In some cases, these kinds of possibilities may be identified as baseline candidates in Chapter 7. Within the project-specific procedure, however, they are considered separately from a consideration of other baseline candidates. This is primarily because they are unlikely to face the same kinds of barriers as other baseline candidates, and in some instances will face unique types of barriers that do not apply to other baseline candidates. The assessment of the continuation of current activities is thus qualitatively different from the assessment of other alternatives for the baseline scenario.

BOX 8.1 The project-specific procedure, additionality, and GHG programs

A determination of additionality is implicit in this procedure in the sense that if the identified baseline scenario is not the project activity, the project activity will be additional. However, the identification of the baseline scenario will always be subject to some degree of subjectivity. It will be up to project developers and those reviewing a GHG project to decide what constitutes a *significant* set of barriers for a project, whether barriers are *insurmountable,* and ultimately how to weigh and compare the cumulative significance of barriers for different alternatives (see section 8.1). Similarly, subjective decisions will be required in any assessment of net benefits, if such an assessment is employed to help identify the baseline scenario (see section 8.2.2). Because of the subjectivity involved, strong attention should be paid to the principles of transparency, conservativeness, completeness, and relevance in performing the project-specific procedure.

In performing this procedure, project developers may also wish to consider how it relates to the policy objectives of GHG programs concerning additionality, as outlined in Chapter 3. The stringency of this procedure is determined by the weight of evidence required to establish any particular claim concerning the final identification of the baseline scenario. GHG programs that desire a stringent additionality determination may impose specific informational requirements for substantiating any claims, or may require that certain methods be used. They may also choose to require certain additionality tests prior to identifying the baseline scenario (which could, for example, eliminate certain baseline candidates from consideration).

8.1 Performing a Comparative Assessment of Barriers

The comparative assessment of barriers determines to what extent the project activity and each baseline candidate are affected by barriers to their implementation.

8.1.1 IDENTIFYING BARRIERS TO THE PROJECT ACTIVITY AND BASELINE CANDIDATES

Identified barriers should include anything that would discourage a decision to try to implement the project activity or baseline candidates. All possible barriers should be considered. The project activity and baseline candidates may each face multiple barriers. Table 8.1 lists major categories of possible barriers. How each category is addressed in identifying and defining actual barriers should be explained.

8.1.2 IDENTIFYING BARRIERS TO THE CONTINUATION OF CURRENT ACTIVITIES

In most cases, there are no barriers to the continuation of current activities. However, if barriers do exist, they are often prohibitive or insurmountable. Barriers to the continuation of current activities could include:

- The end of a piece of equipment's useful lifetime, where the GHG project involves retrofitting this equipment (see Box 8.2).
- Market or regulatory changes that force a shift in existing production, management practices, or technologies. These would be changes that necessitate large-scale shutdown or replacement of existing facilities and equipment, or force changes in current practices (e.g., if a law were passed requiring the destruction of HFC-23 at HCFC-22 production facilities). Such conditions should be fully explained.

8.1.3 ASSESSING THE RELATIVE IMPORTANCE OF THE IDENTIFIED BARRIERS

In some cases, an identified barrier may eliminate an alternative from further consideration. This can occur if the barrier makes the alternative infeasible, or is otherwise prohibitive or insurmountable. However, barriers

TABLE 8.1 Barrier categories

BARRIER TYPES	BARRIER EXAMPLES*
Financial and Budgetary	• High costs • Limited or no access to capital • High perceived risks, resulting in high borrowing costs or lack of access to credit or capital. Perceived risks might be associated with, among other things: • political instability • regulatory uncertainty • unproven technologies or business models • currency fluctuations • poor credit rating of project partners • general risk of project failure
Technology Operation and Maintenance	• Lack of trained personnel capable of maintaining, operating, or managing a technology and lack of education or training resources
Infrastructure	• Inadequate supply or transport infrastructure for inputs, spare parts, fuels, etc. • Lack of infrastructure required to integrate and maintain new technologies/practices
Market Structure	• Market barriers or uncorrected market "failures" impede the adoption of the technology or practice in question
Institutional / Social / Cultural / Political	• Institutional or political opposition to the implementation of the technology or practice in question • Limited or no institutional capacity required to facilitate the technology or practice in question • Low social acceptance of the technology or practice in question • Aversion to high upfront costs or lack of awareness of benefits results in limited uptake of a product or service (e.g., energy-efficient appliances) • Lack of consensus on future management decisions (e.g., with respect to land-use)
Resource Availability	• Irregular or uncertain supply of resources required to implement or operate a technology or practice

*This list is not intended to be exhaustive. Project developers or GHG programs may identify other forms of barriers that are not described here.

BOX 8.2 Retrofit project activities and the continuation of current activities

A retrofit project activity involves modifying existing equipment, or replacing existing equipment with new parts, devices, or systems that:

- improve the equipment's efficiency and lower its rate of GHG emissions; and/or
- increase the equipment's utilization so that it produces more of a particular product or service.

Thus, many retrofit project activities result in two primary effects: (1) lowering the rate of GHG emissions associated with the equipment, and (2) displacing GHG emissions from other sources, for any amount of production greater than historical levels, due to increased utilization.

For the first primary effect, "continuation of current activities" would involve continued operation of the equipment that the project activity is retrofitting. For the second primary effect, "continuation of current activities" would involve continued production from other existing facilities that the project activity's expanded production displaces.

For the first primary effect, the most significant barrier to the continuation of current activities would be the breakdown of existing equipment (e.g., by reaching the end of its useful lifetime). If a piece of equipment would have to be replaced in the near future, then in practical terms this would constitute an absolute barrier to the continuation of current activities, and the continuation of current activities should not be considered as a baseline scenario alternative.

Predicting the remaining life of a piece of equipment can be challenging. It can depend on many variables, such as maintenance practices, owner policies about repairing versus replacing equipment, replacement schedules, the date of installation, and cumulative operating hours. Estimates of remaining equipment life can be derived from manufacturers' specifications, current commercial practice, regulatory standards governing equipment replacement, or the equipment's economically competitive life. The rationale for any equipment life estimates should be explained. If the retrofit involves replacing a component of a larger piece of equipment (e.g., installing more energy-efficient burners in a boiler), the life of the component (burner) should be used, rather than the life of the entire equipment (boiler).

are rarely "absolute" in the sense that they are impossible to overcome. In most cases, therefore, the relative importance of barriers should be assessed relative to each other and for each possible alternative.

Such an assessment can be qualitative, although quantitative components of an assessment should be incorporated where possible. In many cases, an identified barrier either will be specific to one alternative, or will affect all alternatives equally. If an identified barrier affects different alternatives to different degrees, then any differences should be characterized and fully explained. In principle, this could mean distinguishing between:

- the likelihood that a particular barrier would be present for a particular alternative, and
- the significance or extent of the barrier where it is present.

The degree to which an identified barrier affects each alternative may be characterized qualitatively using descriptive explanations and relative rankings (e.g., high, medium, or low).

The relative importance of the identified barriers should be estimated by determining the cumulative effect of all identified barriers on each alternative, and providing a rough ranking of the alternatives according to the barriers they face. Assessments of the cumulative effects of barriers should be substantiated and explained. One way to present the final results is in matrix form, as in Table 8.2. For the purpose of identifying a baseline scenario, it is not always necessary to finely distinguish the rank of each baseline scenario alternative (e.g., in Table 8.2., baseline candidates 2 and 3 both face "medium" barriers).

8.2 Identifying the Baseline Scenario

Before attempting to identify a baseline scenario, project developers should check that the data needed to do so are available. Available data should be relevant, reliable, and verifiable and may involve industry, country, regional, and local information. All possible sources for obtaining the necessary information should be documented. For the comparative assessment of barriers, the data must be adequate to describe the relevance of each barrier in its local context, and to demonstrate how identified barriers affect (or do not affect) the project activity and each baseline candidate. Annex B contains a list of useful information sources. If net benefits are assessed, the

TABLE 8.2 Example of rough ranking of baseline scenario alternatives by cumulative significance of barriers

BASELINE SCENARIO ALTERNATIVES	BARRIER 1 (H)*	BARRIER 2 (L)*	BARRIER 3 (M)*	BARRIER 4 (L)*	RANK BY CUMULATIVE IMPACT
Project Activity	Present	Present	High	Present	(5) Highest barriers
Baseline Candidate 1	Not present	Not present	Low	Present	(2) Second-lowest barriers
Baseline Candidate 2	Not present	Present	Medium	Present	(4) Medium barriers
Baseline Candidate 3	Not present	Not present	Medium	Present	(3) Medium barriers
Continuation of Current Activities	Not present	Not present	Not present	Not present	(1) Lowest (no) barriers

*Relative importance of barriers compared to each other:
H = Significant barrier; M = Moderately significant barrier; L = Less significant barrier
Note: Describing a barrier as "present" may be sufficient in instances where a barrier affects more than one alternative to roughly the same extent.

data must be adequate to substantiate the magnitude of benefits for each alternative.

8.2.1 EXPLAINING BARRIERS TO THE PROJECT ACTIVITY AND HOW THEY WILL BE OVERCOME

The significance of any barriers facing the project activity should be fully explained, and all measures and design features intended to overcome these barriers should be documented. For example, to overcome project activity barriers, GHG projects may be designed to:

- contribute to the transfer of technologies or practices;
- strengthen local manufacturing and maintenance capacities;
- introduce innovative financing arrangements;
- raise awareness of new products, technologies, and practices;
- increase consumer demand; and
- increase competitive pressure for technological or management change in the local market.

8.2.2 IDENTIFYING THE BASELINE SCENARIO USING THE COMPARATIVE ASSESSMENT OF BARRIERS

The comparative assessment of barriers can be used to identify the baseline scenario. For example, if only one alternative faces few or no barriers and all other alternatives (including the project activity) face significant or insurmountable barriers, it can be argued that the baseline scenario is the alternative that faces few or no barriers.

However, the comparative assessment of barriers may be inconclusive where:

- Barriers facing the project activity are not significant. In this case, either the comparative assessment of barriers will be inconclusive or the project activity (if it is the only viable alternative) will be identified as the baseline scenario.
- More than one alternative faces barriers that are not significant or that could be realistically overcome.

In such cases there are two options for identifying the baseline scenario: (a) using the most conservative viable alternative, or (b) conducting a net benefits assessment.

All reasoning and conclusions behind the identification of the baseline scenario should be fully explained. Any contention that barriers for a particular alternative are prohibitive or insurmountable should be substantiated, and explanations should focus on how the barriers would prevent the implementation of the alternative. Any barriers for a particular alternative that are thought to be surmountable but still significant should also be explained.

a) Identifying the Baseline Scenario as the Most Conservative Viable Alternative

The alternative with the lowest level of GHG emissions or the highest level of GHG removals is identified as the baseline scenario. If the project activity does not face significant barriers, it will most likely be the most conservative viable alternative. If the project activity is not considered a viable alternative, its exclusion from consideration should be fully explained.

b) Identifying the Baseline Scenario Using a Net Benefits Assessment

Where the project activity does not face significant barriers, or where it is not possible to identify a baseline scenario using only the comparative assessment of barriers, it may be possible to identify the baseline scenario using an assessment of net benefits. This approach demonstrates that the baseline scenario would involve a particular alternative because it would have had the greatest net payoff, rather than the fewest barriers. A net benefits assessment should be conducted for each alternative whose barriers can be realistically overcome.

A net benefits assessment identifies the baseline scenario as the alternative that would provide the greatest incentives (identified as benefits) to its decision-makers relative to any disincentives (already identified as barriers). Identifying the baseline scenario involves three steps:

1. assessing benefits for each alternative,
2. comparing benefits to identified barriers, and
3. identifying the alternative with the greatest benefits relative to barriers.

BOX 8.3 Assessing benefits with respect to the GHG project

The baseline scenario is specific to an individual project activity and primary effect. However, benefits are usually assessed as they relate to an entire GHG project or baseline candidate, rather than a specific project activity or component activity of a baseline candidate. This is because the decision to implement a particular project activity almost always depends on a decision about implementing the entire GHG project with which it is associated. In some cases, meaningfully assigning benefits (e.g., revenues or public relations value) for an entire GHG project to a specific project activity may be difficult or impossible.

Step 1: Assessing Benefits for Each Alternative

Benefits from implementing the GHG project (see Box 8.3) or baseline candidates can take many forms, including:

- expected financial returns (assessed either qualitatively or quantitatively);
- research and demonstration value for a new technology or practice;
- positioning in or entry into a specific market, strategic alignment, other competitive benefits; and
- public relations benefits.

Regardless of the kinds of benefits identified, the goal is to determine which of the possible alternatives has the highest net benefits—absent any benefit resulting from GHG reductions (see Box 8.4)—and whether the project activity or any of the baseline candidates would be preferable, from the standpoint of decision-makers, to continuing current activities.

BOX 8.4 Excluding benefits resulting from GHG reductions

The baseline scenario is intended to represent what would have been most likely to occur absent any consideration of the project activity's potential for climate change mitigation. For this reason, any potential benefits resulting from GHG reductions are excluded from the assessment of benefits. For example, revenues generated from the sale of GHG reduction "credits" should be excluded from the assessment because they result from the GHG reductions. Similarly, research and demonstration benefits should be excluded if they directly relate to climate change mitigation. On the other hand, benefits that are associated with, but are not the direct result of GHG reductions should still be assessed. For example, there may be costs savings associated with measures that also happen to reduce GHG emissions. These savings should be assessed as benefits.

It is important to assess benefits only from the standpoint of those responsible for making the decision whether to implement the GHG project or activities associated with a particular alternative. For example, a GHG project may incidentally provide widespread benefits to a local community—e.g., by reducing local air pollution or providing supplemental income to local residents (say, from forestry products). These benefits, however, may not directly influence a decision to implement a project activity (assuming the community is not in charge of the decision). Rather, such benefits should be considered only to the extent that they translate into direct benefits for the decision-makers—i.e., the project developer—and thus contribute to a decision on whether to implement a project activity.

Benefits may be assessed qualitatively and quantitatively. Some types of benefits (e.g., public relations benefits) may be difficult or impossible to quantify, and should therefore be assessed qualitatively. A largely qualitative assessment (see Box 8.5) may be sufficient and appropriate if the relative net benefits of the GHG project and baseline candidates can be differentiated clearly enough to identify an unambiguous choice for the baseline scenario (i.e., after benefits are netted against identified barriers, in Step 3, below).

A matrix, such as the one in Table 8.3, can be used to present a ranking of the benefits of possible alternatives according to their relative magnitude. As with the identification of barriers, the final assessment and ranking may be qualitative rather than numerical, but should be based on substantiated assessments for each alternative.

Step 2: Comparing Benefits to Identified Barriers

The net benefits of each alternative can be determined by comparing benefits to identified barriers. Net benefits may be positive or negative. Negative net benefits could occur, for example, if implementing a baseline candidate would be expected to result in a financial loss, or would otherwise result in negative repercussions for decision-makers (e.g., adverse publicity). Alternatives may be excluded from further consideration if it is determined that the expected benefits would offer insufficient incentive for overcoming the identified barriers. Table 8.4 offers a sample matrix for assessing net benefits and screening out unviable alternatives. Some alternatives may have already been rejected at this point—e.g., if they faced insurmountable barriers.

BOX 8.5 Example of a qualitative benefits assessment

A GHG project that captures landfill gas (LFG) to generate electricity would have two project activities: (1) capturing methane that would otherwise be emitted; and (2) displacing GHG emissions from grid-connected electricity plants. The first project activity might have three baseline scenario alternatives: the project activity itself (i.e., capturing methane as part of an LFG-to-energy project); flaring the gas instead of using it for energy; and doing nothing (continuing current activities). Because flaring the gas would incur costs and generate no revenue, it would have negative net benefits. With some basic representative cost analysis and reference to natural gas prices, the project developer might be able to demonstrate that potential revenues from using the gas as a fuel would not cover the cost of installing electricity generation equipment—again resulting in negative financial benefits. Assuming there are no barriers to the continuation of current activities (e.g., no laws requiring LFG flaring), it could be convincingly demonstrated that "doing nothing" is the appropriate baseline scenario without the need for detailed quantitative financial analysis.

TABLE 8.3 Example of rough ranking of alternatives by magnitude of benefits

BASELINE SCENARIO ALTERNATIVES*	MAGNITUDE OF BENEFITS	RELATIVE RANKINGS
Project Activity	Small	Low
Baseline Candidate 1	Large	Highest
Baseline Candidate 2	Medium	Middle
Baseline Candidate 3	Zero	Lowest
Continuation of Current Activities	Small	Low

This table summarizes the results of a benefits assessment by ranking the baseline scenario alternatives according to the relative magnitude of their benefits. It is not necessary to distinguish the rank of every alternative (e.g., the Project Activity and Continuation of Current Activities are both ranked "Low") to identify the baseline scenario, it is only necessary to find the alternative with the greatest benefits relative to identified barriers.

*This assumes all alternatives did not face significant barriers.

TABLE 8.4 Example of assessing net benefits and screening out unviable alternatives

BASELINE SCENARIO ALTERNATIVES	BENEFITS	IDENTIFIED BARRIERS	NET BENEFITS
Project Activity	Small	Highest barriers	Large negative [Exclude]
Baseline Candidate 1	Large	Second-lowest barriers	Large positive
Baseline Candidate 2	Medium	Medium barriers	Zero
Baseline Candidate 3	Zero	Medium barriers	Negative [Exclude]
Continuation of Current Activities	Small	Lowest (no) barriers	Small positive

This table summarizes the comparison of benefits to identified barriers for each baseline scenario alternative. The resulting "net benefits" may be positive or negative. Negative net benefits could occur, for example, if implementing a baseline candidate would be expected to result in a financial loss, or would otherwise result in negative repercussions for decision-makers. Alternatives may be excluded from further consideration if it is determined that benefits would offer insufficient incentive for overcoming the identified barriers.

Comparing financial benefits and barriers (e.g., revenues and costs) is usually straightforward. In many cases, however, benefits will be "netted" against barriers qualitatively. Such analysis may be subjective and should be fully explained for the sake of transparency. If financial returns are a significant source of benefits for more than one alternative, it may be desirable for the sake of transparency and credibility to quantify net financial benefits using an investment analysis. Guidelines for conducting an investment analysis are provided in Annex C.

Step 3: Identifying the Baseline Scenario

Each possible alternative should be assessed with respect to how decision-makers would weigh benefits against perceived barriers. The baseline scenario will have the greatest net benefits relative to the disincentives presented by barriers. The alternative with the highest benefits will not necessarily be the baseline scenario if it faces more significant barriers than other alternatives. If all alternatives have negative net benefits, the alternative with the least negative net benefits should be identified as the baseline scenario. A table like Table 8.5 could be provided to summarize the analysis used to identify the baseline scenario. A full explanation of how the baseline scenario was identified should be provided for transparency.

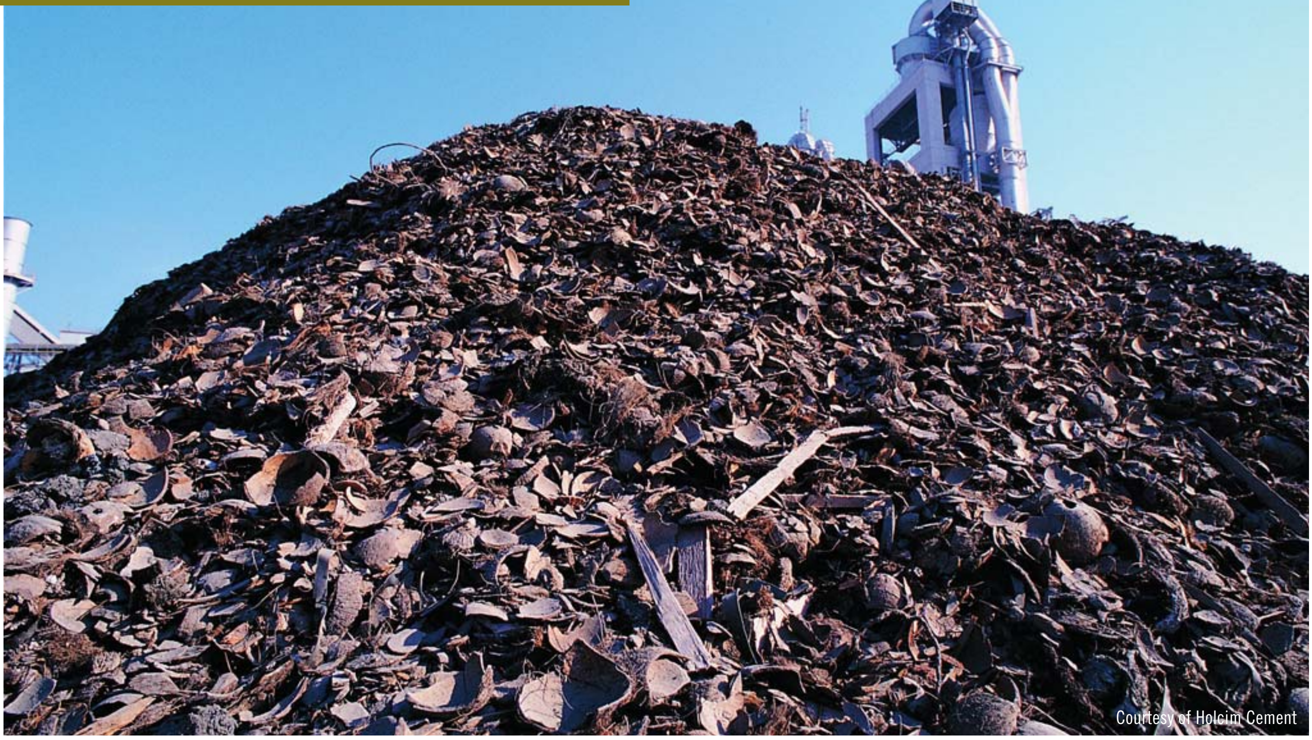
If making an unambiguous distinction between the net benefits of two or more alternatives is difficult, two options are available for identifying the baseline scenario:

- Undertake a more detailed assessment of the barriers and benefits to try to distinguish more clearly between the alternatives—provided the additional level of detail can be substantiated with available information.

TABLE 8.5 Sample summary of the net benefits assessment

BASELINE SCENARIO ALTERNATIVES	NET BENEFITS	CONCLUSIONS
Baseline Candidate 1	Large positive net benefits	Baseline scenario will involve implementation of Baseline Candidate 1
Continuation of Current Activities	Small positive net benefits	Viable, but not most attractive to decision-makers
Baseline Candidate 2	Zero net benefits	Least attractive viable alternative for decision-makers

This table summarizes the final results of the net benefits assessment and indicates the identified baseline scenario, in this case Baseline Candidate 1. The identified baseline scenario is the alternative with the highest net benefits.



- Choose the most conservative viable alternative—i.e., the one with the least GHG emissions or most GHG removals. Note that if the project activity remains as one of the viable alternatives, it will most likely be the most conservative alternative.

8.2.3 JUSTIFYING THE BASELINE SCENARIO

The baseline scenario may be justified using the analysis and documentation associated with the comparative assessment of barriers and, where undertaken, the net benefits assessment. In some cases, the baseline scenario will involve a baseline candidate that would have been implemented later than the project activity. In these cases, additional explanations and justifications for the timing of the baseline scenario should be provided (see Box 8.6).

In some cases, a final "reality check" involving a review of common practice will help strengthen the justification for the baseline scenario. This kind of reality check should involve three steps:

1. Listing all the baseline candidates identified as common practice in Chapter 7, section 7.6.
2. Indicating if the technologies or practices employed by the project activity are common practice, using the same analysis applied to the baseline candidates.
3. Explaining any instances where common practice technologies or practices were rejected from consideration as the baseline scenario. Explanations should be supported by evidence pertaining to the project activity's specific circumstances and discuss why decision-makers would not have implemented a common practice alternative in the baseline scenario.

BOX 8.6 Baseline scenarios that involve later implementation of a baseline candidate

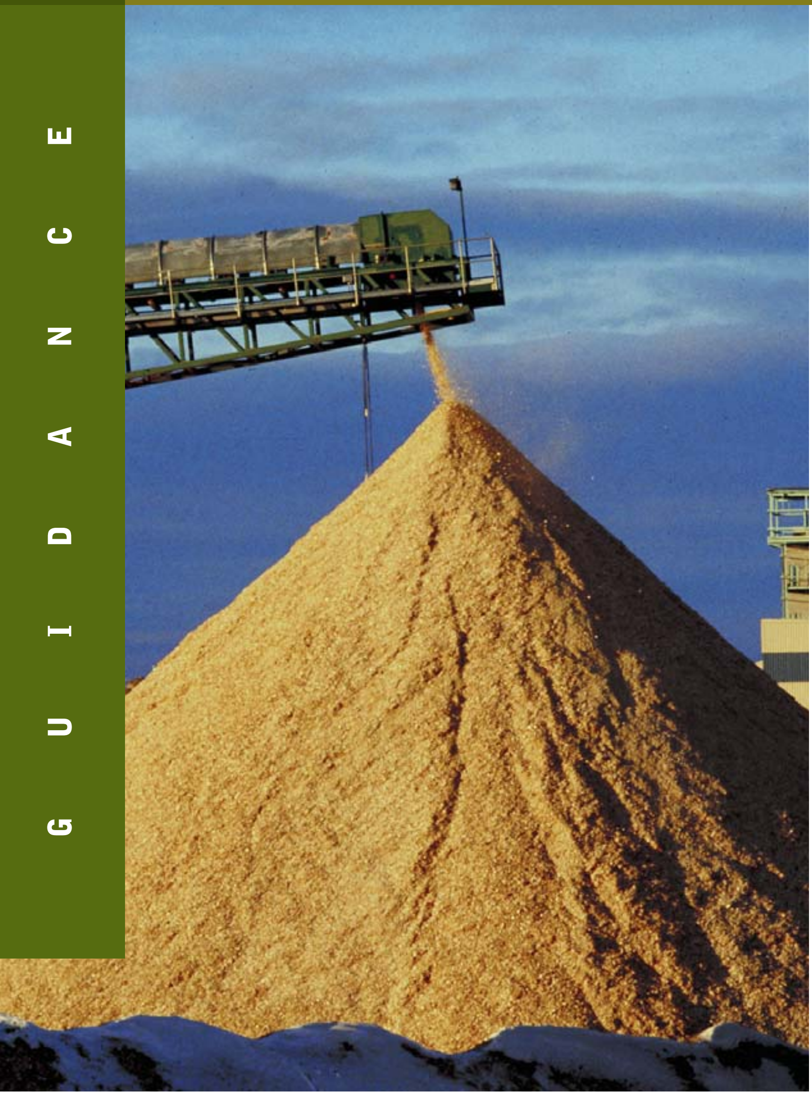
If the identified baseline scenario involves the implementation of a particular baseline candidate, the presumption is usually that the baseline candidate's implementation would have coincided with the project activity's implementation. In many cases, however, a particular baseline candidate could have been implemented significantly later than the onset of the GHG project (but still within the GHG project's lifetime). This might occur if:

- barriers to the baseline candidate are temporary,
- the baseline candidate would only be implemented after a barrier arises to the continuation of current activities, or
- the net benefits from implementing the baseline candidate are low in the near term but would increase substantially under future conditions.

If these kinds of circumstances are expected, they should be explained. In such circumstances, the identified baseline scenario will consist of:

- a period during which the baseline scenario involves the continuation of current activities, and
- a subsequent period during which the baseline scenario involves the implementation of a baseline candidate.

The length of time until a baseline candidate would have been implemented can depend on a variety of factors, including the type of technology or practice involved, economic trends or market conditions, and the nature of any barriers. Precise predictions about the timing of implementation may be difficult; for transparency, all assumptions and analyses should be explained.



8.3 Estimating Baseline Emissions

Baseline emission estimates for the project activity's primary effect should be derived from the types of technologies or practices represented in the baseline scenario. In most cases, it should be possible to specify a GHG emission rate for these technologies or practices, in the form of GHG emissions per unit of product or service (identified in Chapter 7, section 7.1). Total baseline emissions can then be calculated using the project activity's level of production of the product or service.[1] Box 8.7 provides guidance on how to estimate baseline emissions when the baseline scenario involves continuation of current activities. The GHG emission rate for the baseline scenario should be fully explained, and supporting assumptions and calculations should be documented.

Absolute baseline emissions should be estimated when it is difficult or inappropriate to specify a baseline GHG emission rate. This is generally the case for land-use and some fugitive emission project activities.

Box 8.8 provides guidance on estimating baseline emissions when the baseline scenario involves the later implementation of a baseline candidate.

BOX 8.7 Estimating baseline emissions when the baseline scenario involves the continuation of current activities

Baseline emissions from the continuation of current activities can be estimated differently, depending on the type of project activity.

- **Project Activities That Displace or Reduce Production from Other Sources.** For these project activities, baseline emissions are estimated from the GHG emission rates of existing sources whose production will be displaced or reduced. A common example is estimating the "operating margin" for grid electricity production, where electricity will either be displaced (e.g., energy supply projects) or reduced (e.g., end-use energy conservation projects). The method used to estimate GHG emissions from displaced existing sources should be fully explained.
- **Project Activities That Reduce the GHG Emission Rate of an Existing Process (Retrofit Projects).** For these project activities, baseline emissions from the continuation of current activities may be estimated as the historical GHG emission rate for the process or equipment that is being retrofitted.
- **Project Activities That Capture or Destroy Fugitive Emissions.** For these project activities, baseline emissions from the continuation of current activities may be estimated from historical emission rates at the GHG sources affected by the project activity. Where the project activity does not affect the underlying production of GHGs at these sources, baseline emissions will be equivalent to the amount of GHG emissions captured or destroyed by the project activity.
- **Project Activities That Remove or Store GHGs.** For these project activities, baseline emissions from the continuation of current activities will either be equivalent to GHG emissions sequestered by the project activity, or can be estimated using land-use trends or other projections related to GHG removal rates.

BOX 8.8 Estimating baseline emissions when the baseline scenario involves the later implementation of a baseline candidate

Where a baseline candidate is implemented later than the project activity, the baseline scenario will initially involve the continuation of current activities. In this situation, there are two options for estimating baseline emissions:

- Specify different baseline emission rates (or absolute baseline emission estimates) for different time periods. For example, identify a baseline emission rate for the continuation of current activities that will apply up until the baseline candidate is implemented. Then specify another baseline emission rate—derived for the baseline candidate—that will be used for the period after the baseline candidate's implementation.
- Specify a single, combined baseline emission rate for the valid time length of the baseline scenario (see Chapter 2, section 2.11). This generally involves weighting different baseline emission rates according to the length of time during which they will apply. For example, the baseline scenario may be valid for 10 years. The baseline scenario involves the continuation of current activities for three years, after which a baseline candidate will be implemented. In this case, the baseline emission rate can be calculated as 0.3 multiplied by the baseline emission rate for the continuation of current activities plus 0.7 multiplied by the baseline emission rate for the baseline candidate.

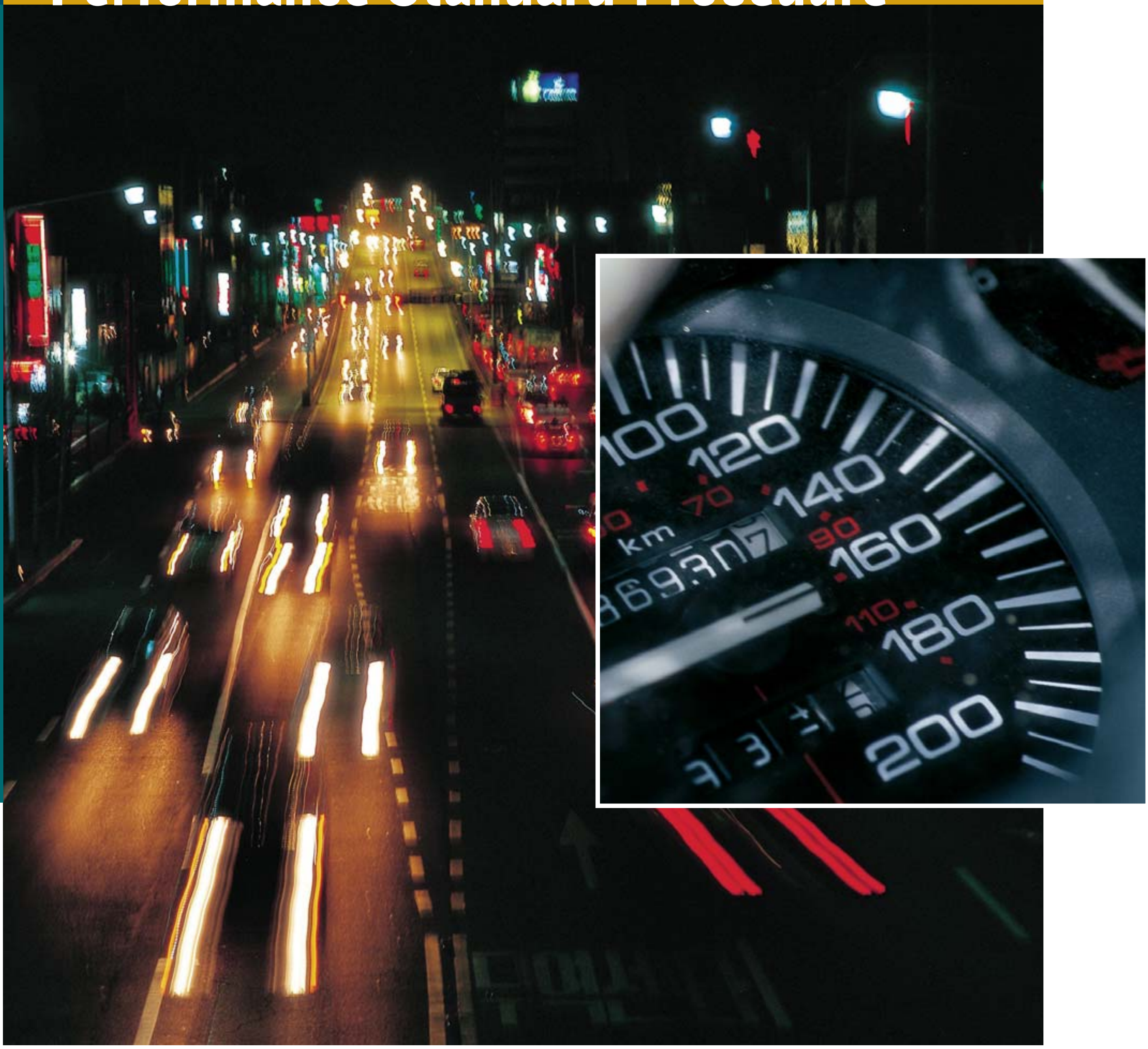
Gary Kramer, Natural Resources Conservation Service

NOTES

[1] Using the project activity's level of output to calculate baseline emissions assumes equivalence in output between the project activity and baseline scenario (see section 2.13). A different basis for calculating total baseline emissions may be necessary if the baseline scenario would not produce equivalent output.

9

Estimating Baseline Emissions—Performance Standard Procedure



The performance standard procedure analyses the GHG emission rates of all baseline candidates identified in Chapter 7 to construct a GHG emission performance standard against which project activity emissions can be compared. The performance standard is used to determine baseline emissions for the project activity's primary effect. Once a performance standard is developed, any number of similar project activities may be compared to it. A performance standard is periodically updated to reflect changing circumstances within the relevant geographic area or temporal range identified in Chapter 7.

The GHG emission rate for a performance standard can be expressed in different ways, depending on the type of project activity involved (see Table 9.1). For energy efficiency, energy generation, and industrial process project activities, a GHG performance standard will generally be defined as a rate of GHG emissions per unit of a product or service produced by all the baseline candidates. This type of performance standard is referred to as a production-based performance standard.

For project activities involving storage or removals of CO_2 by biological processes, fugitive emissions, or waste emissions—where there is no easily measured production of a product or service—the performance standard will usually be defined as a rate of GHG emissions (or removals) per unit of time and size or capacity of the baseline candidates. This type of performance standard is referred to as a time-based performance standard.

TABLE 9.1 Types of performance standard emission rates

TYPES OF PERFORMANCE STANDARDS	RELEVANT TYPES OF PROJECT ACTIVITIES	PERFORMANCE STANDARD EXPRESSED AS:
Production-Based	Energy efficiency, energy generation, and industrial processes	$\frac{\text{GHG Emissions}}{\text{Unit of Product or Service}}$
Time-Based	Waste and fugitive emissions and storage or removals of CO_2 by biological processes	$\frac{\text{GHG Emissions}}{\text{(Unit of Time)} \cdot \text{(Unit of Baseline Candidate Size or Capacity)}}$

The GHG emission rate for a performance standard can be expressed in different ways, depending on the type of project activity involved. For energy efficiency, energy generation, and industrial process project activities, a GHG performance standard will generally be defined as a rate of GHG emissions per unit of a product or service produced by all the baseline candidates. For project activities involving storage and removals of CO_2 by biological processes, fugitive emissions, or waste emissions—where there is no production of a product or service—the performance standard will usually be defined as a rate of GHG emissions (or removals) per unit of time and size or capacity of the baseline candidates.

Requirements

The steps outlined below shall be followed to derive a performance standard relevant to the type and location of the GHG project being proposed.

9.1 Specify appropriate performance metrics for all baseline candidates

Select and report an appropriate performance metric(s), depending on the type of project activity and the number of relevant inputs used by the baseline candidates.

9.1.1 PRODUCTION-BASED PERFORMANCE STANDARDS

For energy efficiency, energy generation, and industrial process project activities, a performance metric shall be identified for each set of baseline candidates that uses the same type of relevant input.

$$\text{Performance Metric} = \frac{I_c}{P}$$

Where:

- I_c = Units of a relevant input common to all baseline candidates of type c
- P = Units of a product or service, common to all baseline candidates, that depends on input I_c

Justify the choice of input, and product or service, for each identified performance metric. The product or service (denominator) shall be the same as that identified in Chapter 7, section 7.1.

Where a baseline candidate does not use any inputs related to the project activity's primary effect, a separate performance metric does not need to be identified and the GHG emission rate for the baseline candidate is zero.

9.1.2 TIME-BASED PERFORMANCE STANDARDS

For project activities involving storage and removals of CO_2 by biological processes, fugitive emissions, or waste emissions, a single performance metric shall be identified that relates GHG emissions to a specific length of time for each baseline candidate:

$$\text{Performance Metric} = \frac{E}{S \cdot t}$$

Where:

- E = Units of GHG emissions or removals
- S = Units of baseline candidate size or capacity
- t = Units of time

Justify why the type of units chosen for S and t are the most appropriate for developing a performance metric. Both the type of GHG emissions in the numerator and the type of units for the denominator shall be common to all baseline candidates.

9.2 Calculate the GHG emission rate for each baseline candidate

For each baseline candidate, calculate and report a GHG emission rate using the performance metric(s) selected above. Perform the following steps, depending on the type of performance standard being derived:

9.2.1 PRODUCTION-BASED PERFORMANCE STANDARDS

For each baseline candidate:

- Obtain the quantity of the relevant input required by the baseline candidate over a specified time period (in units of I_c, as identified in section 9.1.1). The time period used to gather the data shall be reported and justified and shall be comparable for all baseline candidates. Report and justify any discrepancies between the time periods used for different baseline candidates (e.g., different lengths or different periods of time).
- Obtain the quantity of product or service produced by the baseline candidate (in units of P, as specified in section 9.1.1) over the same time period that was used to measure the quantity of relevant input used.

- Convert the quantity of the relevant input to GHG emissions using an appropriate emission factor. Any and all emission factors shall be reported and justified.

Each baseline candidate shall have a GHG emission rate of the form:

- $\frac{\text{Quantity of GHG emissions}}{P}$

9.2.2 TIME-BASED PERFORMANCE STANDARDS

For each baseline candidate:

- Identify the size or capacity of the baseline candidate (in units of S, as specified in section 9.1.2).
- Obtain the quantity of the relevant GHG emissions (in units of E, as specified in section 9.1.2) produced by the baseline candidate over a specified time period (in units of t, as specified in section 9.1.2). Report and justify the time period and its length. Where GHG emissions data for a baseline candidate were collected during a period of time significantly different from other baseline candidates (e.g., during a different year), report and justify this discrepancy.

Each baseline candidate shall have a GHG emission rate in the form:

- $\frac{\text{Quantity of GHG emissions}}{S \cdot t}$

9.3 Calculate GHG emission rates for different stringency levels

Numerically analyse the GHG emission rates of all baseline candidates to calculate the GHG emission rates corresponding to the following stringency levels:

- Most stringent: The best-performing baseline candidate (i.e., the baseline candidate with the lowest GHG emission rate or highest GHG storage/removal rate).
- The weighted mean GHG emission rate.
- The median GHG emission rate (i.e., the 50th percentile, calculated in the same manner as other percentile calculations).
- At least two better-than-average GHG emission rates (e.g., the 25th and 10th percentiles).

The mean, median, and percentile GHG emission rates shall be calculated to reflect the relative contribution of each baseline candidate to total production (production-based performance standards) or to the aggregate size or capacity of all baseline candidates (time-based performance standards).

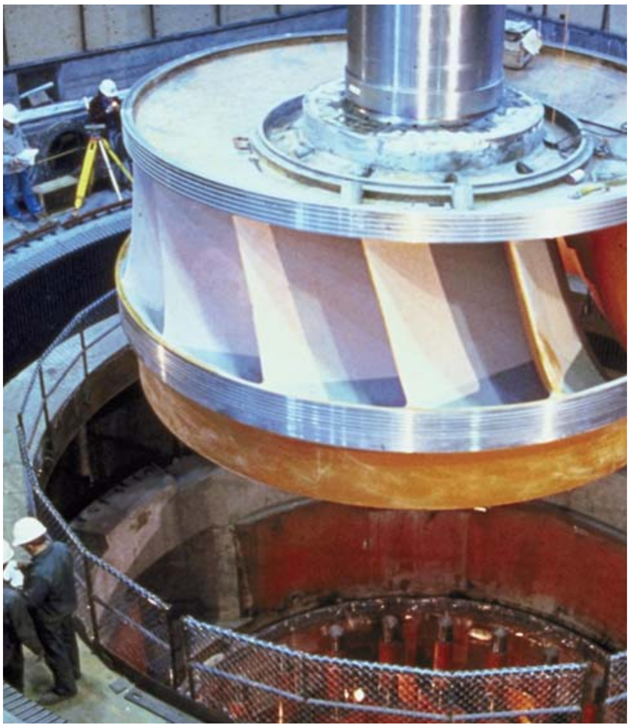
9.4 Select an appropriate stringency level for the performance standard

Choose the stringency level from those calculated in section 9.3 that is most appropriate for approximating baseline emissions. The GHG emission rate associated with this stringency level shall be the performance standard. Report the selected stringency level and associated performance standard and justify why it was chosen.

9.5 Estimate baseline emissions

For production-based performance standards, calculate baseline emissions by multiplying the level of production of the project activity (i.e., total units of product or service produced) by the performance standard emission rate.

For time-based performance standards, calculate baseline emissions by multiplying the relevant time period (e.g., one year) and the project activity size or capacity by the performance standard emission rate.



Guidance

GHG performance standards are derived from an analysis of the GHG emission rates of the baseline candidates identified in Chapter 7. Calculating GHG emission rates for the baseline candidates, however, requires identifying the processes that give rise to their GHG emissions. For production-based performance standards, baseline candidate GHG emissions generally arise (directly or indirectly) from the use of an input, or factor of production. GHG emissions for coal-burning power plants, for example, result directly from the combustion of coal needed to generate electricity. For time-based performance standards, baseline candidate GHG emissions arise from processes inherent to the land or equipment associated with the baseline candidates. GHG removals on agricultural lands, for example, typically arise from the carbon sequestration process in soils.

Therefore, the first step in deriving a performance standard is to identify appropriate performance metrics for the baseline candidates, connected to the processes that give rise to their GHG emissions.

9.1 Specifying the Appropriate Performance Metrics

This step involves identifying the units of measure that will be used to gauge the performance of baseline candidates. Actually measuring performance and converting this performance to a GHG emission rate for each baseline candidate is completed in section 9.2.

The performance metrics that need to be specified will depend on the type of performance standard being derived and the types of relevant inputs used by different baseline candidates. Table 9.2 provides some examples of different GHG projects and their possible performance metrics.

9.1.1 PRODUCTION-BASED PERFORMANCE STANDARDS

Numerous inputs are required to produce most products and services. A relevant input, however, is one that is related to the primary effect of the project activity (see Chapter 5)—i.e., to the intended change in GHG reductions caused by the project activity.

For example, producing plastic toys requires at least two major inputs that contribute to GHG emissions: electricity and plastic. A proposed GHG project might involve producing plastic toys using less electricity, with no change in the type or quantity of plastic. The GHG project would consist of a single project activity, whose primary effect would be to reduce combustion emissions from generating grid-connected electricity. Units of electricity (rather than units of plastic) per plastic toy would be used to specify the performance metric. Any change in GHG emissions from changes in plastic consumption required to make toys would be addressed as a secondary effect.

In some cases, baseline candidates may use inputs unrelated to a project activity's primary effect. For example, a project activity's primary effect may involve a reduction in combustion emissions from generating grid-connected electricity. However, some types of power plants (e.g., hydroelectric plants) do not produce combustion emissions. If one of the baseline candidates is a power plant that does not use fossil fuels as an input, specifying a performance metric for it is unnecessary and its GHG emission rate is zero.

When There Is Only a Single Relevant Input for All Baseline Candidates

In many cases, all baseline candidates use the same relevant input. If all baseline candidates use only one relevant input (e.g., electricity) to produce the product or service provided by the project activity, then only one performance metric needs to be identified.

For example, a refrigerator efficiency project activity's primary effect is reducing combustion emissions from generating grid-connected electricity. The only relevant input used by baseline candidates (i.e., alternative refrigeration technologies) is electricity. Thus, a single performance metric (e.g., kilowatt-hours per unit of cooling/refrigeration) would be appropriate for all baseline candidates.

When Baseline Candidates Use Multiple Relevant Inputs

If baseline candidates use a variety of relevant inputs (e.g., various types of fuel), then multiple performance metrics should be identified—one for each type of relevant input identified.

TABLE 9.2 Examples of performance metrics for different types of project activities

GHG PROJECT	PROJECT ACTIVITY	PRIMARY EFFECT	SAMPLE BASELINE CANDIDATES	POSSIBLE PERFORMANCE METRICS
PRODUCTION-BASED PERFORMANCE METRICS				
Wind Power Project	Generate grid-connected electricity from wind turbines	Reduction in combustion emissions from generating grid-connected electricity	Other electricity-generating technologies on the grid, such as fossil fuel or other renewable-energy technologies	• m^3 of gas consumed/kWh electricity generated • Tonnes coal/kWh electricity generated
Energy Efficiency Project	Improve energy efficiency of lighting by using energy-efficient light bulbs	Reduction in combustion emissions from generating grid-connected electricity	• Incandescent light bulbs • Compact fluorescent light bulbs • Halogen light bulbs	kWh electricity consumed/m^2 of lighted space
Transportation Fuel Switch Project	Change from fossil fuel to biofuel in buses	Reduction in combustion emissions from generating energy or off-grid electricity, or from flaring	• Diesel • Gasoline • Ethanol • Biodiesel • LNG	Litres of diesel fuel consumed/kilojoules of energy required for transportation
Industrial Fuel Switch Project	Fuel switch to natural gas at an off-grid stationary combustion plant	Reduction in combustion emissions from generating energy or off-grid electricity, or from flaring	• Other fossil fuels, such as coal or oil • Renewable energy sources	Tonnes of coal consumed/tonne of steam produced
TIME-BASED PERFORMANCE METRICS				
Afforestation Project	Change land-use to enhance carbon storage	Increased storage or removals of CO$_2$ by biological processes	• Continuation of current land-use • Cropland growing different food crops • Pastureland	Tonnes of CO$_2$eq sequestered/ha/yr
Forest Management Project	Change forest management to enhance carbon storage	Increased storage or removals of CO$_2$ by biological processes	• Continuing current forest management • Variations in forest management, such as increasing thinning or fertilisation	Tonnes of CO$_2$eq sequestered/ha/yr
Agricultural Tillage Project	Change tillage practices to enhance carbon storage	Increased storage or removals of CO$_2$ by biological processes	• Continuing current tillage practices • No-till or zero tillage • Mouldboard ploughing • Conventional tillage • Ridge tillage	Tonnes of CO$_2$eq sequestered/ha/yr
Landfill Gas (LFG) Project	a) Install equipment to capture methane b) Generate grid-connected electricity from captured methane	a) Reduction in waste emissions b) Reduction in combustion emissions from generating grid-connected electricity	a) • Continuation of current activity • Flaring of LFG • Use of LFG for fuel b) Other electricity-generating technologies on the grid, such as fossil fuel or renewable energy technologies	a) Tonnes of methane/m^3 landfill waste/month b) Tonnes coal/kWh electricity generated

For example, electricity can be produced using a variety of generation technologies that rely on different fuels. For a project activity whose product is electricity production, project developers should identify a series of performance metrics corresponding to all fuel types used by the baseline candidates (e.g., tonnes of coal per kilowatt-hour, cubic meters of natural gas per kilowatt-hour, etc.).

As another example, water heaters within a certain geographic area and temporal range may use either gas or electricity as a primary energy source. A project activity that involves reducing water heater energy consumption should be compared to a GHG performance standard derived from performance metrics for both gas and electric water heaters.

9.1.2 TIME-BASED PERFORMANCE STANDARDS

Performance metrics for time-based performance standards have three components: units of GHG emissions in the numerator, and units of time and size or capacity in the denominator. Units of time will often be years, but could be any other appropriate length of time. Appropriate units for size could include, for example, hectares of land, kilometres of natural gas pipeline, or tonnes of landfill waste. Units of capacity could include cubic meters of natural gas or potential throughput volume (e.g., for gas pipelines or compressor stations).

Where all baseline candidates are of the same size or capacity, then the "size" units could be expressed simply in terms of a single baseline candidate—e.g., a piece of equipment. The performance metric would then take the form of GHG emissions per specific length of time per piece of equipment.

9.2 Calculating the GHG Emission Rate for Each Baseline Candidate

This step involves measuring the performance of each baseline candidate using the appropriate performance metric, and calculating an associated GHG emission rate.

9.2.1 PRODUCTION-BASED PERFORMANCE STANDARDS

For production-based performance standards, the performance rate is converted to a GHG emission rate. For example, the performance of a power plant may be measured in terms of cubic meters of natural gas consumed per kilowatt-hour produced. This would then be converted to a GHG emission rate by calculating the amount of CO_2 emitted per cubic meter of natural gas consumed.

To measure performance, data should be collected for each baseline candidate. The appropriate time period over which input use and production data are collected to determine GHG emission rates varies by technology and depends on engineering variables, rates of production, and possible fluctuations in production efficiency, among other things. The time period should be sufficiently representative for the technology in question. For example, if the technology's production is cyclical, it is important that the entire cycle be considered when establishing input and production quantities. Similarly, if GHG emissions vary over the course of a baseline candidate's operation (e.g., between ramping up periods and steady operation), or are affected by certain environmental conditions, it is important to account for such variations.

The appropriate emission factor to use for converting units of relevant input to units of GHG emissions depends on whether consumption of the relevant input results in GHG emissions directly or indirectly.

For Relevant Inputs That Result Directly in GHG Emissions

For relevant inputs whose consumption directly results in GHG emissions, identifying the appropriate emission factor is usually straightforward. If the relevant input is a fossil fuel, for example, it can be converted to CO_2 emissions based on its carbon content and the conditions under which it was burned. Appropriate default emission factors for different fossil fuels are available from the Intergovernmental Panel on Climate Change (IPCC), the GHG Protocol calculation tools, and other sources. Alternatively, GHG emissions for each baseline candidate can be monitored directly, avoiding the need for an emission factor.

For Relevant Inputs That Result Indirectly in GHG Emissions

Some types of inputs cause GHG emissions indirectly during their production. These inputs may have different emission factors, depending on where and how they were produced. For example, if the relevant input for the baseline candidates is electricity, the GHG emissions

Britt Sandler, Program on Energy and Sustainable Development

arise from its generation rather than its consumption, and the appropriate emission factor will depend on where and how the electricity is generated. Electricity may cause zero emissions if it is produced by non-GHG-emitting generators, such as wind turbines, but may cause substantial emissions if it is produced by an inefficient coal plant.

Emission factors for electricity also differ based on locations and time periods. For these emission factors, it is important to consider where and how the relevant input would have been produced in the project activity's absence. There are two basic possibilities:

- The relevant input would have been produced at the same locations and in the same manner. In this case, the same emission factor is used for the baseline candidates as for the project activity. For example, an energy-efficient industrial motor installed at an existing factory will reduce combustion emissions from generating grid-connected electricity. The baseline candidates—consisting of various motor technologies—against which this project activity is compared are drawn from a geographic area encompassing several different countries. However, the project activity will reduce electricity consumption only from the local grid in the country where it is located. Any alternative to the project activity would have to be in the same location as the existing factory. Thus, the GHG emission rate for each baseline candidate should be calculated using an emission factor (converting kilowatt-hours to kilograms of CO_2) for the grid where the project activity is located—not where each baseline candidate is located.
- The relevant input would have been produced at different locations or from different sources. Different emission factors may be required for the same relevant input produced at different locations and used by different baseline candidates. For example, a proposed project activity involves constructing a new energy-efficient toy factory. Without the factory, the toys that it produces would have been provided by a combination of several other factories (baseline candidates) in six different countries. The GHG emission rate for each baseline candidate should be calculated using an electricity emission factor for the grid where each baseline candidate is located.

For baseline candidate GHG emission rates to be credible, transparency regarding their derivation is essential. For determining electric grid emission factors, users of this Protocol are also advised to consult the GHG Protocol guidance related to grid-connected electricity projects.

9.2.2 TIME-BASED PERFORMANCE STANDARDS

For time-based performance standards, calculating the GHG emission rate involves measuring GHG emissions for each baseline candidate over a certain time period, as well as noting the size or capacity of each baseline candidate. The length of time over which GHG emission data are collected to determine the rate should be comparable for each baseline candidate.

9.3 Calculating the GHG Emission Rate for Different Stringency Levels

The *stringency* of a GHG performance standard refers to how low its GHG emission rate (or how high its GHG removal rate) is relative to the GHG emission rates of all the baseline candidates. A *stringency level* is essentially a better-than-average GHG emission rate. Different stringency levels are identified and reported to enhance the transparency of the performance standard's derivation. Stringency levels may be specified as a GHG emission rate corresponding to a certain percentile (better than the 50th percentile) or to the lowest-emitting baseline candidate.

For all stringency levels other than the most stringent, GHG emission rates are derived using basic statistical measures (i.e., the mean and various percentiles). To prevent small baseline candidates from skewing the results, baseline candidate GHG emissions are weighted by size or contribution to total production.

The following procedures can be used to derive a GHG emission rate for each of the required stringency levels. (An example of the percentile calculations is also provided in Box 9.1).

Determining the most stringent stringency level

Identify the GHG emission rate of the best-performing baseline candidate—i.e., the baseline candidate with the lowest GHG emission rate, or highest GHG storage/removal rate.

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Calculating the size- or production-weighted mean GHG emission rate

Use the following formula:

$$\text{Weighted mean GHG emission rate} = \frac{\sum_{j=1}^{n} (ER_j \cdot Q_j)}{\sum_{j=1}^{n} Q_j}$$

Where:

- ER_j = GHG emission rate of baseline candidate j
- Q_j = quantity of product or service produced by baseline candidate j over a certain time period, e.g., one year (production-based performance standards) or the size or capacity of baseline candidate j (time-based performance standards)
- n = total number of baseline candidates.

The time period used to quantify production should be the same for all baseline candidates. However, this period does not need to coincide with the period used to determine each baseline candidate's GHG emission rate.

Determining the median GHG emission rate

Calculate the GHG emission rate corresponding to the 50th percentile, using the methods described below.

Calculating the GHG emission rate for a given percentile

Use the following approach:

a) For each baseline candidate using a particular relevant input (where calculating a production-based performance standard) or for each baseline candidate (where calculating a time-based performance standard):

   - Quantify total production over a certain time period (e.g., one year) or quantify its size or capacity.
   - Assign a GHG emission rate to each unit of product or service produced (e.g., each individual kilowatt-hour) by the baseline candidate over that time period or to each unit of the baseline candidate's size or capacity (e.g., each hectare).

b) Sort each unit of product or service produced (for all baseline candidates using a particular relevant input) or each unit of size or capacity (for all baseline candidates) by their assigned GHG emission rates, from lowest to highest. Label them so that x_1 is the smallest value, and x_a is the largest value, where:

- x_m is the GHG emission rate assigned to each unit, m, produced by a baseline candidate
- a is the aggregate number of items or units produced by all baseline candidates using a particular relevant input, or the aggregate units of size or capacity for all baseline candidates
- m is the rank of the unit produced with respect to its assigned GHG emission rate (each unit should have a distinct rank; assign ranks sequentially to each unit with the same GHG emission rate)

c) Calculate the GHG emission rate corresponding to a specific percentile (pc) between 0 and 100 by first calculating its approximate rank, w:

$$w = \frac{(a \cdot pc)}{100} + 0.5$$

Once w has been calculated, let g be the integer part of w, and f be the fraction part of w (e.g., if $w = 10.375$, then $g = 10$ and $f = 0.375$).

d) Calculate the emission rate (pe) of the chosen percentile (pc) using the following equation:

$$pe = (1 - f)\, x_g + f x_{g+1}$$

(Note: If the aggregate number of units produced, a, is large, x_g and x_{g+1} will rarely correspond to different GHG emission rates. In practice, this means that any given percentile is likely to correspond to the GHG emission rate of a specific baseline candidate).

Where the Baseline Candidates Have Multiple Relevant Inputs

- Calculate pe for each type of relevant input (i.e., repeat the above four steps for each relevant input).
- Calculate the production-weighted average of the percentile GHG emission rates using the following formula:

$$\text{Production-Weighted Average Percentile} = \frac{\sum_{i=1}^{n} (ER_i \cdot Q_i)}{\sum_{i=1}^{n} Q_i}$$

Where:

- ER_i = pe (i.e., the GHG emission rate at percentile pc) for relevant input i
- Q_i = quantity of product or service produced from all baseline candidates using relevant input i over a certain time period, e.g. one year (same as a, above)
- n = total number of relevant inputs

9.4 Selecting an Appropriate Stringency Level for the Performance Standard

The final step in deriving a GHG performance standard is to choose an appropriate stringency level. The GHG performance standard is the GHG emission rate corresponding to the appropriate stringency level.

An appropriate stringency level reasonably approximates baseline emissions for the type of project activity under consideration. What is reasonable depends on many considerations and ultimately depends on program policy decisions about additionality (see Chapter 3 and Box 9.2). Generally, an appropriate stringency level should reflect a performance rate that is better (lower-emitting or higher-removing) than the (weighted) mean GHG emission rate, taking into account trends in such factors as:

- regulatory requirements,
- recent and planned investments,
- technology penetration,
- policies or practices, and
- management regimes.

Note that for some technologies, a "best practice" or "best candidate" stringency level may be most

BOX 9.1 Sample calculation of specific percentiles

Consider a set of five baseline candidates representing different power plants, which all use the same fuel and had the following production levels and GHG emissions over the past year:

Baseline Candidates	1	2	3	4	5
Production (kWh)	2,500	1,000	5,000	10,000	4,000
GHG emission rate (kg C/kWh)	0.300	0.227	0.217	0.330	0.317

The most stringent stringency level is equal to the lowest GHG emission rate among the baseline candidates: 0.217 kg C/kWh.

The production-weighted mean GHG emission rate is calculated as:

$$\frac{(2{,}500 \cdot 0.300) + (1{,}000 \cdot 0.227) + (5{,}000 \cdot 0.217) + (10{,}000 \cdot 0.330) + (4{,}000 \cdot 0.317)}{(2{,}500 + 1{,}000 + 5{,}000 + 10{,}000 + 4{,}000)} = 0.295 \text{ kg C/kWh}$$

The median (50th percentile), 25th, and 10th percentile emission rates are calculated as follows:

- First, assign each kilowatt-hour produced by each power plant the emission rate of the power plant that produced it. For example, each kilowatt-hour produced by Baseline Candidate 1 would be assigned an emission rate of 0.300 kg C/kWh.
- Next, sort every kilowatt-hour by its emission rate from lowest to highest:

Rank, m, for each kWh	1–5,000	5,001–6,000	6,001–8,500	8,501–12,500	12,501–22,500
Assigned GHG emission rate, x_m	0.217	0.227	0.300	0.317	0.330

- To determine the median (50th percentile) GHG emission rate:

$$w = \frac{(22{,}500 \cdot 50)}{100} + 0.5 \qquad w = 11{,}250.5$$

Therefore, $g = 11{,}250$ and $f = 0.5$

$$pe = (1 - 0.5) \cdot 0.317 + 0.5 \cdot 0.317 = 0.317 \text{ kg C/kWh}$$

- To determine the 25th percentile GHG emission rate:

$$w = \frac{(22{,}500 \cdot 25)}{100} + 0.5 \qquad w = 5{,}625.5$$

Therefore, $g = 5{,}625$ and $f = 0.5$

$$pe = (1 - 0.5) \cdot 0.227 + 0.5 \cdot 0.227 = 0.227 \text{ kg C/kWh}$$

- To determine the 10th percentile GHG emission rate:

$$w = \frac{(22{,}500 \cdot 10)}{100} + 0.5 \qquad w = 2{,}250.5$$

Therefore, $g = 2{,}250$ and $f = 0.5$

$$pe = (1 - 0.5) \cdot 0.217 + 0.5 \cdot 0.217 = 0.217 \text{ kg C/kWh}$$

BOX 9.2 Performance standards, additionality, and GHG programs

The final selection of the stringency level for the performance standard is implicitly linked to considerations about additionality. The objective is to ensure that GHG reductions across multiple project activities are "additional" in aggregate, rather than to try to determine the additionality of any individual project. However, there is no "technically correct" stringency level for a performance standard. For GHG programs, part of the selection of a stringency level involves balancing the overall additionality of registered GHG reductions with program participation. High stringency levels tend to reduce the incidence of non-additional GHG reductions receiving credit, but at the same time may eliminate many projects from consideration, some of which might have been additional. Policy objectives will thus play a role in setting a performance standard.

Furthermore, in some instances GHG programs may decide that a performance standard by itself is insufficient to guarantee the level of environmental integrity they wish to achieve. Under some circumstances, even a very stringent performance standard might in practice allow more non-additional GHG reductions to be registered than additional GHG reductions. In some cases, therefore, performance standards may be combined with additionality tests to ensure that only project activities that are likely to be additional are considered for crediting. Such tests often take the form of basic eligibility criteria. Examples include:

- Making eligible only project activities that are not required by law.
- Making eligible only technologies of a certain type or subtype (e.g., those with low market penetration).
- Making eligible only project activities of a certain size.
- Making eligible only project activities that are explicitly designed to overcome certain barriers.

Finally, some GHG programs may decide to use a high stringency level to determine which projects are eligible for credit, and then a lower stringency level for calculating baseline emissions.

appropriate. This is generally the case where lower GHG emissions correlate with better economic performance and fewer implementation barriers (e.g., absent technical barriers and differences in capital costs, the most attractive boiler investments may also tend to be the most efficient in terms of fuel use and, therefore, the lowest emitting). Less demanding stringency levels may be appropriate where the best-performing candidates have higher costs or greater barriers to practical implementation (e.g., many types of end-use energy efficiency project activities), or where the baseline candidates represent planned rather than existing technologies.

Project developers should keep all of these considerations in mind when using the performance standard procedure. They should also carefully apply the principles of transparency, conservativeness, completeness, and relevance in deriving a performance standard.

9.5 Estimating Baseline Emissions

Once a performance standard is derived, calculating baseline emissions is, in most cases, simply a matter of multiplying project activity production levels by the performance standard GHG emission rate (for production-based performance standards), or project activity size or capacity and length of time by the performance standard GHG emission rate (for time-based performance standards). Exceptions to this will occur only where it is believed that baseline production levels would differ from project activity production levels (see the discussion in Chapter 2, section 2.13 on equivalence).


Hisham Zerriffi, Program on Energy and Sustainable Development

10 Monitoring and Quantifying GHG Reductions

Courtesy of Holcim Cement

This chapter provides requirements and guidance for monitoring GHG emissions related to each project activity's primary and secondary effects, and any parameters related to baseline emissions estimates. It also contains requirements and guidance for quantifying GHG reductions.

Requirements

10.1 Create a plan for monitoring GHG emissions and baseline parameters related to each project activity's GHG effects.

The monitoring plan shall contain provisions for:

- monitoring GHG emissions from all GHG sources and sinks related to primary and significant secondary effects within the GHG assessment boundary;
- monitoring any data related to assumptions underlying baseline emission estimates (i.e, baseline parameters); and
- describing data storage and quality assurance/quality control (QA/QC) measures.

10.1.1 MONITOR PROJECT ACTIVITY EMISSIONS

For each GHG source or sink related to a primary or significant secondary effect, the following shall be described in the monitoring plan:

- The data that will be monitored relating to GHG emissions.
- Whether the data are measured, modelled, calculated, or estimated; the level of uncertainty in any measurements or estimates; and how this uncertainty will be accounted for.
- Where relevant, the project activity operating conditions during periods when data are monitored.
- All measurement or other data collection methods used. Include all relevant assumptions, constants, mathematical relationships, and formulas.
- Technical information related to the collection of measurement data.
  - For technology-based projects this includes such information as the location and specifications of meters; procedures for meter reading, calibration, and maintenance; the length of measurement periods, etc.
  - For practice-based projects, this includes a description of equipment and methods used to gather data, control sites (if any), procedures for calibrating and maintaining equipment, etc.
- The frequency of monitoring activities.
- All sources of data and information.

Justify any instances where GHG emissions associated with a secondary effect are too costly to monitor and must therefore be estimated.

10.1.2 MONITOR BASELINE PARAMETERS

All baseline parameters shall be described in the monitoring plan, including:

- What data will be monitored and how they relate to baseline emission estimates for the primary and secondary effects.
- Whether the data are measured, modelled, calculated, or estimated; the level of uncertainty in any measurements or estimates; and how this uncertainty will be accounted for.
- All measurement or other data collection methods used. Include all relevant assumptions, constants, mathematical relationships, and formulas.
- Technical information related to the collection of measurement data.
- The frequency of monitoring activities.
- All sources of data and information.

10.1.3 DESCRIBE QA/QC MEASURES

How the GHG project data will be maintained and how QA/QC measures will be implemented shall be described in the monitoring plan and include the following information:

- Entity(ies) or person(s) responsible for measurement and data collection procedures.
- Length of time the data will be archived.
- Data transmission, storage, and backup procedures and strategies for identifying and managing lost or poor-quality data.
- All QA/QC procedures for measurement, calculation, and data collection procedures.

10.2 Quantify GHG reductions for the GHG project.

GHG reductions shall be quantified using the following steps.

10.2.1 IDENTIFY THE TIME PERIOD OVER WHICH GHG REDUCTIONS WILL BE QUANTIFIED.

- For each project activity and primary effect, identify and justify the valid time length for the corresponding baseline scenario or performance standard.
- Quantify GHG reductions for a period of time no longer than the shortest valid time length identified.

10.2.2 USING MONITORED DATA, QUANTIFY THE GHG REDUCTIONS FOR THE GHG PROJECT ON A PERIODIC BASIS—E.G., ANNUALLY.

- Quantify the project's GHG reductions as the sum of all primary effects and significant secondary effects for all project activities.
- Document the calculation methods used to quantify GHG reductions and any uncertainties associated with estimates of each project activity's GHG emissions.

Guidance

10.1 Creating a Monitoring Plan

Monitoring is the process of collecting the data used to quantify GHG reductions and to validate assumptions underlying the quantification. A monitoring plan is a working document that describes procedures for collecting data on project activity emissions, for collecting data related to baseline emission estimates, and for ensuring and controlling the quality of the collected data. The monitoring plan should be updated whenever the methodologies used to estimate, calculate, or measure project activity or baseline emissions are changed. Such changes should also be fully explained.

Every time GHG reductions are quantified and reported, the project developer should check:

a) The accuracy, completeness, and consistency of all monitored data.

b) The validity of any assumptions made during the project development phase regarding baseline emissions and project activity emissions. This requires analyzing collected data to verify that:

  - each project activity has been implemented and is performing as expected; and
  - any parameter values used to estimate the baseline emissions continue to be valid.

Monitoring should always be conducted in a way that allows a complete and transparent quantification of GHG reductions. In general, project developers should follow the GHG Accounting Principles (Chapter 4 and Box 10.1) when designing a GHG project monitoring plan.

10.1.1 MONITORING PROJECT ACTIVITY EMISSIONS

Monitoring GHG emissions (or removals) for the project activity can be achieved through:

- direct measurements of GHG emissions (e.g., measuring emissions from a smokestack); and
- indirect measurements of GHG emissions combined with calculations (e.g., calculating GHG emissions from fuel consumption data or calculating sequestered carbon from measured tree diameters).

BOX 10.1 Applying the GHG accounting principles to monitoring

Relevance: The levels of accuracy and uncertainty associated with monitoring methods should reflect the intended use of the data and the objectives of the GHG project; some intended uses may require more accuracy than others.

Completeness: All primary effects and all significant secondary effects should be monitored or estimated. All monitoring methods and data collection procedures should be fully documented.

Consistency: Methods used to monitor, check, and store data should be consistent over time to ensure comparability and verifiability.

Transparency: All monitoring methods, calculations, and associated uncertainties should be explained. Monitoring must be sufficient to allow the transparent quantification of GHG reductions.

Accuracy: Measurements, estimates, and calculations should be unbiased, and uncertainties reduced as far as practical. Calculations and measurements should be conducted in a manner that minimizes uncertainty.

Conservativeness: Where there are uncertainties in monitored data, the values used to quantify GHG reductions should err on the side of underestimating GHG reductions.

Both direct measurement and calculation-based approaches are subject to uncertainties (see Box 10.2). The relative accuracy of these approaches depends on the instruments used, the quality of the 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 explained. Where uncertainty is significant, lower and upper bounds or confidence intervals for all measurements should be identified. The project developer should be conservative and use data for quantification that reflect uncertainties and that will tend to underestimate GHG reductions.

The GHG sources or sinks that must be monitored can vary by size, location, and type, and monitoring methods can differ greatly in terms of cost. Choices will be required about how much analytical effort and monitoring resources to devote to each GHG source or sink. These choices may involve tradeoffs among cost, accuracy, and uncertainty. Available monitoring methods and their associated accuracies should be explained. If project developers use a less accurate method for monitoring a particular GHG source or sink, they should explain why this method was chosen.

In some cases, changes in GHG emissions associated with secondary effects may be small, even though they are significant. They may in turn be costly to monitor. As a general rule, the cost of monitoring should not exceed the value of the GHG emissions being monitored. The value of GHG emissions can be derived from a number of sources, including prices for tradable GHG allowances or credits. Where cost does exceed value, it may be prudent to estimate rather than monitor the GHG emissions associated with a secondary effect. All estimates of GHG emissions associated with a secondary effect should be explained.

10.1.2 MONITORING BASELINE PARAMETERS

In some cases, monitoring data indicative of baseline emissions can aid the credibility of quantifying GHG reductions. This will most often be the case where the project-specific procedure was used. There are two basic types of baseline parameters that can be monitored:

- **Baseline parameters that indicate the continued validity of certain assumptions.** For example, it may be necessary to monitor changes in regulations that would affect baseline emissions, or whether assumptions about the barriers considered in the project-specific procedure are still valid. If monitoring these parameters indicates that a key baseline assumption is no longer valid, then the

BOX 10.2 Understanding uncertainty

In general terms, uncertainties associated with GHG reductions can be categorized into "scientific uncertainty" and "estimation uncertainty." Scientific uncertainty arises when the science of the actual emissions and/or removal processes is not completely understood. Estimation uncertainty arises any time GHG emissions are monitored and quantified, and can be further divided into "model uncertainty" and "parameter uncertainty." Chapter 7 of the Corporate Accounting Standard addresses these particular types of uncertainty in further detail. In addition, an online uncertainty tool, available on the GHG Protocol Web site, provides useful information on uncertainty.

baseline scenario (or associated baseline emission estimates) should be reconsidered.

- **Baseline parameters that help determine baseline emission estimates.** Some baseline parameters are monitored to help calculate baseline emissions. For example, baseline parameters may be monitored prior to the implementation of a GHG project as a way to calibrate baseline emission estimates. If baseline emissions are estimated dynamically (see Chapter 2, section 2.12), baseline parameters may include emission factors or other variables that directly determine baseline emissions over time. For example, baseline emissions may be determined by an annually updated electricity GHG emission factor for project activities that displace grid-connected power plants.

10.1.3 DESCRIBING QA/QC MEASURES

QA/QC measures are necessary to ensure that data related to GHG emissions are reliable. QA/QC measures encompass a variety of activities, including site audits, central data control, site technician reminders, and maintaining service sheets. In general, QA/QC should focus primarily on data collection activities, and secondarily on data processing and storage. The credentials of any parties responsible for monitoring should be documented. In addition, for data quality assurance:

- ensure data have been properly entered into data templates, forms, or software; and
- assess calculation results to ensure data have been properly processed.

Chapter 7 of the Corporate Accounting Standard (on "Managing Inventory Quality") provides additional guidance that may be useful for QA/QC of monitored GHG emissions data from project activities.

10.2 Quantifying GHG Reductions

The final step in GHG project accounting is to quantify GHG reductions. Both *ex post* quantification and the *ex ante* estimation of GHG reductions can be performed using the same basic procedures. An *ex ante* estimate involves making predictions about the project activity's performance (and possibly how baseline emissions may change). *Ex post* quantification of GHG reductions uses actual monitored data once the GHG project has been implemented.

10.2.1 IDENTIFYING THE TIME PERIOD OVER WHICH GHG REDUCTIONS WILL BE QUANTIFIED

How long a baseline scenario or performance standard should remain valid for the purpose of quantifying GHG reductions will be subject to uncertainty (see Chapter 2, section 2.11). It may help to consider the following questions in justifying a time length:

- How quickly are economic conditions changing?
- How quickly are changes occurring in the technologies or practices providing the same product or service as the project activity?
- At what point are the criteria and assumptions used to identify the geographic area or temporal range for baseline candidates likely to change?
- When might the barriers (or net benefits) faced by the project activity or baseline candidates change significantly?
- If the project activity involves a retrofit, when would the retrofitted equipment have otherwise reached the end of its useful lifetime?
- Are baseline emission estimates static or dynamic?

Given the uncertainties involved, there will seldom be a single "right answer" to what the valid time length should be; the conservativeness principle should guide any justification. Alternatively, project developers may wish to use a standard valid time length prescribed by an existing GHG program (see Chapter 3 for a discussion of the policy aspects of this decision).

10.2.2 USING THE DATA TO QUANTIFY GHG REDUCTIONS

The following formulas should be used to quantify the GHG reductions for all GHG projects that involve changes in GHG emissions as the primary effect:

- **GHG Reduction**$_y$ (t CO_2eq) $= \Sigma_z$ Project Activity Reduction$_{zy}$

  Where:
  Project Activity Reduction$_{zy}$ $=$ Primary Effects$_{zy}$ $+$ Secondary Effects$_{zy}$

  Primary Effects$_{zy}$ $= \Sigma_p$ [Baseline Emissions$_{pzy}$ – Project Activity Emissions $_{pzy}$]

  Baseline Emissions$_{pzy}$ $=$ Baseline GHG emissions related to the primary effect, p, for each project activity, z, in year y (in t CO_2eq)

  Project Activity Emissions$_{pyz}$ $=$ GHG emissions related to primary effect, p, for each project activity, z, in year y (in t CO_2eq)

  Secondary Effects$_{zy}$ $= \Sigma_s$ [Baseline Emissions$_{szy}$ – Project Activity Emissions$_{szy}$]

  Baseline Emissions$_{szy}$ $=$ Baseline GHG emissions related to the secondary effect, s, for each project activity, z, in year y (in t CO_2eq)

  Project Activity Emissions$_{szy}$ $=$ GHG emissions related to secondary effect, s, for each project activity, z, in year y (in t CO_2eq)

The following formulas should be used to quantify the GHG reductions for all GHG projects involving biological GHG storage or removals as the primary effect:

- **GHG Reduction**$_y$ (t CO_2eq) = Σ_z Project Activity Reduction$_{zy}$

  Where:

  Project Activity Reduction$_{zy}$ = Primary Effect$_{zy}$ + Secondary Effects$_{zy}$

    Primary Effect$_{zy}$ (t CO_2eq) = Net Stocks$_{zy}$ $\cdot$ $\frac{44}{12}$ t CO_2/t carbon

      Net Stocks$_{zy}$ (t carbon) = Σ_p [Project Activity Carbon Stocks$_{pzy}$ – Baseline Carbon Stocks$_{pzy}$]

        Project Activity Carbon Stocks$_{pzy}$ = Σ_k carbon stocks from each biological carbon pool, k, related to each primary effect, p, for project activity, z, in year y (in t carbon)

        Baseline Carbon Stocks$_{pzy}$ = Σ_k baseline carbon stocks from each biological carbon pool, k, related to each primary effect, p, for project activity, z, in year y (in t carbon)

    Secondary Effects$_{zy}$ = Emissions Secondary Effects$_{zy}$ + Removals Secondary Effects$_{zy}$

      Emissions Secondary Effects$_{zy}$ = Σ_s [Baseline Emissions$_{szy}$ – Project Activity Emissions$_{szy}$]

        Baseline Emissions$_{szy}$ = Baseline GHG emissions related to the secondary effect, s, for each project activity, z, in year y (in t CO_2eq)

        Project Activity Emissions$_{szy}$ = GHG emissions related to secondary effect, s, for each project activity, z, in year y (in t CO_2eq)

      Removals Secondary Effects$_{zy}$ (t CO_2eq) = Net Stocks$_{zy}$ $\cdot$ $\frac{44}{12}$ t CO_2/t carbon

        Net Stocks$_{zy}$ (t carbon) = Σ_s[Project Activity Carbon Stocks$_{szy}$ – Baseline Carbon Stocks$_{szy}$]

          Project Activity Carbon Stocks$_{szy}$ = Σ_k carbon stocks from each biological carbon pool, k, related to each secondary effect, s, for project activity, z, in year y (in t carbon)

          Baseline Carbon Stocks$_{szy}$ = Σ_k baseline carbon stocks from each biological carbon pool, k, related to each secondary effect, s, for project activity, z, in year y (in t carbon)

Where GHG emission rates are used to quantify baseline and project activity emissions, use the following formulas:

- **Project Activity Emissions**$_y$ = (Production Level$_y$) $\cdot$ (Project Activity Emission Rate$_y$)
- **Baseline Emissions**$_y$ = (Production Level$_y$) $\cdot$ (Baseline Emission Rate$_y$)

  Where:

    Project Activity Emission Rate$_y$ = tonnes of CO_2eq per unit of production in year y for the project activity

    Baseline Emission Rate$_y$ = tonnes of CO_2eq per unit of production in year y specified for the project activity's baseline scenario or performance standard

    Production Level$_y$ = the amount produced in year y of the project activity's product or service (as defined in Chapter 7)

Where measuring the production level is not possible, a conservative estimate should be made. Unless there are exceptional circumstances (see discussion of "Equivalence" in Chapter 2, section 2.13), the production level used to estimate baseline emissions should be equivalent to the project activity's actual production level.

NOTE: The formulas above use annual values for project activity and baseline emissions as a default. Where there is significant sub-annual variability in project activity and baseline emissions, it may be more accurate to quantify GHG reductions more frequently than on an annual basis.

11 Reporting GHG Reductions

This chapter presents a list of the information that must be compiled and reported to ensure transparency and enable third-party reviewers to evaluate the quantification of GHG reductions for a GHG project. These are minimum reporting requirements and may be supplemented as necessary based on guidance contained in Chapters 5–10. Project developers should retain all data, assumptions, criteria, assessments, and explanations used to support reported information and should follow the principles of transparency and completeness in reporting GHG reductions.

Requirements

Project developers shall report the following information.

11.1 Description of the GHG Project

The following information describing the GHG project shall be reported:

- Name of the GHG project.
- Names and contact details of project developers, including any significant intermediaries.
- Reason for quantifying the GHG reductions and their anticipated use—e.g., internal company strategy, meeting targets in a voluntary or mandatory GHG program.
- Short description of the GHG project and of the products or services that its project activities will provide. Where relevant, describe the type of technology employed by the GHG project.
- If the GHG project is part of a larger initiative, a brief summary of the overall initiative, including any other GHG projects in this larger initiative.
- Geographic location. Indicate if the GHG project involves activities or effects in more than one political jurisdiction.
- Start date of the GHG project, and the date when GHG reductions are first generated.
- Expected operational life of the GHG project.
- The valid time length of the baseline scenario or performance standard for each project activity, and its justification.
- General market and regulatory conditions for the products or services provided by each project activity.

11. 2 The GHG Assessment Boundary

The GHG assessment boundary shall be reported, including:

- Each project activity associated with the GHG project.
- The primary effect(s) resulting from each project activity.
- All significant secondary effects resulting from each project activity.
- Justifications for excluding any secondary effects and why they are not significant.

11.3 Baseline Emissions for Each Project Activity and Primary Effect

The following shall be reported for each project activity and primary effect.

11.3.1 ALL IDENTIFIED BASELINE CANDIDATES

A list and description of identified baseline candidates shall be reported, along with:

- The product or service provided by the project activity and each baseline candidate.
- The rationale for the defined geographic area and temporal range used to identify baseline candidates.
- Any other criteria used to identify the baseline candidates.
- If the project-specific procedure is used to estimate baseline emissions, an identification of which baseline candidates represent common practice.

11.3.2 PROJECT-SPECIFIC BASELINE EMISSIONS ESTIMATE

If the project-specific procedure is used to estimate baseline emissions, the estimated baseline emission rate shall be reported, along with:

- An explanation for why the project-specific procedure was used to estimate baseline emissions.
- How baseline emissions were estimated, including all necessary information to show the project-specific procedure was carried out according to the require-

ments in Chapter 8. This shall include a description and justification of the identified baseline scenario.

11.3.3 PERFORMANCE STANDARD BASELINE EMISSIONS ESTIMATE

If the performance standard procedure is used, the estimated baseline emission rate shall be reported, including:

- An explanation for why the performance standard procedure was used to estimate baseline emissions.
- How the baseline emissions were estimated, including all necessary information to show the performance standard procedure was carried out according to the requirements in Chapter 9. This shall include:
  - The GHG emission rates for different stringency levels, including the most stringent level; the mean GHG emission rate; the median GHG emission rate; and at least two low-percentile GHG emission rates.
  - The selected stringency level for the performance standard, including a justification for why it is appropriate.

11.4 Estimated GHG Reductions for the GHG Project

Before implementing a GHG project, project developers shall report an estimate of annual and total GHG reductions expected to result from the GHG project over the time period for which GHG reductions will be quantified (see Chapter 10, section 10.2). They shall also report the calculation methods used to estimate and quantify GHG reductions and any uncertainties associated with the estimates of each project activity's GHG emissions.

11.5 Monitoring Plan

How all GHG sources or sinks within the GHG assessment boundary will be monitored once the GHG project is implemented shall be reported, including the following elements of the monitoring plan:

- The procedures for collecting data necessary to determine actual GHG emissions or removals for each project activity (and to evaluate whether assumptions concerning the project activity remain valid), as well as the frequency of monitoring related to each GHG source or sink and an assessments of data collected, e.g., reliability, etc.
- The procedures that will be followed to collect the data necessary to estimate (and update assumptions about) baseline emissions, as well as the frequency of monitoring related to each GHG source or sink and assessments of data associated with any collected data.
- The data collection and storage system, including:
  - Data report format, reporting frequency, and length of time records are archived.
  - Data transmission, storage, and backup procedures and strategies for identifying and coping with lost or poor-quality data.
  - Entity (or entities) responsible for measurement and data collection procedures.
- All QA/QC procedures to be implemented for measurement and data collection procedures—e.g., site audits, calibration, central data control, site technician reminders, maintenance procedures, service sheets.

11.6 Annual Monitoring and GHG Reduction Quantification Reports

An annual monitoring and quantification report shall be produced to confirm that the GHG project has been implemented as planned and to update or revise any assumptions. Any changes to the monitoring plan shall also be reported. The report shall contain a quantification of GHG reductions for the GHG project based on actual monitored GHG emissions data.

Part III

GHG Project Accounting Examples

EXAMPLE 1 **Cement Sector GHG Project**
Using the Project-Specific Baseline Procedure

EXAMPLE 2 **Compressor Station Efficiency Improvement GHG Project**
Using the Performance Standard Baseline Procedure

Cement Sector GHG Project Using the Project-Specific Baseline Procedure

This case study illustrates the application of Part II of the Project Protocol to a hypothetical GHG project, using the project-specific procedure to estimate baseline emissions. The numbering of the sections in this example corresponds to the numbering of the chapters in Part II of the Project Protocol. This case study is intended to be illustrative in nature; additional details or justifications may be needed for various sections for an actual project. The square brackets found throughout the text denote where additional explanations and justification may be required for actual GHG projects.

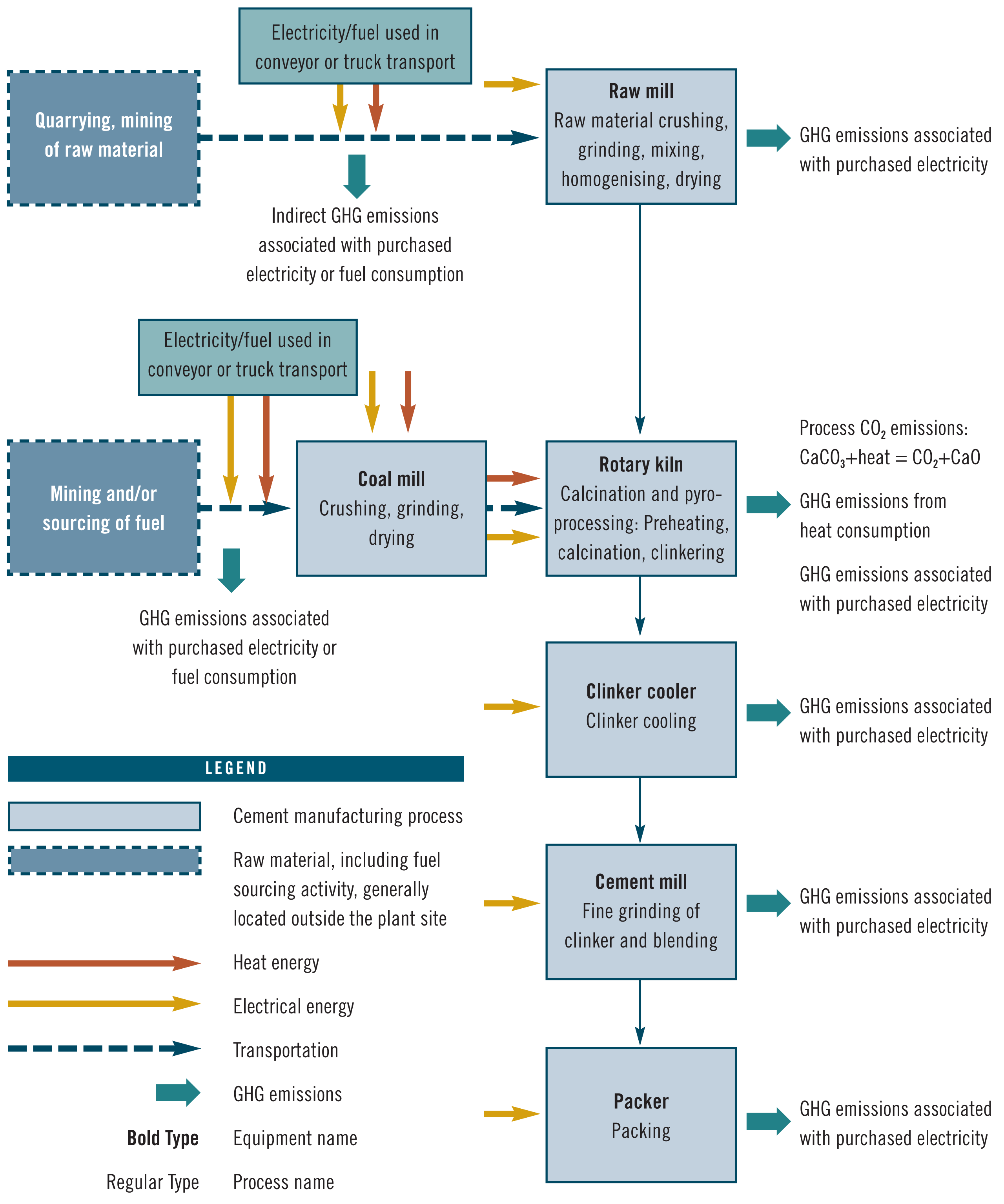
The GHG project presented here involves the reduction of GHG emissions associated with a cement manufacturing plant, owned by "Company X." This project is intended to reduce GHG emissions: (1) by reducing process GHG emissions associated with cement clinker production, and (2) by reducing GHG emissions associated with energy production and consumption.

Background and Overview of GHG Emissions from Cement Manufacturing

Portland cement is manufactured by a complex process of "burning" (pyro-processing) selected raw materials and then fine-grinding the resulting clinker. The process entails the conversion of a chemically designed and physically prepared raw material mixture into cement clinker. In Company X's facilities, this is done in a rotary kiln through the controlled combustion of coal.

Figure E1.1 illustrates a typical cement manufacturing process (dry process with rotary kiln), energy consumption, and the types of GHG emissions generated in a

FIGURE E1.1 **Flow diagram of cement manufacturing process (dry process with rotary kiln), with energy consumption points and types of GHG emissions generated in a cement facility**



cement facility. The raw materials—consisting of limestone, silica sand, clay, and other blending materials—are quarried and transported by either conveyor belt or truck, depending on the distance of raw material sources to the plant. Clinker raw materials, clay, limestone, and silica sand are crushed, ground, and homogenized prior to calcination and pyro-processing. Fuels, particularly those of solid form (coal or alternative fuels, such as waste tyres, municipal solid waste, and biofuels) are also ground and dried. The ground raw material is then preheated. The calcination of limestone and pyro-processing takes place by burning the fuel and preheated raw material at a very high temperature (above 2,000˚C) in the rotary kiln to form clinker nodules. The clinker nodules are cooled in the clinker cooler. In the cement mill, clinker is fine-ground and blended with additives to produce cement.

GHG emissions from cement manufacturing depend on the fuel mix, energy consumption, plant technology, and other variables, and are plant-specific. The two main GHG emission sources are:

- **Calcination/pyro-processing,** which is generally the largest source of GHG emissions. ($CaCO_3$+ heat => $CaO+CO_2$). The GHG emissions from this source are categorized as industrial process emissions, which can generate 50 percent or more of total cement manufacturing GHG emissions (OECD/IEA 2000).
- **Fuel burning in pyro-processing,** which requires flame temperatures above 2,000˚C and large quantities of fuels. Depending on the raw materials and the actual production process, a cement plant consumes fuel at a rate between 3,200 and 5,500 megajoules per tonne (MJ/t) of clinker.

GHG Project Description

The information in this section is intended to provide context for the GHG project. Some of this information is reported to meet the requirements in Chapter 11 of the Project Protocol. Additional information should also be reported when documenting and reporting an actual GHG project (see Chapter 11).

Company X has three manufacturing facilities in Indonesia producing ordinary Portland cement (OPC). Each facility is equipped with a cement kiln. The facilities are situated in different provinces on different islands—one in Kalimantan and two in West Java (see Figure E1.2).

Company X's proposed GHG project consists of two project activities:

- **Project Activity 1: Reducing clinker content in cement production by increasing material additives.** Currently, Company X produces OPC clinker with a clinker-to-cement ratio of 95 percent. Company X proposes to manufacture blended cement, which uses increased proportions of limestone and pozzolan additives in the fine-grinding process. The result is cement with a lower clinker fraction (81 percent) with a

FIGURE E1.2 Location of Company X's cement manufacturing facilities

strength comparable to that of OPC. Lowering the clinker-to-cement ratio reduces both process emissions and associated fuel-related GHG emissions.

The pozzolanic additives used include coal fly ash and volcanic ash (trass). The use of these materials will require investment in new equipment to improve clinker quality. With its existing equipment, Company X can only slightly reduce its clinker-to-cement ratio (from 95 percent to 91 percent).

- **Project Activity 2: Switching fuels from coal to biofuels (palm kernel and rice husk) in kiln burning.** All of Company X's cement kilns use coal as fuel for clinker burning. Company X intends to replace a portion of the coal with biofuels found near its plants, and consequently to reduce GHG emissions.

Chapter 5: Defining the GHG Assessment Boundary

5.1 IDENTIFYING PROJECT ACTIVITIES

This GHG project consists of two project activities—reducing clinker content and switching fuels.

5.2 & 5.3 IDENTIFYING PRIMARY EFFECTS AND CONSIDERING ALL SECONDARY EFFECTS

The primary effects and possible secondary effects associated with each project activity are listed below in section 5.4 & 5.5 along with an estimation of their magnitude and assessment of significance for the secondary effects. [For many GHG projects it will make sense to list these separately.]

5.4 & 5.5 ESTIMATING THE RELATIVE MAGNITUDE AND ASSESSING THE SIGNIFICANCE OF SECONDARY EFFECTS

Project Activity 1: Reducing Clinker Content

This project activity reduces GHG emissions in two ways, both of which are related to the reduced amount of clinker required to produce cement. The activity therefore has two primary effects:

- Reduction in industrial process emissions from the calcination process.
- Reduction in combustion emissions from generating energy for pyro-processing.

Possible secondary effects and their magnitude and significance include:

- Reduction in combustion emissions from reduced electricity use during the clinker production process (e.g., in the operation of the rotary kiln, raw material grinding, and fuel preparation). This positive secondary effect is smaller than the two primary effects. In the interest of being conservative, it will not be included in the GHG assessment boundary.
- Reduction in combustion emissions from the reduced transport and preparation of raw materials. This positive secondary effect is expected to be small. As a conservative measure, it will be excluded from the GHG assessment boundary.
- Increased combustion emissions from the transportation of additives (e.g., fly ash and trass) to the plant site. The increase in GHG emissions is expected to be small compared to the primary effects (less than one percent). Because this secondary effect will be counterbalanced by GHG reductions from the reduced transport and preparation of the raw materials, it is considered insignificant and will not be included in the GHG assessment boundary.
- Increased combustion emissions from additional electricity required for the preparation of additive materials. The increase in GHG emissions is expected to be small compared to the primary effects (less than half a percent). Because this secondary effect is counterbalanced by the reduction in GHG emissions from reduced electricity use in clinker production and is not expected to change over time, it is considered insignificant and will not be included in the GHG assessment boundary.
- Possible increase in GHG emissions at other cement companies, who also use fly ash and trass. This could result from the decreased availability of these inputs because of Company X's GHG project (i.e., a market response). A feasibility study on the availability of

additive materials suggests that these additive materials are abundant. Thus, this market response is considered insignificant.

Project Activity 2: Switching Fuels

This project activity is intended to reduce combustion emissions by substituting coal with biofuels. Coal is used to produce heat energy in the clinker kilns.

The project activity's primary effect is the reduction in combustion emissions from generating energy, due to the switch from coal to biofuels. Possible secondary effects include:

- Increased combustion emissions associated with the transportation of biofuels.
- Reduced combustion emissions associated with the transportation of coal.
- Reduced waste emissions due to less waste materials being burned or anaerobically decomposing in landfills (the biofuel would have otherwise been disposed of in landfills).
- Reduced combustion emissions from using less electricity for coal preparation.
- Possible increase in combustion emissions from generating energy caused by the reduced availability of biofuels (i.e., a market response).

A preliminary estimation indicates that the reduced GHG emissions associated with the second, third, and fourth secondary effects listed above are greater than the increased GHG emissions from the transportation of biofuels (the first secondary effect). Although the effects yield a further 4 percent reduction in GHG emissions for this project activity, they have been excluded from the GHG assessment boundary as a conservative measure.

Regarding the last secondary effect, other users of rice husks and palm kernels may need to increase their consumption of fossil fuels to generate energy, thereby increasing GHG emissions. However, preliminary research indicates that rice husks and palm kernel shells are available in abundance. Based on current demand, the supply of these materials is approximately 1.5 times greater than the expected demand. Therefore, this secondary effect is considered insignificant and is excluded from the GHG assessment boundary.

Chapter 6: Selecting a Baseline Procedure

The project-specific procedure was chosen to estimate baseline emissions for both project activities. The project-specific procedure was preferred over a performance standard approach because of difficulties in obtaining performance data on individual cement kilns in Indonesia. Further, the total number of comparable cement kilns in Indonesia is small, making it difficult to develop a robust statistical performance standard.

Chapter 7: Identifying the Baseline Candidates

For the project-specific procedure, the baseline candidates identified include representative types of plants, technologies, or practices that produce the same product or service as the project activities within a specified geographic area and temporal range.

7.1 DEFINING THE PRODUCT OR SERVICE PROVIDED BY THE PROJECT ACTIVITY

The primary characteristic of the baseline candidates is that they must provide the same or similar products or services as those provided by the two project activities.

- For Project Activity 1, the product is cement that is equally as strong as OPC.
- For Project Activity 2, the product is heat energy for kiln burning to create clinker.

7.2 IDENTIFYING POSSIBLE TYPES OF BASELINE CANDIDATES

Project Activity 1: Reducing Clinker Content

Two materials that can be used to replace clinker in cement production are trass and fly ash. Trass is a fine, sandy, volcanic ash that is abundant in volcanic regions of the country. To avoid prohibitive transport costs, trass deposits that are close to the plants are used. In West Java, trass is found in Cianjur and Nagrek, and in Tasikmalaya, which is near the X1 and X2 plants. Trass is currently mostly used for small-scale, light brick-making projects.

Fly ash is produced in large quantities in Indonesia as a waste product of electricity generation from coal. Coal is the preferred national energy generation source because of

Indonesia's large coal reserves. The Indonesian Hazardous Waste Regulation (PP No. 18/1999) classifies fly ash from power plants as hazardous waste, affecting the availability of its beneficial use. Exemption to this classification can be granted if fly ash successfully passes Toxic Characteristic Leaching Procedure (TLCP) and Lethal Dosis (LD) 50 tests.

Based on this information and the questions outlined in Chapter 7, section 7.2 of the Project Protocol, the range of technical options that could produce cement with strength equal to that of OPC include:

- Production of current OPC cement with a clinker-to-cement ratio of 95 percent.
- Production of OPC with a lower clinker-to-cement ratio (e.g., 91 percent). Existing technologies allow an increase of additives of up to 4 percent to produce this type of OPC.
- Production of Portland Pozzolan Cement (PPC). PPC is another type of cement with a lower clinker-to-cement ratio than that of the OPC. However, the strength of PPC develops more slowly than OPC and generates less heat during the curing process. The additive used in PPC is mainly trass.
- Production of OPC with new equipment to achieve an 81 percent clinker-to-cement ratio (as proposed for project activity 1).

Project Activity 2: Switching Fuels

A range of possible fuels could be used to provide energy for producing clinker. These include:

- Coal.
- Natural gas.
- Industrial diesel oil.
- Non-renewable resources, such as waste tyres, waste oil, and hazardous waste. However, continuous streams of these resources are not found in Indonesia. There is no regulation that requires the reuse or recycling of hazardous waste, such as burning of hazardous wastes in cement kilns. (Waste fuels may also have negative side effects in terms of dioxin and other pollutant emissions).
- Renewable energy fuels, such as biomass (which could partly replace coal or other fuels, as proposed for Project Activity 2).

7.3 DEFINING THE GEOGRAPHIC AREA AND TEMPORAL RANGE

7.3.1 DEFINING THE GEOGRAPHIC AREA

Project Activity 1: Reducing Clinker Content

The geographic area defined was Indonesia because:

- The principal market for cement produced by Company X is Indonesia, and the cement produced must comply with the national standard SNI 15-3500-1994.
- Company X's facilities are located in different areas in Indonesia: two plants are located in West Java within one province, the other is located on Kalimantan in South Kalimantan province.

- Cement manufacturing facilities need to be located close to the source of demand. Cement produced in Kalimantan mostly serves Kalimantan and Sulawesi (the island next to Kalimantan) customers, while the facilities in Java mostly serve customers in Java.

Project Activity 2: Switching Fuels

The geographic area defined was Indonesia because:

- Only dry-process kilns are currently operating in Indonesia. In a larger geographic area (e.g., Southeast Asia), different types of kilns are operating. For example, in the Philippines, dry-process cement kilns make up about 51 percent of overall capacity, while the rest is wet-process cement kilns (Mohanty 1997).
- All fuel is obtained domestically, and fuel prices for each type of fuel are uniform within the country. Different fuel prices in different countries in the Southeast Asia regions make a larger regional geographic area inappropriate.
- Some cement companies in Indonesia have manufacturing facilities in different provinces, including Company X. This makes the smaller provincial level inappropriate because the sourcing of fuel may differ from one province to another.

7.3.2 DEFINING THE TEMPORAL RANGE

Project Activity 1: Reducing Clinker Content

The temporal range chosen was from 1997 to the present. The beginning of this time period coincides with the Asian economic crisis, providing a discrete break point where cement technology changed. A majority of the wet kilns were shut down at this point, and when the market recovered, a number of new dry kiln plants were constructed to meet the growing demand.

Project Activity 2: Switching Fuels

The temporal range chosen was from 1997 to the present, for reasons similar to those for Project Activity 1. Cuts in fuel subsidies have been imposed as part of the IMF Financial Package granted to Indonesia to support recovery from the Asian economic crisis in 1997. This measure was expected to raise general energy efficiency awareness and bring about fuel switching to renewable energy. However, reducing fuel subsidies is unpopular, and in the past has caused civil unrest, so the fuel subsidies still exist.

7.4 DEFINING OTHER CRITERIA USED TO IDENTIFY BASELINE CANDIDATES

Project Activity 1: Reducing Clinker Content

Blended cement is classified under the Indonesian standard SNI 15-3500-1994 (Semen Campur). Following this standard, blended cement may contain various additives (artificial and natural trass, limestone, and others) at unspecified proportions. Therefore, legal requirements are not relevant, and no other criteria were identified.

Project Activity 2: Switching Fuels

Indonesia has no stated legal requirements with respect to fuels used in clinker burning, and no other criteria were identified to define baseline candidates.

7.5 IDENTIFYING THE FINAL LIST OF BASELINE CANDIDATES

Based on the necessary characteristics and the defined geographic area and temporal range, the final list of baseline candidates for each project activity is as follows.

Project Activity 1: Reducing Clinker Content

- Baseline Candidate 1: Continuation of current activities—production of OPC with a clinker-to-cement ratio of 95 percent. This candidate also reflects the average Indonesian clinker-to-cement ratio content.
- Baseline Candidate 2: Production of OPC with a lower clinker-to-cement ratio (91 percent). International and Indonesian cement standards allow OPC to be produced with additive materials in addition to gypsum. Company X can produce OPC with a clinker-to-cement ratio of 91 percent without significant additional equipment or other investment. This baseline candidate is considered to be a "safe" business measure where investment risks are negligible.
- Baseline Candidate 3: Production of OPC with new equipment to achieve an 81 percent clinker-to-cement ratio. This baseline candidate is identical to Project Activity 1, and so will be referred to as Project Activity 1 in the rest of the example.

The production of PPC is eliminated from the list of baseline candidates because it does not provide similar types of product characteristics. Although the final strength is comparable to that of OPC (420 kg/cm^2), the strength of PPC develops more slowly than that of OPC and generates less heat during the curing process.

TABLE E1.1 Indonesian market share for different types of cement (percent)

TYPE OF CEMENT	1999	2000	2001	2002
OPC	74.8	77.2	77.7	81.9
PPC + Masonry	25.2	22.8	22.3	18.1
Blended	0	0	0	0

Source: Indonesia Cement Association, 2002 and laboratory tests on OPC cement from each cement manufacturing plant where published data were unavailable.

Project Activity 2: Switching Fuels

- Baseline Candidate 1: Continuation of current activities—using coal as the primary fuel for clinker burning. Coal is readily available and is the cheapest fuel for clinker burning.

- Baseline Candidate 2: Replacement of coal with natural gas. Natural gas is available, and Company X's manufacturing facility is equipped with a gas pipeline and gas burner. Prior to 1997, some kilns belonging to Company X used natural gas for clinker burning, as the cost was comparable to the cost of coal. Since the economic downturn in 1997, however, the natural gas price has been about 25 percent higher than that of coal.

- Baseline Candidate 3: Replacement of coal with fuel oil. Oil (diesel oil or fuel oil) supply is available for continuous use. Almost all kilns in the Indonesian cement industry are equipped with oil burners. The price of fuel oil is about twice that of coal.

- Baseline Candidate 4: Replacement of coal with renewable energy fuels, such as biomass. This baseline candidate is identical to Project Activity 2, and so will be referred to as Project Activity 2 in the rest of the example.

Replacement of coal with such non-renewable resources as waste tyres, waste oil, and hazardous waste is eliminated as a baseline candidate, since a continuous stream of these sources is not available in Indonesia.

7.6 IDENTIFYING BASELINE CANDIDATES THAT REPRESENT COMMON PRACTICE

Project Activity 1: Reducing Clinker Content

All cement manufacturing in Indonesia uses a dry process (i.e., rotary kilns and pre-heaters). There is no significant difference in the production systems from one cement company to another. The cement used in Indonesia is dominated by high-quality OPC with a 28-day strength of about 420 kg/cm^2. Current practice focuses on the production of OPC with a clinker-to-cement ratio of 95 percent. The market share of OPC in Indonesia is about 82 percent, whereas the market share of the PPC and masonry cement accounts for about 18 percent (see Table E1.1).

Table E1.1 indicates that the production of OPC (95 percent clinker-to-cement ratio) is common practice. In 1996 Company X introduced blended cement "R." Production was discontinued in 1998 due to lack of acceptance by the market. The blended cement "R" was of a slightly lower quality than OPC, and many customers were not satisfied with its performance. Since then, no other cement companies have attempted to produce blended cement.

Project Activity 2: Switching Fuels

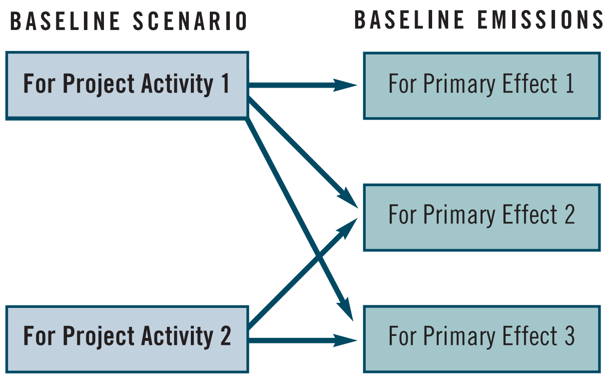
Clinker burning in Indonesia is based almost entirely on coal. Coal is locally available in abundance at a competitive price. There is no significant difference in the production systems or fuel usage from one cement company to another. Coal is identified as the common practice fuel.

Chapter 8: Estimating Baseline Emissions—Project-Specific Procedure

The project-specific procedure estimates baseline emissions by identifying a baseline scenario for each project activity. The list of possible alternatives for each project activity—the baseline candidates—is evaluated using a comparative assessment of barriers.

This GHG project consists of two project activities with a total of three primary effects and the baseline scenarios for these primary effects are interrelated. Project

FIGURE E1.3 How baseline emissions for each primary effect are derived from the project activity baseline scenarios



Primary Effects 1 and 2 are the primary effects associated with Project Activity 1. Primary Effect 3 is the primary effect associated with Project Activity 2.

Activity 1 has two primary effects: (1) reduction in industrial process emissions resulting from reduced clinker in the calcination process, and (2) reduction in combustion emissions from generating energy for pyro- processing resulting from reduced clinker in the calcination process. The baseline scenario identified for Project Activity 1 will be used to estimate baseline emissions for all primary effects. Baseline emissions for the second primary effect will also depend on the type of fuel used to produce heat energy, which is determined by the baseline scenario for Project Activity 2. Finally, baseline emissions for Primary Effect 3 will in part depend on the clinker content of cement.

In sum, two baseline scenarios are identified for the GHG project, and these are used in combination to estimate the baseline emissions for the three primary effects (see Figure E1.3 and descriptions in Table E1.2).

The remainder of this section is organised so that all the information pertaining to the two project activities is kept together.

8.1A PERFORMING A COMPARATIVE ASSESSMENT OF BARRIERS: Project Activity 1—Reducing Clinker Content

The possible alternatives for the baseline scenario include:

- Implementation of the same technologies as those involved in Project Activity 1 (i.e., 81 percent clinker content).
- Baseline Candidate 1: Continuation of current activities (i.e., continued production of OPC cement with a clinker-to-cement ratio of 95 percent).
- Baseline Candidate 2: Production of OPC with a lower clinker-to-cement ratio (91 percent).

TABLE E1.2 How baseline emission estimates are derived

PRIMARY EFFECT	BASELINE SCENARIO ANALYSIS USED	ESTIMATE OF BASELINE EMISSIONS
Project Activity 1: Reduction in process emissions	Clinker composition used in cement production	Baseline emissions derived from the percentage of clinker used in cement production
Project Activity 1: Reduction in combustion emissions from generating energy	a) Clinker composition used in cement production (which determines the amount of heat required); and b) Type of fuel used to produce heat energy	Combustion emissions derived from the amount of heat required to produce the clinker and an emission factor for the type of fuel used to produce heat
Project Activity 2: Reduction in combustion emissions from generating energy	Type of fuel used to produce heat energy	Combustion emissions derived from the amount of heat required to produce the clinker* and an emission factor for the type of fuel used to produce heat

*For the baseline emissions of Primary Effect 3, the clinker composition is assumed to be 81 percent, premised on the implementation of Project Activity 1. See the Monitoring and Quantification analysis (related to Chapter 10, below) for a full description of how baseline emissions and GHG reductions are estimated and quantified.

8.1A.1 IDENTIFYING BARRIERS TO THE PROJECT ACTIVITY AND BASELINE CANDIDATES

Based on the barrier categories in Table 8.1 (in Chapter 8 of the Project Protocol), the following barriers were identified:

Financial and Budgetary Barriers

There are two types of barriers in this category: investment risk and high cost.

Investment Risk: Country risk and uncertain economic growth will hinder investment in any industrial sector, including the cement industry. Five years after the 1997 economic crisis, Indonesia began to experience a slow economic recovery. Some economic indicators, such as export and import shares, show signs of improvement. The country's position in terms of international competitiveness, legal certainty, and general level of risk for investment remains unfavourable for foreign investors.

The *2002 World Investment Report* by the United Nations Conference on Trade and Development (UNCTAD) ranked Indonesia 138 out of 146 countries surveyed for Foreign Direct Investment (FDI) performance between 1998 and 2000. Moreover, between 1998 and 2000 Indonesia's FDI index value was -0.6, meaning that Indonesia did not have a favourable investment environment. The situation is exacerbated by safety concerns associated with terrorist attacks to several businesses and continuing conflicts in some regions, such as in Aceh and Papua. The International Country Risk Group considers Indonesia to be riskier for business than its Asian neighbours.

As a consequence, financial institutions have set up loan restrictions. This limitation is normally defined in terms of a maximum cash amount available for loans. Since the risk is directly linked to the duration of the loan, more restrictive limitations are imposed on longer-term transactions, such as loans to obtain the technology required to produce blended cement. [This barrier can be substantiated using financial analysis and notes from negotiations with financial institutions.]

Poor investment conditions would not be a barrier if Company X simply continued with its current activities (Baseline Candidate 1) or pursued Baseline Candidate 2, which requires no significant investment. Therefore, this barrier only applies to Project Activity 1, which requires significant new investment.

High Cost: Project Activity 1 will require extensive investment in new equipment and research and development.

New equipment investments are expected to cost approximately $5 million (U.S.) and include:

- *Improved quality control.* Additional laboratory equipment is needed, including x-ray fluorescence (XRF) and x-ray diffraction (XRD) automatic samplers.
- *Storage, handling, and proportioning equipment for additive materials.* Additional hoppers/storage facilities, feeders, conveyors, limestone crushers, and cement grinding equipment is needed.
- *Increased cement grinding fineness.* Air separators are needed.
- *Additional environmental controls.* Pre-dedusting systems are needed.

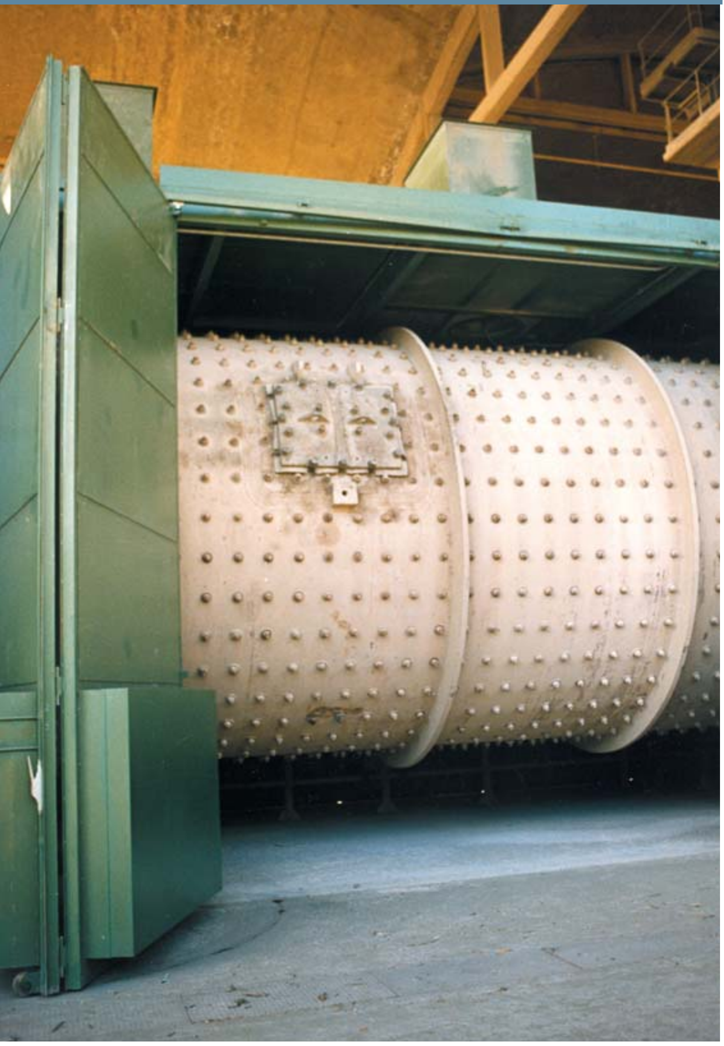
Research and development efforts are needed to determine how the new and existing equipment can be used to produce blended cement. Before blended cements can be launched in the market, extensive testing is needed both internally and externally. The research and development for Project Activity 1 will require an investment of approximately $3 million (U.S.). These tasks include:

- Trial production involving laboratory testing by Company X to obtain indicative information on required fineness, sulphite content, additive composition, etc.
- Full-scale trial production in selected mills.
- Laboratory testing and field testing of the new blended cement by Company X. Additional testing by third parties, such as universities and contractors, is also needed.

Baseline Candidate 1 (continuation of current activities) would require no additional investment, and expenditures associated with Baseline Candidate 2 would be minimal. [Additional information may be required to demonstrate that the expenditures for Baseline Candidate 2 would be minimal.]

Technology Operation and Maintenance Barriers

Existing technology and human resources at Company X are inadequate to increase the quality of clinker and improve quality assurance in producing blended cement. New technology and training are needed (see above), because Company X has no prior experience with these



technologies and they are not readily available in Indonesia. Utilizing the technology will also require additional research and development efforts (see above).

This barrier affects Project Activity 1 and to a lesser extent Baseline Candidate 2. Baseline Candidate 2 has less complicated technology. Technology operation and maintenance is not a barrier for Baseline Candidate 1.

Infrastructure and Market Structure Barriers
No significant infrastructure or market structure barriers affect Project Activity 1 or any of its baseline candidates.

Institutional, Social, and Cultural Barriers
The market share of OPC in Indonesia is about 82 percent, whereas the market share of the PPC and masonry cement accounts for 18 percent, and the share of blended cement is 0 percent (see Table E1.1). A cement blend like that proposed for Project Activity 1 (81 percent clinker-to-cement ratio) may face difficulties competing with more established cement products. Blended cement is (mistakenly) perceived to be of inferior quality in Indonesia. A significant effort is needed to educate consumers regarding new cement types with strength and characteristics comparable to those of OPC. This perception is a barrier primarily for Project Activity 1, where the significantly lower clinker-to-cement ratio is likely to affect consumers' perceptions because it is significantly darker in colour than OPC. It will not be a significant barrier for Baseline Candidates 1 or 2.

Resource Availability Barriers
No significant resource availability barriers affect Project Activity 1 or any of its baseline candidates. For the project activity, additive materials are available in abundant amounts.

8.1A.2 IDENTIFYING BARRIERS TO THE CONTINUATION OF CURRENT ACTIVITIES

There are no barriers to the continuation of current activities (Baseline Candidate 1), and no legal or market shifts that would affect the continuation of current activities are expected.

8.1A.3 ASSESSING THE RELATIVE IMPORTANCE OF THE IDENTIFIED BARRIERS

The relative importance of barriers is assessed for each baseline scenario alternative. Overall, the financial and budgetary barriers are the most significant type of barrier. Social and cultural barriers are of similar significance, although these only affect Project Activity 1 and not the other alternatives. Technological barriers exist, but are less important than the others.

Table E1.3 presents a matrix that shows a rough ranking of the possible baseline scenario alternatives based on the barriers they face. This indicates that the alternative with the lowest barriers is Baseline Candidate 1, which is the continuation of current activities. Baseline Candidate 2, however, faces low barriers and cannot be excluded from consideration as the baseline scenario.

8.2A IDENTIFYING THE BASELINE SCENARIO: Project Activity 1—Reducing Clinker Content

8.2A.1 EXPLAINING BARRIERS TO THE PROJECT ACTIVITY AND HOW THEY WILL BE OVERCOME

Below are short descriptions of how Company X will overcome the barriers to Project Activity 1. [Additional explanatory information may be required for an actual GHG project.]

TABLE E1.3 Rough ranking of baseline scenario alternatives by the cumulative importance of barriers

BASELINE SCENARIO ALTERNATIVES	BARRIER 1: INVESTMENT/BUDGETARY (H)*	BARRIER 2: TECHNOLOGY O&M (L)*	BARRIER 3: SOCIAL/CULTURAL (M)*	RANK BY CUMULATIVE IMPACT
Project Activity 1	High	High	High	Highest barriers
Baseline Candidate 1: Continuation of current activities	Not present	Not present	Not present	No barriers
Baseline Candidate 2: OPC production with 91% clinker-to-cement ratio	Low	Low	Low	Low barriers

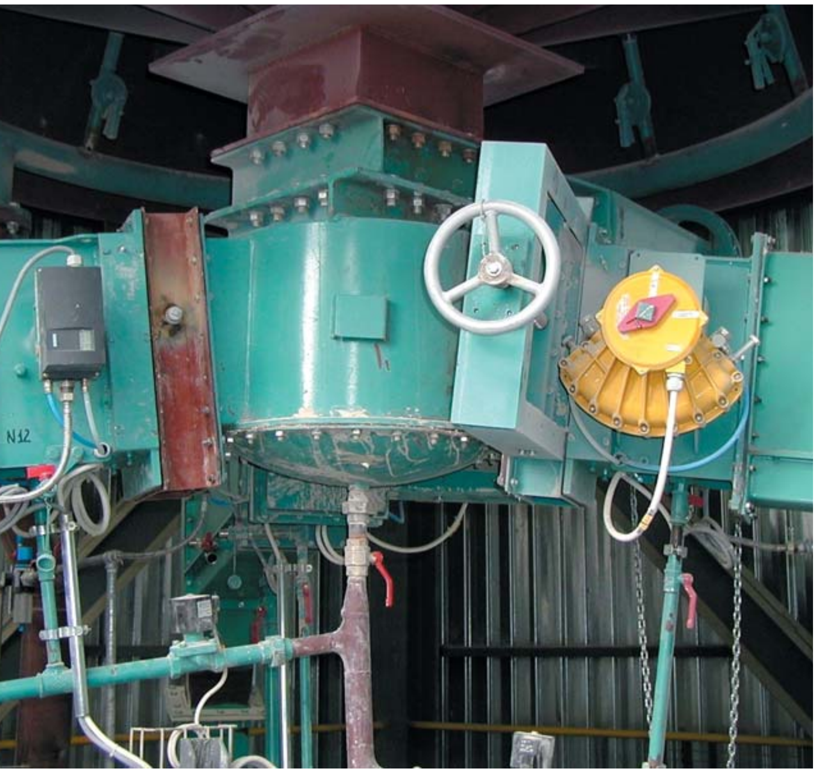
*The relative importance of the barriers compared to each other: H = Significant barrier; M = Moderately significant barrier; L = Less significant barrier.

Financial and Budgetary Barriers

Company X must assure financial institutions that the investment it is making in blended cement will pay off. Company X is seeking tradable credits associated with the GHG reductions from this GHG project; the expected revenue from these credits will help to assure investors that the blended cement investment will pay off.

Technology Operation and Maintenance Barriers

Company X has contracted to purchase the required technology and receive training and research and development assistance from a developed-country manufacturer of blended cement in exchange for a percentage of the GHG reduction credits this GHG project will generate.



Institutional, Social, and Cultural Barriers

Blended cement will very likely require significant marketing efforts to penetrate the market. This marketing effort will be aimed at the negative consumer perceptions concerning the quality of blended cement.

Based on marketing studies conducted by Company X, the marketing strategy will involve:

- *Price.* A lower introductory price will be used when the blended cement first enters the marketplace, the challenge being to avoid the market perception that lower price means lower quality.
- *Branding.* The new blended cement will be differentiated through new branding (name, logo, packaging, etc.).
- *Promotion.* Customers (consultants, architects, contractors, etc.) will be informed that the quality of blended cement is comparable to that of OPC, and that its initial strength will be somewhat higher. Customers will be educated through seminars and with study tours to cement companies in Europe and the United States for selected key clients. All collaborations with universities, government institutions, industry associations, etc., will also be publicised. Promotional material will include brochures, leaflets, and other forms of advertising.

TABLE E1.4 Results of comparative assessment of barriers

BASELINE SCENARIO ALTERNATIVES	RANK BY CUMULATIVE IMPACT OF BARRIERS	CONCLUSION
Project Activity 1	Highest barriers	Reject as baseline scenario
Baseline Candidate 1: Continuation of current activities	No barriers	Could be the baseline scenario
Baseline Candidate 2: OPC production with 91% clinker-to-cement ratio	Low barriers	Could be the baseline scenario

8.2A.2 IDENTIFYING THE BASELINE SCENARIO USING THE COMPARATIVE ASSESSMENT OF BARRIERS

The summary of the comparative assessment of barriers in Table E1.3 suggests that identifying the baseline scenario conclusively from this assessment is not possible. For both Baseline Candidates 1 and 2, barriers are either nonexistent or are low enough that they could be easily overcome. Therefore, neither possibility can be excluded from consideration as the baseline scenario. Table E1.4 summarizes the results of the barriers analysis and initial conclusions concerning identification of the baseline scenario.

Identifying the Baseline Scenario Using a Net Benefits Assessment

Because the comparative assessment of barriers does not conclusively identify a baseline scenario for Project Activity 1, there are two options:

- Identify the more conservative baseline scenario from Baseline Candidate 1 and Baseline Candidate 2. The more conservative alternative would be Baseline Candidate 2, which would have lower GHG emissions than the continuation of current activities (Baseline Candidate 1).
- Assess the net benefits of each alternative.

For this example, we will assess the net benefits of each alternative to identify the baseline scenario. For completeness, the net benefits of Project Activity 1 are also assessed (even though Project Activity 1 was rejected as the baseline scenario using the comparative assessment of barriers).

For the net benefits assessment, the approximate net benefits of each alternative are estimated and compared—in the absence of any considerations of benefits resulting from GHG reductions. Incremental costs are evaluated and a qualitative and quantitative assessment is made of the expected benefits. Benefits are assessed from the perspective of relevant "decision-makers," who for Project Activity 1 and the two baseline candidates are the project developer, Company X.

Net benefits are evaluated over a 20-year time period. This is the expected length of time that the process changes represented by the project activity and Baseline Candidate 2 would be likely to continue at Company X without further modification (i.e., the project lifetime).

The most significant source of identified net benefits relates to potential financial benefits, as summarized in Table E1.5. [This is a summary table; the conclusions presented would require supporting data and analysis for an actual GHG project.]

Another potential benefit for Project Activity 1 is early positioning in the blended cement market should the demand for blended cement increase in the future. This benefit is speculative and is insufficient to outweigh the negative net benefits from investment.

Baseline Candidate 1 (continuation of current activities) results in zero net benefits (i.e., there is no change in current levels of costs and benefits). Baseline Candidate 2 results in large expected net benefits. Since its associated investment and technology barriers are low, the net financial benefits expected for Baseline Candidate 2 are positive.

Table E1.6 summarizes the ranking of the baseline scenario alternatives. This is based on a comparison of barriers to net benefits. Project Activity 1 is not the baseline scenario, since it has high barriers and negative net benefits. The continuation of current activities, although it faces no barriers, gives no potential income growth for Company X. Therefore, Baseline Candidate 2 is selected as the baseline

TABLE E1.5 Incremental costs and net financial benefits for Project Activity 1 and associated baseline candidates

	INCREMENTAL COSTS	INCREMENTAL BENEFITS	NET FINANCIAL BENEFITS
Project Activity 1	Investment costs— • Equipment and human resources to improve clinker quality and QA/QC. Additional operating costs— • Additional cost of additive material to reduce clinker-to-cement ratio from 95 percent to 81 percent. • Additional cost of transporting the additive materials. • Additional electricity cost for preparing the additive materials. Market entry costs— To gain market entry there will be additional marketing costs for the first four years.	• Slight reduction in fuel costs from a reduction in clinker production. • Revenues from the sale of cement (same for other alternatives). • If the market for blended cement grows in Indonesia, Company X may benefit from this project activity in terms of gaining early entry into the market.	*Direct Financial:* A negative net income is expected. Incremental investment and the additional operating and marketing costs exceed the cost savings from reduced clinker use and sale of cement. Using the weighted average capital cost of 12 percent as the discount rate, the NPV for 20 years is: negative $ 3 million (U.S.). *Market Entry:* At this point such benefits are speculative and insufficient to justify the incremental costs. *Conclusion:* Negative net benefits.
Baseline Candidate 1: Continuation of current activities	Zero relative costs (no additional investment required or costs foreseen).	Zero relative benefits (no additional savings or revenues foreseen).	Zero net benefits.
Baseline Candidate 2: OPC production with a 91 percent clinker-to-cement ratio	Additional operating costs— • Additional cost of additive material to reduce clinker-to-cement ratio from 95 percent to 91 percent. • Additional cost of transporting additive materials. • Additional electricity cost for preparing the additive materials.	• Small reduction in fuel costs from a reduction in clinker production. • Revenues from the sales of cement (same for other alternatives).	Increase in income from the savings associated with a lower clinker usage. This gives a positive cash flow. Using the weighted average capital cost of 12 percent as the discount rate, the NPV for 20 years is $20 million (U.S.). *Conclusion:* Large positive net benefits.

scenario, since the barriers are considered low and it offers financially attractive net benefits to Company X.

8.2A.3 JUSTIFYING THE BASELINE SCENARIO

The identified baseline scenario is Baseline Candidate 2. It involves minimal capital investment but offers significant monetary savings associated with reduced clinker production. It is also conservative, because it would result in fewer GHG emissions than the other viable alternative—Baseline Candidate 1 (the continuation of current activities).

Common practice is identified as OPC cement with a 95 percent clinker-to-cement ratio. Both the identified baseline scenario and Project Activity 1 have lower GHG emissions than common practice.

8.1B PERFORMING A COMPARATIVE ASSESSMENT OF BARRIERS: Project Activity 2—Switching Fuels

The possible alternatives for the baseline scenario include:

- Implementation of the same technologies as those involved in Project Activity 2 (i.e., switching from coal to biofuels in kiln burning).

TABLE E1.6 **Screening baseline scenarios based on comparison of barriers to expected benefits**

BASELINE SCENARIO ALTERNATIVES	IDENTIFIED BARRIERS	OVERALL NET BENEFITS	CONCLUSION
Project Activity 1	High barriers	Negative net benefit	Exclude
Baseline Candidate 1: Continuation of current activities	No barriers	Zero	A viable baseline scenario but not the most attractive
Baseline Candidate 2: OPC production with 91 percent clinker-to-cement ratio	Low barriers	Large positive net benefit	Identified as the baseline scenario

- Baseline Candidate 1: Continuation of current activities (i.e., continued use of coal as the primary fuel for clinker burning).
- Baseline Candidate 2: Replacement of coal with natural gas.
- Baseline Candidate 3: Replacement of coal with fuel oil.

8.1B.1 IDENTIFYING BARRIERS TO THE PROJECT ACTIVITY AND BASELINE CANDIDATES

Based on the barrier categories in Table 8.1 (in Chapter 8 of the Project Protocol), the following barriers were identified:

Financial and Budgetary Barriers

There are two types of barriers in this category: investment risk and high cost.

Investment Risk: The financial and investment context described for Project Activity 1 also applies to Project Activity 2. The absence of incentives and the difficulty in procuring funds for new equipment needed to utilize biofuels present a large barrier to Project Activity 2. This barrier does not affect any of the baseline candidates, since no significant capital expenditures are required for Company X to use coal, natural gas, or fuel oil.

High Cost: Project Activity 2 will require new equipment investments, which are expected to cost approximately $15 million (U.S.). These investments include:

- Installation of storage for the biofuels, transportation and collection systems, and fuel feeding and burning systems.
- Pneumatic devices or bucket elevators to deliver rice husks and palm kernel shells from ground-level storage into an intermediate storage bin above the feed point level.
- Environmental controls that cover the biofuels supply chain from source to final combustion. This will include specialized collection systems, secured storage facilities, and other fuel-specific handling systems.

Fuel costs are another possible financial and budgetary barrier. Both natural gas and fuel oil (Baseline Candidates 2 and 3) have higher costs than coal (Table E1.7).

TABLE E1.7 **Comparison of fuel prices**

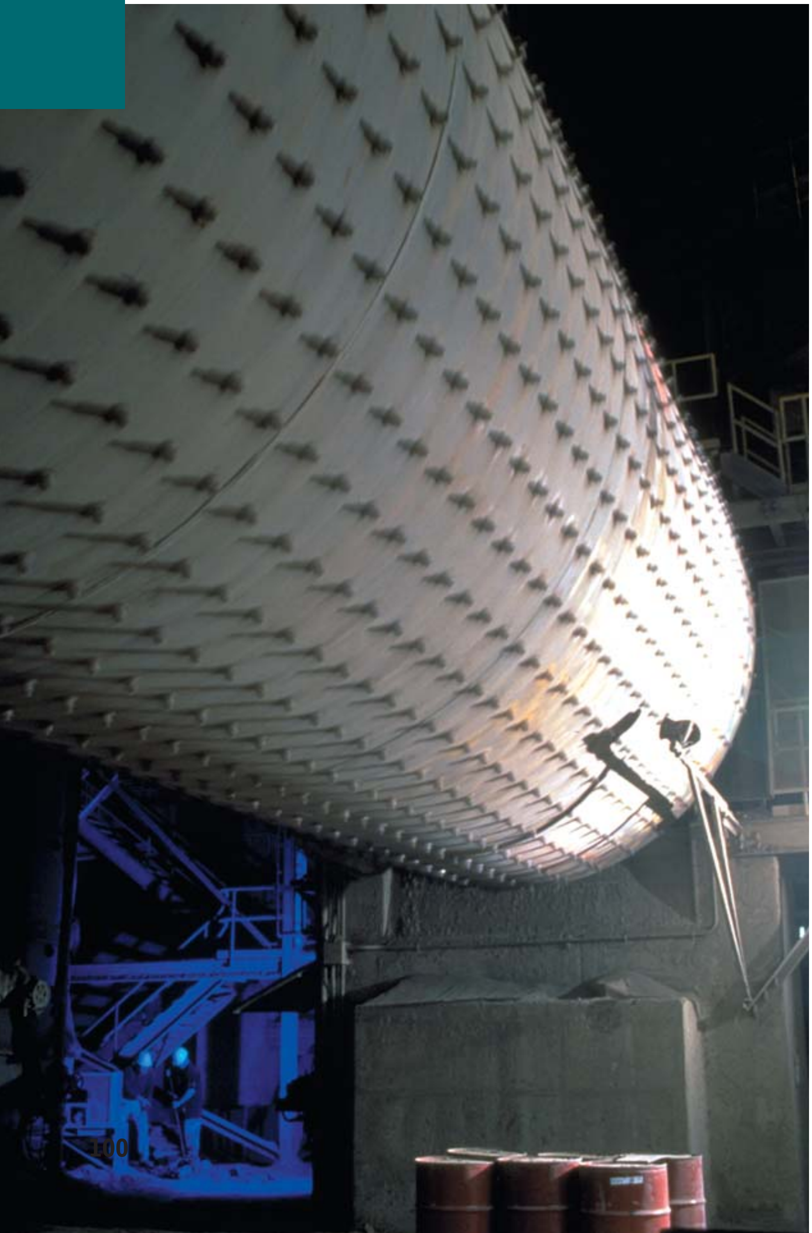
FUEL TYPE	PRICE (U.S.$)*/TONNE	CALORIFIC VALUE (MCAL/TONNE)**	PRICE (U.S.$)*/MCAL
Coal	412.00	5,800	0.071
Gas	900.00	10,103	0.089
Fuel Oil	1,350.00	9,700	0.142
Rice Husk	30.20	3,500	0.009
Palm Kernel Shell	25.00	4,300	0.006

*Original price is in rupiah.
**Mcal = Megacalories. Calorific value of coal is based on supplier data, while the calorific values of other fuel types are taken from IPCC default value (IPCC, 1996).

TABLE E1.8 Assessment of financial and budgetary barriers for Project Activity 2 and its associated baseline candidates

BASELINE SCENARIO ALTERNATIVE	INVESTMENT COST	FUEL COST	CONCLUSION
Project Activity 2	U.S. $15 million	U.S. $0.007/Mcal*	Lower fuel costs but high up-front investment costs required, with limited access to capital due to the poor Indonesian investment climate.
Baseline Candidate 1: Continuation of current activities (coal)	None	U.S. $0.071/Mcal	Current activities have the least cost overall.
Baseline Candidate 2: Replacement of coal with natural gas	None	U.S. $0.089/Mcal	Significantly more expensive than using coal (U.S. $0.02/Mcal higher cost).
Baseline Candidate 3: Replacement of coal with fuel oil	None	U.S. $0.142/Mcal	More expensive than using coal or natural gas.

*Assuming weighted average of rice husk and palm kernel shell utilization. Utilization of renewable sources increases heat consumption per tonne of clinker produced. This heat consumption increase depends on the amount of biofuel used with the actual increase requiring monitoring.



The cost of the biofuels is much less than that of coal. Therefore, some cost savings accrue to Project Activity 2 from the reduction in coal usage and the lower cost of the biofuels. However, these savings are not enough to cover the cost of the additional equipment needed to utilize biofuels. The higher moisture content of biofuels also means that more heat is needed to produce clinker. This results in higher energy use during clinker production and more frequent monitoring of the process. Table E1.8 summarizes the significance of the financial and budgetary barriers facing each alternative. [This is a summary table; the conclusions presented would require supporting data and analysis for an actual GHG project.]

Technology Operation and Maintenance Barriers

No significant technology barriers affect Project Activity 2 or any of its baseline candidates.

Infrastructure Barriers

The rice husks and palm kernel shells used in Project Activity 2 are regarded as waste. Rice husks can be sourced from areas close to the cement plants and can be compacted to lower bulk-density, which reduces transportation costs. The palm oil industry produces palm kernel shells. These wastes are mostly available in Kalimantan and, to a lesser extent, in Java, and are cheaper than conventional fuel (Table E1.8). However, the current infrastructure for waste collection, treatment, and final disposal is underdeveloped compared with other countries. Utilizing biofuels will require waste collection and treatment systems to be implemented (approximately

$6 million out of the total $15 million (U.S.) investment). This barrier only affects Project Activity 2.

Infrastructure barriers do not apply to Baseline Candidates 1, 2, and 3, since the infrastructure for fossil fuel collection, transportation, storage, and utilization is already in place at Company X's facilities.

Market Structure Barriers

No significant market structure barriers affect Project Activity 2 or any of its baseline candidates.

Institutional, Social, and Cultural Barriers

No significant institutional, social, or cultural barriers affect Project Activity 2 or any of its baseline candidates.

Resource Availability Barriers

No significant resource availability barriers affect Project Activity 2 or any of its baseline candidates. Rice husks and palm kernel shells are available in abundance; the only barriers to their use are infrastructural. There is some possibility that other cement companies will follow Company X's lead to use biofuels, causing future resource availability issues. Any increase in the use of biofuels will need to be monitored.

8.1B.2 IDENTIFYING BARRIERS TO THE CONTINUATION OF CURRENT ACTIVITIES

There are no barriers to the continuation of current activities (Baseline Candidate 1); no legal or market shifts are expected that would affect the continuation of current activities.

8.1B.3 ASSESSING THE RELATIVE IMPORTANCE OF THE IDENTIFIED BARRIERS

Overall, the financial and budgetary barriers are the most significant barriers. The infrastructural barriers can be overcome by working with local government permitting authorities and obtaining access to financing. Thus, the importance of financial and budgetary barriers is determined to be high, while the importance of infrastructural barriers is medium.

Project Activity 2 is affected by all identified barriers. Baseline Candidates 2 and 3 face relatively high financial and budgetary barriers. Baseline Candidate 1 faces no barriers. The net affect of barriers for each alternative is summarized in Table E1.9.

8.2B IDENTIFYING THE BASELINE SCENARIO

8.2B.1 EXPLAINING BARRIERS TO THE PROJECT ACTIVITY AND HOW THEY WILL BE OVERCOME

Following are short descriptions of how Company X will overcome the barriers to Project Activity 2. [Additional explanatory information may be required for an actual GHG project.]

Financial and Budgetary Barriers

Similar to Project Activity 1, Company X must assure financial institutions that the investment it makes in using biofuels will pay off. Company X is seeking recognition and tradable credits associated with the GHG reductions from this GHG project. The expected revenue from these credits will help to assure investors that the biofuel investment will pay off.

TABLE E1.9 Rough ranking of baseline scenario alternatives by cumulative significance of barriers

BASELINE SCENARIO ALTERNATIVES	BARRIER 1: INVESTMENT/BUDGETARY (H)*	BARRIER 2: INFRASTRUCTURE (M)*	RANK BY CUMULATIVE IMPACT
Project Activity 2	High	High	Highest Barriers
Baseline Candidate 1: Continuation of current activities	Not present	Not present	No barriers
Baseline Candidate 2: Replacement of coal with natural gas	Medium	Not present	Medium barriers
Baseline Candidate 3: Replacement of coal with fuel oil	Medium/high	Not present	Medium/high barriers

*The relative importance of barriers compared to each other: H = Significant barrier; M = Moderately significant barrier.

TABLE E1.10 Results of comparative assessment of barriers

BASELINE SCENARIO ALTERNATIVES	RANK BY CUMULATIVE IMPACT	CONCLUSION
Project Activity 2	Highest barriers	Rejected as the baseline scenario.
Baseline Candidate 1: Continuation of current activities	No barriers	Identified as the baseline scenario.
Baseline Candidate 2: Replacement of coal with natural gas	Medium barriers	Rejected as the baseline scenario.
Baseline Candidate 3: Replacement of coal with fuel oil	Medium/high barriers	Rejected as the baseline scenario.

Infrastructure Barriers

Company X will invest the money required to build the necessary infrastructure to utilize biofuels and work with local government officials to ensure that biofuel collection and treatment facilities can be constructed.

8.2B.2 IDENTIFYING THE BASELINE SCENARIO USING THE COMPARATIVE ASSESSMENT OF BARRIERS

Based on the comparative assessment of barriers, Project Activity 2 and Baseline Candidates 2 and 3 are rejected as the baseline scenario (Table E1.10). Baseline Candidate 1, which is the continuation of current activities, faces no barriers and is identified as the baseline scenario.

8.2B.3 JUSTIFYING THE BASELINE SCENARIO

The identified baseline scenario is the continuation of current activities—i.e., the use of coal as the fuel for clinker production. It involves no capital investment and faces no barriers. This baseline scenario is reasonable, since it also represents common practice. Project Activity 2 is not common practice.

8.3 ESTIMATING BASELINE EMISSIONS

Baseline emissions are estimated for each primary effect, based on the identified baseline scenarios for each project activity.

Project Activity 1: Reducing Clinker Content

Primary Effect 1: Reduction in industrial process emissions resulting from reduced clinker in the calcination process.

The CO_2 emission factor for calcination from a tonne of clinker is 0.525 t CO_2/t clinker.[1]

Baseline emissions for this primary effect are equal to the clinker content of the cement multiplied by the CO_2 emission factor for calcination:

$$= (0.91 \text{ t clinker/t cement}) \cdot (0.525 \text{ t } CO_2\text{/t clinker})$$

$$= 0.478 \text{ tonnes of } CO_2eq \text{ for every tonne of cement produced by Company X}$$

Primary Effect 2: Reduction in combustion emissions from generating energy for pyro-processing resulting from reduced clinker in the calcination process.

Only CO_2 emissions are considered, since nitrous oxide and methane emissions from the clinker burning process are considered insignificant (Ellis 2000). The baseline scenario involves coal as the fuel used in clinker burning. Coal from Indonesia has an emission factor of 0.402 kg CO_2eq/Megacalorie (CO_2/Mcal). As a preliminary estimate, it is assumed that clinker requires an energy input of 755 Mcal/t of clinker.

Baseline emissions for this primary effect are equal to the CO_2 emission factor for coal multiplied by the energy input required for clinker production, multiplied by the clinker content of the cement:

$$= (0.402 \text{ kg } CO_2eq\text{/Mcal}) \cdot (755 \text{ Mcal/t clinker}) \times (0.91 \text{ t clinker/t cement}) / (1{,}000 \text{ kg } CO_2\text{/t } CO_2)$$

$$= 0.276 \text{ tonnes of } CO_2eq \text{ for every tonne of cement produced by Company X}$$

Project Activity 2: Switching Fuels

Primary Effect 3: Reduction in combustion emissions from generating energy due to the switch from coal to biofuels.

Project Activity 2 effectively reduces the GHG emission rate associated with the fuel used for clinker burning, which in the baseline scenario is coal. Project Activity 1 results in a reduction in the amount of clinker required for every tonne of cement produced. Thus, baseline emissions for Project Activity 2 are premised on the lower amount of clinker required by Project Activity 1—i.e., 0.81 tonnes of clinker/tonne of cement.

For Project Activity 2 the baseline emissions are equal to the CO_2 emission factor for coal multiplied by the energy input required for clinker production, multiplied by the lower clinker content of the cement:

$$= (0.402 \text{ kg } CO_2\text{eq/Mcal}) \cdot (755 \text{ Mcal/t clinker}) \times (0.81 \text{ t clinker/t cement}) / (1{,}000 \text{ kg } CO_2\text{/t } CO_2)$$

= **0.246 tonnes of CO_2eq for every tonne of cement produced by Company X**

Chapter 10: Monitoring and Quantifying the GHG Reductions

10.1 CREATING A MONITORING PLAN

The monitoring plan presented here is an overview and, as with the requirements for Chapter 8, this section is organised by following all the requirements for each project activity sequentially. A detailed monitoring plan will include provisions for monitoring frequency, record keeping, and methods used to measure, calculate, or estimate data on GHG emissions and baseline parameters.

10.1A.1 MONITORING PROJECT ACTIVITY EMISSIONS:

Project Activity 1—Reducing Clinker Content

GHG emissions are monitored using indirect measurement and calculations. The data that need to be monitored for Project Activity 1 and brief assessments of the uncertainty associated with these data are provided in Table E1.11. [Additional detail would in most cases be necessary for an actual project.]

TABLE E1.11 Data requirements and uncertainty levels for monitoring Project Activity 1 emissions

GHG EFFECT / SOURCE	DATA	LEVEL OF UNCERTAINTY	UNCERTAINTY FACTORS	HOW UNCERTAINTIES ARE ADDRESSED
Primary Effect 1: Industrial process emissions	Clinker-to-cement ratio of blended cement	Low	N/A	N/A
	CO_2 emission factor due to calcination process	Low	MgO and CaO content of raw material and clinker	Conduct a laboratory analysis using x-ray analyser.
	Tonnes of cement produced by Company X	Low	N/A	N/A
Primary Effect 2: Combustion emissions from generating energy for pyro-processing	CO_2 emission factor for coal used in clinker production process (tonnes CO_2/Mcal)	Low	Heat values for coal used	• Conduct a laboratory analysis to test the heating values for coal used. • In the absence of laboratory analysis, use IPCC default emission factors.
	Energy content of coal used in clinker production process (Mcal/tonne)	Low	Heat values for coal used	• Conduct a laboratory analysis to test the heating values for coal used. • In the absence of laboratory analysis, use IPCC default emission factors.
	Amount of coal used in clinker production process (tonnes)	Low	N/A	N/A

TABLE E1.12 Data requirements and uncertainty levels for monitoring baseline parameters related to Project Activity 1 (reducing clinker content)

BASELINE PARAMETER/ ASSUMPTION	DATA	LEVEL OF UNCERTAINTY	UNCERTAINTY FACTORS	HOW UNCERTAINTIES ARE ADDRESSED
Additive materials (fly ash, trass) remain abundantly available	Availability of unused additive materials	Medium	Displacement of other users of fly ash and trass	Regular surveys of other users of fly ash and trass to ascertain level of use.
Blended cement has limited market penetration in Indonesia	Total sales of OPC in Indonesia	Low	Lack of records and available data on cement market	• Conduct a data assessment from the cement market association and existing market studies. • Conduct a regular survey and investigation of the OPC and blended cement market. • An independent expert should validate the data quality for the cement sector.
	Total sales of blended cement in Indonesia			
	Sales of non-OPC and non-blended cement in Indonesia			
	Market share of blended cement in Indonesia			
	Strength of blended cement and OPC cement	Low	N/A	Conduct a laboratory analysis to assess the OPC and blended cement strength.

10.1A.2 MONITORING BASELINE PARAMETERS

The data in Table E1.12 will be monitored to ensure that baseline emission estimates for Project Activity 1 remain valid.

For the first assumption, if additive materials were to become scarce, significant secondary effects may arise from other users of these materials switching to conventional raw materials, thus increasing their GHG emissions. Baseline emission estimates may need to be revised to account for this switch. This secondary effect would then need to be included in the GHG assessment boundary. The availability of unused additive materials will be verified annually.

For the second assumption, if the market share of blended cement in Indonesia rises above 30 percent, the baseline scenario will no longer be assumed to be valid, and no more GHG reductions will be quantified for Project Activity 1. The market penetration of blended cement will be verified annually.

10.1A.3 DESCRIBING QA/QC MEASURES

Most of the data required in the monitoring plan, the monitoring frequency, and measurement/estimation methods are already accounted for in the existing ISO 9001 system and the audited management accounting system for Portland cement. Furthermore, each year an independent verifier from an accredited entity will verify the actual GHG reductions generated.

10.1B.1 MONITORING PROJECT ACTIVITY EMISSIONS:

Project Activity 2—Switching Fuels

The data needed to determine GHG emissions related to the primary effect of Project Activity 2 are the same used to determine GHG emissions associated with the second primary effect for Project Activity 1 (see Table E1.11). Project Activity 2 does not have any significant secondary effects. Therefore, no separate monitoring plan is required for the GHG emissions associated with Project Activity 2.

10.1B.2 MONITORING BASELINE PARAMETERS

The data in Table E1.13 will be monitored to ensure that baseline emission estimates for Project Activity 2 remain valid.

Before the GHG project begins, data on the energy input required to produce clinker are required in order to calibrate estimates of baseline emissions. As noted above, under Estimating Baseline Emissions (section 8.3), the estimated specific heat consumption when coal is used as a fuel is 755 Mcal/t of clinker.[2] To accurately estimate baseline emissions, this preliminary estimate will need to be verified and modified if necessary.

If the availability of rice husks and palm kernel shells drops below 1.5 times the amount used by other users, then significant secondary effects may arise from the project activity because other users of these biofuels may switch to more conventional fuels with higher GHG emissions. Baseline emission estimates would then need to be revised to account for this fuel switch. This secondary effect would then need to be included in the GHG assessment boundary. The availability of unused rice husks and palm kernel shells will be verified annually.

10.1B.3 DESCRIBING QA/QC MEASURES

Most of the data required in the monitoring plan, the monitoring frequency, and measurement/estimation methods, are already accounted in the existing ISO 9001 system and audited management accounting system for Portland cement. Furthermore, each year an independent verifier from an accredited entity will verify the actual GHG reductions generated.

10.2 QUANTIFYING GHG REDUCTIONS

10.2.1 IDENTIFYING THE TIME PERIOD OVER WHICH GHG REDUCTIONS WILL BE QUANTIFIED

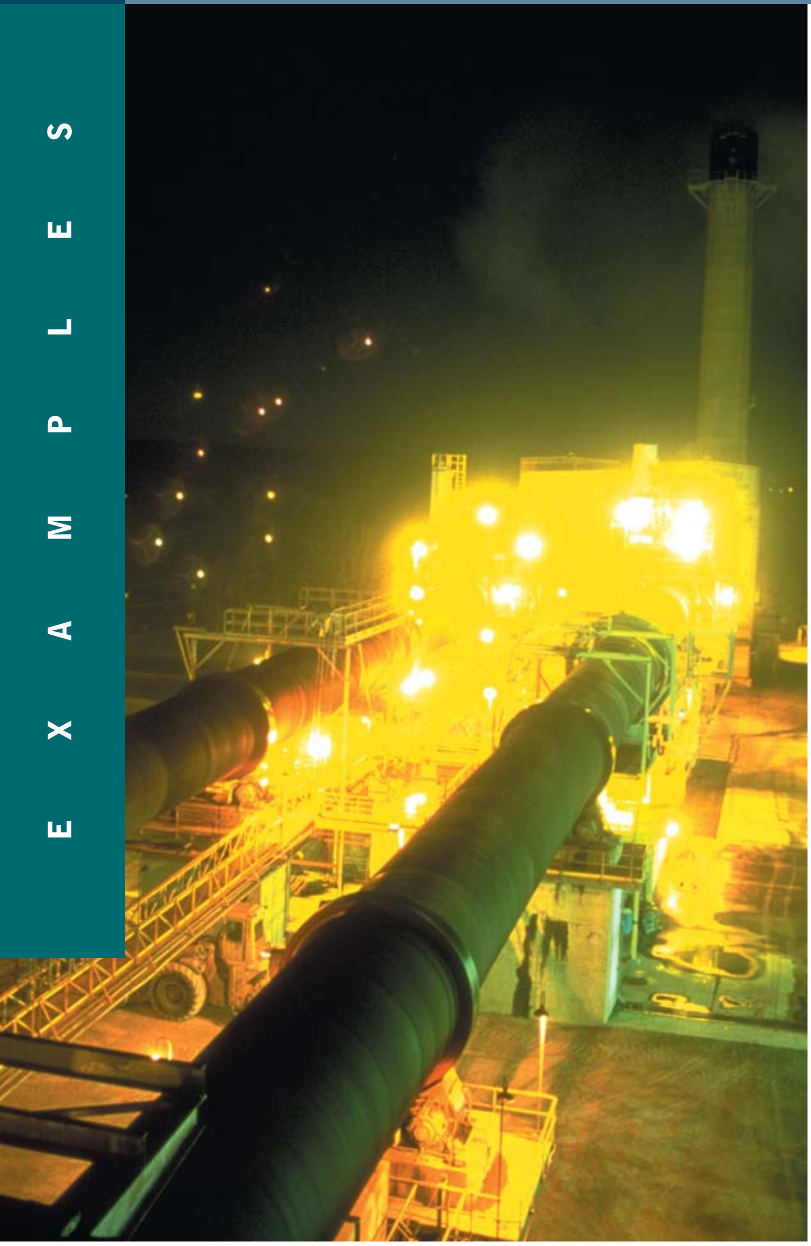
Project Activity 1: Reducing Clinker Content

The valid time length for the baseline scenario is estimated at 5 years. This is based on the expectation that the market penetration of blended cement in Indonesia could reach 30 percent within 5 years, after which the production of blended cement would be considered common practice.

The market share of blended cement varies considerably across countries. For instance, it is around 47 percent in

TABLE E1.13 Data requirements and uncertainty levels for monitoring baseline parameters related to Project Activity 2 (switching fuels)

BASELINE PARAMETER/ ASSUMPTION	DATA	LEVEL OF UNCERTAINTY	UNCERTAINTY FACTORS	HOW UNCERTAINTIES ARE ADDRESSED
Energy input required to produce one tonne of clinker	Specific heat consumption using coal fuel only	Low	N/A	Pre-project documentation of specific heat consumption of coal used for clinker production.
Biofuels remain abundantly available	Availability of unused rice husks and palm kernel shells	Medium	Quantity of unused rice husks and palm kernel shells	Regular surveys of sources for rice husks and palm kernel shells to ascertain level of availability.
	Biofuels used by other users	Medium	Quantity of biofuel used by other users	Regular surveys of other users of rice husks and palm kernel shells to ascertain level of use.



India and around 21 percent in Malaysia. Increasing the blended cement share to 47 percent in India took about 5 years (1999–2003). Blended cement is also sold in Mexico and Costa Rica. In Japan, blended cement had a 26 percent market share in 2002, and about 50 percent of the cement is blended in Germany.

Based on these figures, the opinions of international experts consulted, and on Company X's international experience, it appears that setting the common practice threshold for blended cement in Indonesia at 30 percent within 5 years would be a justifiable time period for quantifying GHG emissions.

Project Activity 2: Switching Fuels

The valid time length of the baseline scenario is assumed to be 15 years. This period reflects an assessment of long-term assumptions about common practice fuel usage for clinker production. Specifically, the use of fuels other than coal is not common practice and is likely to remain unchanged for several reasons:

- Coal is locally available in abundance at competitive prices.
- The infrastructure for renewable waste collection, treatment, and final disposal is underdeveloped compared to that in many developed countries.
- Clinker burning in the Indonesian cement industry is presently based almost entirely on coal.
- The total cost (including infrastructure) to use fossil fuels is lower than the cost for alternative fuels, and the cement industry tends to use fossil fuels, rather than investing in new equipment to enable the use of alternative energy sources.

Any change in these circumstances will depend largely on government policy and efforts to improve waste fuel infrastructure. The Indonesian national action plan on Urban Waste Management 2003 has a projected 15-year time frame for improving the waste management infrastructure to acceptable levels. This time frame may decrease or increase, depending on national and local government commitments and their efforts to solicit public engagement.

GHG Project

The time period over which GHG reductions will be quantified for the GHG project is 5 years, corresponding to the shortest valid baseline scenario time length (Project Activity 1).

10.2.2 CALCULATIONS FOR QUANTIFYING GHG REDUCTIONS

Estimating GHG Reductions

Ex ante GHG reductions are estimated preliminarily here on an annual basis. In reality, GHG project (and baseline) emissions will change over time—e.g., as overall production expands and as biofuels are phased in over time to substitute for coal. The formulas used to quantify GHG reductions *ex post* will differ from those used to estimate *ex ante* GHG reductions, since combustion emissions, for example, can be determined directly from monitored fuel usage. *Ex post* calculation formulas are presented below in the section on quantifying GHG reductions.

GHG reductions are estimated in units of CO_2eq tonnes. Baseline emissions and project emissions are calculated for each primary and significant secondary effect.

PRIMARY EFFECTS:
PROJECT ACTIVITY 1— REDUCING CLINKER CONTENT

Primary Effect 1: Reduction in industrial process emissions resulting from reduced clinker in the calcination process.

Process emissions from cement production are estimated to be 0.525 t CO_2/t clinker. Project Activity 1 will use a clinker-to-cement ratio of 81 percent.

GHG emissions from Project Activity 1, Primary Effect 1 are:

= (0.81 t clinker/t cement) · (0.525 t CO_2/t clinker)

= **0.425 tonnes of CO_2eq for every tonne of cement produced by Company X**

Baseline emissions for Primary Effect 1 were estimated above (section 8.3) as 0.478 t CO_2/t of cement.

GHG reductions will therefore be:

= 0.478 – 0.425

= **0.053 t CO_2eq/t cement produced**

Primary Effect 2: Reduction in combustion emissions from generating energy for pyro-processing resulting from reduced clinker in the calcination process.

Again, the project activity will use a clinker-to-cement ratio of 81 percent. The change in fuel mix is accounted for under Project Activity 2, so here the reduction in coal combustion emissions associated with reducing fuel usage required for clinker production are calculated.

GHG emissions from Project Activity 1, Primary Effect 2 are:

= (0.402 kg CO_2eq/Mcal) · (755 Mcal/t clinker) · (0.81 t clinker/t cement) / (1,000 kg CO_2/t CO_2)

= **0.246 tonnes of CO_2eq for every tonne of cement produced by Company X**

Baseline emissions for Primary Effect 2 were estimated above (section 8.3) as 0.276 t CO_2eq/t of cement.

GHG reductions will therefore be:

= 0.276 – 0.246

= **0.03 t CO_2eq/t cement produced**

PRIMARY EFFECTS:
PROJECT ACTIVITY 2—SWITCHING FUELS

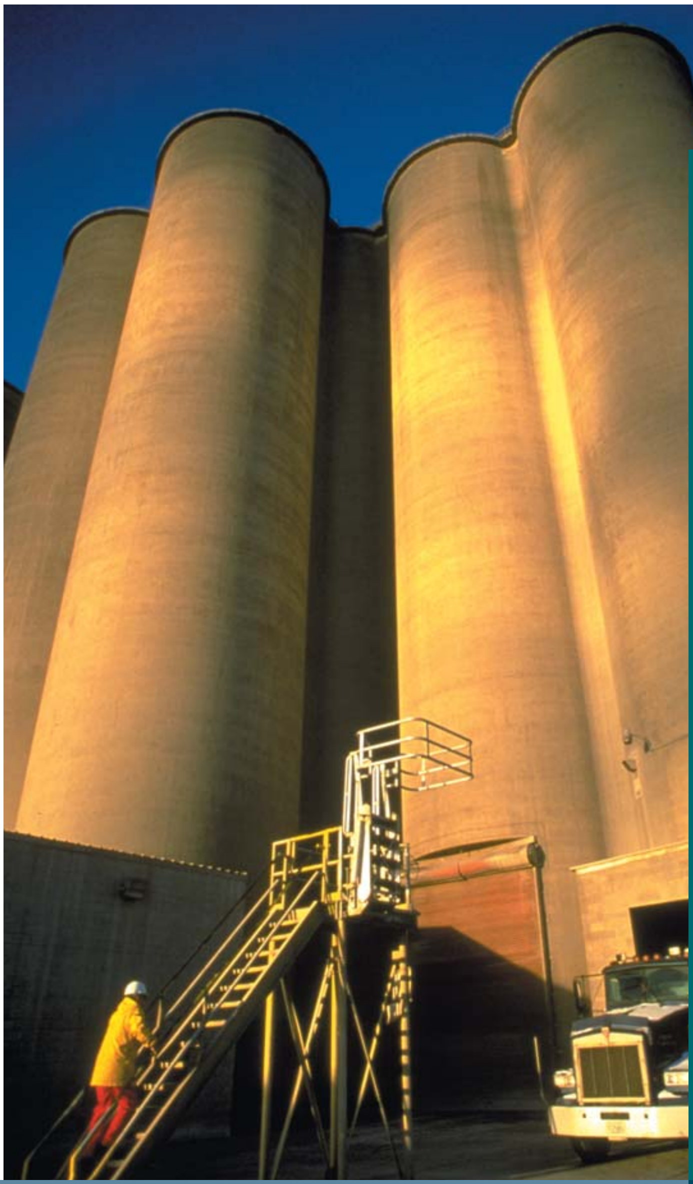
Primary Effect 3: Reduction in combustion emissions from generating energy due to the switch from coal to biofuels.

Biofuels will be gradually substituted for coal until they account for about 15 percent of the fuel mix on an overall heat input basis. Since biofuels effectively have a zero emissions factor, the overall fuel-mix emission factor will equal 85 percent of baseline emissions. GHG emissions from Project Activity 2 related to its primary effect are therefore:

= (0.246 t CO_2eq/t cement) · (0.85)

= **0.209 t CO_2eq/t cement**

Baseline emissions for Project Activity 2 were estimated above (section 8.3) as 0.246 t CO_2eq/t of cement.



GHG reductions will therefore be:

$= 0.246 - 0.209$

$= \mathbf{0.037\ t\ CO_2eq/t\ cement\ produced}$

Aggregating the GHG reductions associated with each primary effect together, total GHG reductions related to primary effects will be:

$= 0.053 + 0.03 + 0.037$

$= \mathbf{0.12\ t\ CO_2eq/t\ cement\ produced}$

Secondary Effects

No significant secondary effects were identified for either project activity, so secondary effects do not need to be estimated.

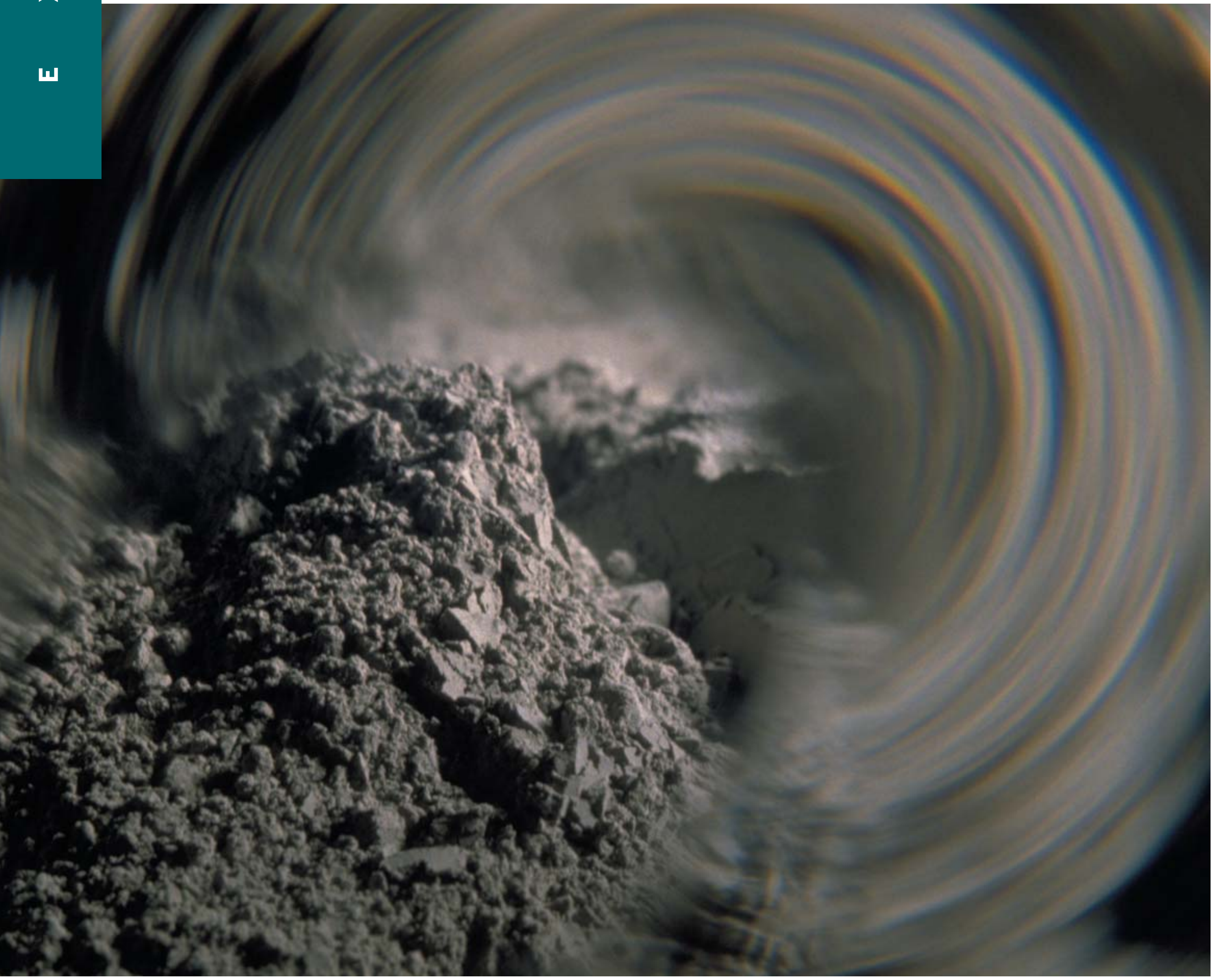
Total Estimated GHG Reductions

Company X's cement production is expected to expand over time. However, average annual production will be in the neighbourhood of 2 million tonnes of cement. Thus, annual GHG reductions are estimated at:

$= (2\text{ million tonnes}) \cdot (0.12\text{ tonnes } CO_2eq/t\text{ cement})$

$= \mathbf{240{,}000\ tonnes\ CO_2eq.}$

This is a rough estimate based on preliminary assumptions; actual quantification of GHG reductions may differ once the project is implemented, and the GHG project is monitored and verified.



Quantifying GHG Reductions

GHG reductions for the GHG project are quantified *ex post* using monitored data. Therefore, the calculations and formulas used will differ somewhat from those used to estimate GHG reductions *ex ante*. The formula for the annual quantification of GHG reductions is as follows:

$R = BE - PE$

Where:

R = Annual GHG reductions for the entire GHG project

BE = Total annual baseline emissions for all three GHG project primary effects

PE = Total annual GHG project emissions

$BE = [\text{Process Emissions}] + [\text{Combustion Emissions}]$
$= [C_y \cdot CF_b \cdot EF_p] + [C_y \cdot CF_b \cdot E \cdot EF_c]$

Where:

C_y = Quantity of cement produced in year y, in tonnes

CF_b = Fraction of clinker in cement, baseline scenario = 0.91

EF_p = Emission factor for process emissions from clinker production = 0.525 t CO_2/t clinker (WBCSD Cement Protocol 2001).

E = Energy input from coal required to produce a tonne of clinker = 755 Mcal/tonne of clinker (as determined through pre-implementation monitoring)

EF_c = Emission factor for coal combustion = 0.402 kg CO_2eq/Mcal (as determined under the monitoring plan)

$PE = [\text{Process Emissions}] + [\text{Combustion Emissions}]$
$= [C_y \cdot CF_p \cdot EF_p] + [F_y \cdot EC_c \cdot EF_c]$

Where:

CF_p = Fraction of clinker in cement, GHG project = 0.81

F_y = Amount of coal consumed in year y, in tonnes

EC_c = Energy content of coal in units of Mcal/tonne, as determined under the monitoring plan

NOTES

[1] 0.525 tonnes of CO_2/tonne of clinker is the default emission factor for the calcination process in the cement industry (WBCSD Cement Protocol 2001).

[2] This figure would differ if other fuels were used, but the identified baseline scenario involves continued use of coal.

With the exception of the picture on page 88, all pictures in this example were provided by Italcementi, to whom we are particularly thankful.

Compressor Station Efficiency Improvement GHG Project Using the Performance Standard Baseline Procedure

Following is a hypothetical project illustrating how to use the performance standard procedure to estimate baseline emissions. All names in the example are fictional. Also, the information here is quite general; project developers would normally be expected to provide more detailed information.

The numbering of the sections in this example corresponds to the numbering of the chapters in Part II of the Project Protocol.

Background and Overview of Natural Gas Compressor Station GHG Emissions

Natural gas compressor stations, which are typically found every 100 to 150 km along a gas pipeline, are instrumental in maintaining adequate pressure for the gas to travel through a pipeline system. Compressor stations usually contain more than one compressor. Although the compressor itself is not a source of GHG emissions, the compressor is powered by a driver, typically a gas or diesel engine or gas turbine that releases GHG emissions, specifically carbon dioxide (CO_2) and methane (CH_4). It is the complete unit encompassing the compressor and its associated driver that is hereafter referred to as the "compressor."

Significant reductions in CO_2 and CH_4 can be achieved by improving the compressor efficiency or the process efficiency (e.g., load optimization). This hypothetical case study illustrates a pipeline project in Indonesia that reduces CO_2 and CH_4 emissions at a new compressor station by installing higher-efficiency (lower-emitting) compressors. The case study is designed to illustrate the steps a project developer would take to develop a performance standard for compressor station GHG emissions. The efficiency values are illustrative and should not be used to develop an actual performance standard. Each compressor installed under this GHG project has a fuel efficiency of 10.6 megajoules of natural gas/kilowatt hour of compression (MJ/kWh).

GHG PROJECT DESCRIPTION

The information provided in this case study is intended to provide context for the GHG project. Some of this information is reported to meet the requirements in Chapter 11 of the Project Protocol. Additional information should also be reported when documenting and reporting an actual GHG project (see Chapter 11).

GHG project title: Jogja pipeline compressor station efficiency improvement project.

Description: The GHG project will install high-efficiency compressors used to maintain adequate pressure for gas to move along a pipeline. This involves installing compressors as part of an extension of a pipeline within an existing natural gas transmission system. Each compressor will be fuelled by natural gas. This pipeline extension will deliver gas to a natural gas power plant that is currently under construction.

Size: The GHG project installs 30 new state-of-the-art, high-efficiency compressors.

Geographical location: Yogyakarta region in Indonesia.

Names of project partners: Jogja Gas Pipelines, Inc. (a private natural gas transmissions company), and the Indonesian Energy Agency (the government agency that deals with gas pipelines). The pipeline is owned by Jogja Gas Pipelines, Inc., and the land and gas in the pipeline are owned by the Indonesian Energy Agency.

Project technology: High-efficiency pipeline compressors. (These compressors require 10.6 MJ/kWh of compression.)

Chapter 5: Defining the GHG Assessment Boundary

5.1 IDENTIFYING PROJECT ACTIVITIES

This GHG project involves just one project activity: installing higher-efficiency compressors as part of an extension of a pipeline within an existing natural gas transmission system.

5.2 & 5.3 IDENTIFYING PRIMARY EFFECTS AND CONSIDERING ALL SECONDARY EFFECTS

The primary and secondary effects associated with this project activity are identified in Table E2.1.

5.4 & 5.5 ESTIMATING THE RELATIVE MAGNITUDE AND ASSESSING THE SIGNIFICANCE OF SECONDARY EFFECTS

Since the power plant's demand for natural gas—and the associated pipeline and compressors required to deliver this gas—will be the same with or without the GHG project, there will be no net difference between baseline emissions and project activity emissions associated with one-time activities, and therefore no one-time effects. By reducing natural gas usage at the compressors, the GHG project will slightly reduce demand for natural gas. This in turn will slightly reduce GHG emissions from extracting and transporting natural gas. To be conservative, such GHG reductions will be ignored. Therefore, no significant secondary effects are identified. Therefore, the GHG assessment boundary includes only GHG sources associated with the primary effect.

Chapter 6: Selecting a Baseline Procedure

The performance standard procedure was chosen, since there is a relative degree of uniformity for compressor technology in the commercial market.

Chapter 7: Identifying the Baseline Candidates

To identify the list of baseline candidates, different alternatives are considered whose products or services are comparable to the project activity within a relevant geographic area and temporal range. Since the performance standard procedure is being used, baseline candidates include all the individual plants, technologies, or practices whose products or services are similar to those of the project activity.

EXAMPLES

TABLE E2.1 Primary and secondary effects

PRIMARY EFFECT	SECONDARY EFFECTS	
	ONE-TIME EFFECTS	UPSTREAM AND DOWNSTREAM EFFECTS
Reduction in combustion emissions from generating off-grid electricity from reduced fuel use by compressors (per unit of natural gas transported).	**Considered:** • GHG emissions associated with the manufacture, installation, and decommissioning of compressors. **Magnitude/Significance:** The project activity will cause GHG emissions associated with the manufacture, installation, and decommissioning of compressors. However, these same activities would have occurred in the baseline scenario, producing GHG emissions from the same GHG sources. The result is zero net change between project activity GHG emissions and baseline emissions, so there are no one-time GHG effects.	**Considered:** • Reduced GHG emissions associated with reduced mining/extraction of natural gas. • Reduced GHG emissions associated with reduced transportation of natural gas. **Magnitude/Significance:** The project will cause an absolute reduction in demand for natural gas, leading to reductions in GHG emissions associated with extracting and transporting natural gas. Such GHG reductions would constitute positive secondary effects; to be conservative, these GHG reductions are assumed to be zero. No other inputs or outputs are associated with the project that might cause secondary effects.

7.1 DEFINING THE PRODUCT OR SERVICE PROVIDED BY THE PROJECT ACTIVITY

The service provided by the project activity is the compression of a particular volume of natural gas so that the gas can be delivered to a power plant.

7.2 IDENTIFYING POSSIBLE TYPES OF BASELINE CANDIDATES

Since only compressor stations can provide this service, the identified baseline candidates include all compressor stations used for gas pipelines within the geographic area and temporal range described under section 7.3.

7.3 DEFINING THE GEOGRAPHIC AREA AND TEMPORAL RANGE

7.3.1 DEFINING THE GEOGRAPHIC AREA

As an initial default, the geographic area considered was the country of Indonesia. However, this default was rejected, despite a sufficient number of compressors found in Indonesia to develop a performance standard. Instead, the final geographic area selected was global, since the project involves implementing technologies that are commercially available globally.

7.3.2 DEFINING THE TEMPORAL RANGE

The initial temporal range considered was all compressors that went into operation during the last five years. However, compressor efficiency improves at a fairly rapid pace, so it was decided to use a temporal range of the previous three years. This takes a conservative approach by considering only the more recent and more efficient compressor technologies, and still provides a large enough data set to develop the performance standard.

7.4 DEFINING OTHER CRITERIA USED TO IDENTIFY BASELINE CANDIDATES

The following factors were considered in identifying baseline candidates:

- **General market conditions.** Due to the energy mix in Indonesia, the host country, natural gas is the only potential fuel source for the proposed power plant. Similarly, receipt of the gas via a pipeline is the only viable option for transporting the natural gas.
- **Relevant legal requirements.** There are no regulations or laws in Indonesia governing the use of compressor technology or installation for the purposes of transporting natural gas in pipelines. To check for legal

requirements, applicable national, regional, and local laws were researched. In addition, Jogja Gas Pipelines, Inc., checked with local lawyers and government officials for any additional information. No applicable laws were found.

7.5 IDENTIFYING THE FINAL LIST OF BASELINE CANDIDATES

The resulting list of baseline candidates and associated data are provided in Table E2.2. This list consists of all compressors that went on line between 2001 and 2003 globally. All selected candidates are capable of providing the same quality and quantity of service as the compressors employed by the GHG project.

Chapter 9: Estimating Baseline Emissions—Performance Standard Procedure

9.1 SPECIFYING THE APPROPRIATE PERFORMANCE METRICS

For this project activity, a production-based performance metric is appropriate, since it is possible to quantify performance in terms of units of input per unit of product or service. The service in this case is the compression of natural gas. The amount of compression provided by compressor station drivers can be reliably inferred from their kilowatt-hours of electrical output. Thus, the units of service for the performance metric are kilowatt-hours (kWh).

The compressor station input related to the project activity's primary effect is a fuel: natural gas. Quantities of natural gas can be measured in terms of energy content (e.g., megajoules (MJ)). Therefore, for this project activity, the units for the relevant input are megajoules.

TABLE E2.2 Identified baseline candidates and data set for developing the GHG performance standard

COMPRESSOR	YEAR OPERATION STARTED	# OF COMPRESSOR UNITS AT EACH STATION	CAPACITY (KW/UNIT)	DESIGN FUEL USAGE (MJ/KWH)
Station A (Russia)	2003	25	70	10.5
Station B (China)	2003	10	70	11.1
Station C (Germany)	2003	5	50	12.2
Station D (Norway)	2003	25	55	11.5
Station E (Chile)	2003	30	65	12.7
Station F (Russia)	2003	22	60	11.5
Station G (Algeria)	2003	21	50	12.5
Station H (U.S.)	2002	18	50	15.5
Station I (U.S.)	2002	6	60	14.8
Station J (Nigeria)	2002	12	50	14
Station K (Qatar)	2002	15	60	14
Station L (China)	2002	23	55	15
Station M (China)	2002	36	50	15.5
Station N (Indonesia)	2002	14	30	16
Station O (Russia)	2002	20	40	15.5
Station P (U.S.)	2002	25	60	15.5
Station Q (Russia)	2002	25	50	15.9
Station R (Norway)	2001	13	40	16
Station S (Bolivia)	2001	26	50	15.2
Station T (Russia)	2001	21	50	15.5
Total # of Compressors		**392**		

The performance metric used to determine GHG emissions from baseline candidates is MJ/kWh.

9.2 CALCULATING THE GHG EMISSION RATE FOR EACH BASELINE CANDIDATE

Data on the performance rates for each baseline candidate were obtained in the process of identifying the baseline candidates (Table E2.2). Performance rates for compressor stations are measured using the performance metric MJ/kWh, also called the "design fuel usage." Design fuel usage data were found from the manufacturers' specification sheets for the drivers used at the compressor stations. The design fuel usage for a particular technology depends on the load at which the technology is run. Where the load data proved difficult to find, 100 percent load was assumed in order to be conservative (see Box E2.1). (This would result in the lowest possible design fuel usage for a particular technology.)

GHG emission rates were calculated for each baseline candidate using the IPCC emission factor for natural gas: 15.3 tonnes of C/TJ = 0.056 kg CO_2eq/MJ. The results are shown in Table E2.3.

BOX E2.1 Sample calculation of design fuel usage where load data are unavailable

A compressor station has a maximum rated capacity of 70 kilowatts (kW). Fuel usage over one year was measured at 7.5 million MJ, but no data are available on load or output (in kWh). Design fuel usage would be calculated as follows:

$$\frac{(7.5 \text{ million MJ/year})}{(70 \text{ kW}) \cdot (8{,}760 \text{ hours/year}) \cdot (100\% \text{ load factor})} = 12.2 \text{ MJ/kWh}$$

This fuel usage calculation is conservative, because if the load were in fact less than 100 percent, actual design fuel usage (and resulting GHG emissions) would be higher.

9.3 CALCULATING THE GHG EMISSION RATE FOR DIFFERENT STRINGENCY LEVELS

Different stringency level GHG emission rates were calculated as follows:

Most stringent: The lowest-emitting baseline candidate is Station A (0.59 kg CO_2eq/kWh).

TABLE E2.3 Baseline candidate GHG emission rates

BASELINE CANDIDATE	GHG EMISSION RATE (KG CO_2/KWH)
Station A	0.59
Station B	0.62
Station C	0.69
Station D	0.65
Station E	0.71
Station F	0.65
Station G	0.70
Station H	0.87
Station I	0.83
Station J	0.79
Station K	0.83
Station L	0.84
Station M	0.87
Station N	0.90
Station O	0.87
Station P	0.87
Station Q	0.89
Station R	0.90
Station S	0.85
Station T	0.87

Mean: The output-weighted average emission rate is 0.78 kg CO_2eq/kWh.

Median: The median (50th percentile) of this data set is equal to the GHG emission rate of the twelfth most efficient group of compressor units in the data set—i.e., Station S. This emission rate is 0.85 kg CO_2eq/kWh.

25th percentile: The 25th percentile of this data set is equal to the GHG emission rate of the sixth most efficient group of compressor units in the data set—i.e., Station G. This emission rate is 0.70 kg CO_2eq/kWh (see Box E2.2).

10th percentile: The 10th percentile of this data set is equal to the GHG emission rate of the third most efficient group of compressor units in the data set—i.e., Station D. This emission rate is 0.65 kg CO_2eq/kWh (see Box E2.2).

BOX E2.2 How to calculate the 10th and 25th percentiles

KG CO_2/KWH	COMPRESSOR RANKING
0.59	1–25
0.62	26–35
0.65	36–60
0.65	61–82
0.69	83–87
0.70	87–108
0.71	109–138
0.79	139–150
0.83	151–156
0.83	157–171
0.84	172–194
0.85	195–220
0.87	221–245
0.87	246–265
0.87	266–301
0.87	302–319
0.87	320–340
0.89	341–365
0.90	366–378
0.90	379–392

For the 25th percentile:

$$w = (392) \cdot \left(\frac{25}{100}\right) + 0.5 = 98.5 \quad g = 98, f = 0.5, \text{ and } a = 392$$

$$pe = (1 - 0.5) \cdot (0.70) + 0.5(0.70) = \mathbf{0.70\ kg\ CO_2eq/kWh}$$

For the 10th percentile:

$$w = (392) \cdot \left(\frac{10}{100}\right) + 0.5 = 39.7 \quad g = 39, f = 0.7, \text{ and } a = 392$$

$$pe = (1 - 0.7) \cdot (0.65) + 0.7(0.65) = \mathbf{0.65\ kg\ CO_2eq/kWh}$$

9.4 SELECTING AN APPROPRIATE STRINGENCY LEVEL FOR THE PERFORMANCE STANDARD

The 10th percentile stringency level was chosen, corresponding to a performance standard of 0.65 kg CO_2eq/kWh. This stringency level is equivalent to the emission rates of Stations D and F, both recently constructed compressor stations. The data graphed in Figure E2.1 reveal that the compressor stations that started operation in 2003 (Stations A–G) have significantly lower emission rates on average than those that came on line in 2001 and 2002 (Stations H–T). Taking account of this trend, the 10th percentile seems reasonable, given that it equates roughly to the average emission performance of the 2003 compressor stations. For this and other reasons (e.g., considerations about additionality, which are not discussed here), the 10th percentile stringency level is determined to be a reasonable estimate for the baseline emission rates for future compressor stations.

9.5 ESTIMATING BASELINE EMISSIONS

Baseline emissions are calculated as the performance standard emissions rate multiplied by the project activity level of service (measured in kWh). It is assumed that the kilowatt-hours of output (and therefore the amount of gas compressed) remains the same in the baseline scenario and project, since the project activity itself will not significantly alter the supply of, or demand for, natural gas. Annual baseline emissions are calculated under section 10.2.2 as part of quantifying the GHG reductions.

Chapter 10: Monitoring and Quantifying the GHG Reductions

For this project example, monitoring and quantifying GHG reductions are relatively straightforward. This section presents a simple overview of how monitoring and quantification requirements can be met. Technical details related to monitoring conditions and equipment specifications are omitted.

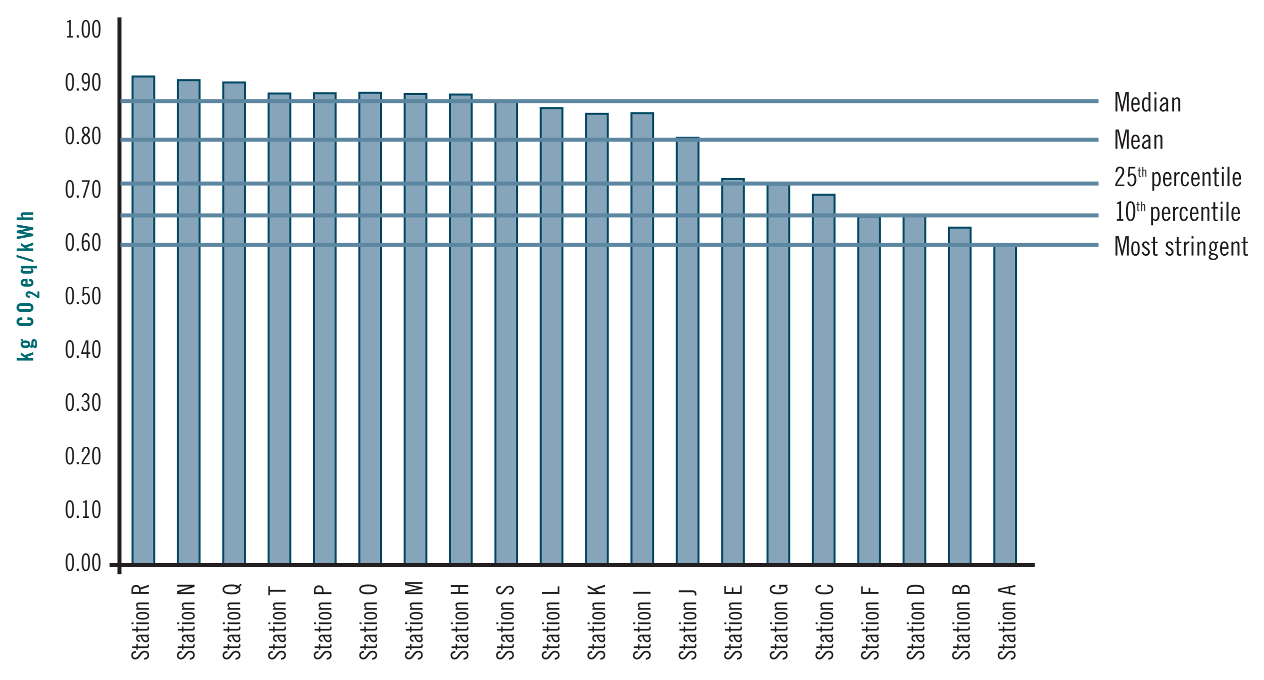
10.1 CREATING A MONITORING PLAN

Because there are no significant secondary effects, the monitoring plan is devoted to the Jogja project's single primary effect—i.e., reductions in combustion emissions from generating off-grid electricity resulting from reduced fuel use by compressors. Elements of the monitoring plan are described below.

10.1.1 MONITORING PROJECT ACTIVITY EMISSIONS

- For each of the 30 compressors installed under the GHG project, fuel usage data will be collected continuously using natural gas flow meters. The data will be converted to units of MJ, based on standard factors for the energy content of natural gas. Uncertainty associated with these measurements will be low.

FIGURE E2.1 Different stringency levels applied to the compressor data set



- CO_2 emissions will be calculated by multiplying fuel usage data (in MJ) for each compressor by the IPCC emission factor for natural gas (0.056 kg CO_2eq/MJ).

10.1.2 MONITORING BASELINE PARAMETERS

No baseline parameters are monitored. The performance standard is assumed to be a valid indicator of baseline emissions for a period of 3 years (see section 10.2.1).

10.1.3 DESCRIBING QA/QC MEASURES

- All data will be collected electronically and archived for 10 years.
- Equipment will be checked and calibrated bi-annually.

10.2 QUANTIFYING GHG REDUCTIONS

10.2.1 IDENTIFYING THE TIME PERIOD OVER WHICH GHG REDUCTIONS WILL BE QUANTIFIED

From the limited global data set on new compressor stations between 2001 and 2003, it appears that compressor station efficiency and GHG emissions performance have been improving and improved noticeably in 2003. The gains in efficiency seen in 2003, however, are not expected to proceed as rapidly in the near future. Given recent trends and future expectations, the performance standard is assumed to be valid for a period of 3 years.

10.2.2 CALCULATIONS FOR QUANTIFYING GHG REDUCTIONS

The GHG reductions are calculated as the difference between the baseline emissions and the project activity emissions:

GHG Reduction = Baseline emissions
− Project activity emissions

Because secondary effects were considered negligible (i.e., baseline and project activity emissions associated with one-time, upstream, and downstream GHG sources are equivalent), they were not included in the GHG reduction equation. Therefore, the total GHG reductions are equal to the change in GHG emissions associated with reducing fuel consumption by the compressors.

Table E2.4 illustrates the assumptions used for calculating baseline and project activity emissions. All compressors operate under the same conditions (i.e., load and hours of operation). The GHG project will install thirty compressors.

TABLE E2.4 Baseline and project activity emissions

	ASSUMPTION FACTORS	BASELINE VALUES	PROJECT ACTIVITY VALUES
1	Power/Max Load (kW)	70	70
2	Operating Hours (hrs/yr)	8,300	8,300
3	Load Factor (%)	80	80
4	No. of Compressors	30	30
5	GHG Emission Rate* (kg CO_2eq/kWh)	0.65	0.60

*These figures are rounded; results below were calculated with unrounded numbers.

Baseline emissions for a compressor are expressed by the performance standard emission rate (0.65 kg CO_2eq/kWh) multiplied by the total kWh of compression provided (13.9 million kWh, derived from rows 1–4 of Table E2.4). Project activity emissions are calculated using the high-efficiency compressor design fuel usage (10.6 MJ/kWh) multiplied by the IPCC emission factor for natural gas (0.056 kg CO_2eq/MJ) multiplied by the total kWh of compression provided (also 13.9 million kWh).

Compressor Station GHG Project

Baseline Emissions =

(Power load) · (Operating Hours) · (Load Factor) · (# of Compressors) · (Performance Standard Emission Rate) / 1,000

$$= \frac{(70) \cdot (8{,}300) \cdot (80\%) \cdot (30) \cdot (0.65)}{1{,}000}$$

$= 9{,}004 \text{ t } CO_2eq/\text{year}$

Project Activity Emissions =

(Power load) · (Operating Hours) · (Load Factor) · (# of Compressors) · (Project Activity Emission Rate) / 1,000

$$= \frac{(70) \cdot (8{,}300) \cdot (80\%) \cdot (30) \cdot (0.60)}{1{,}000}$$

$= 8{,}299 \text{ t } CO_2eq/\text{year}$

GHG Reductions =

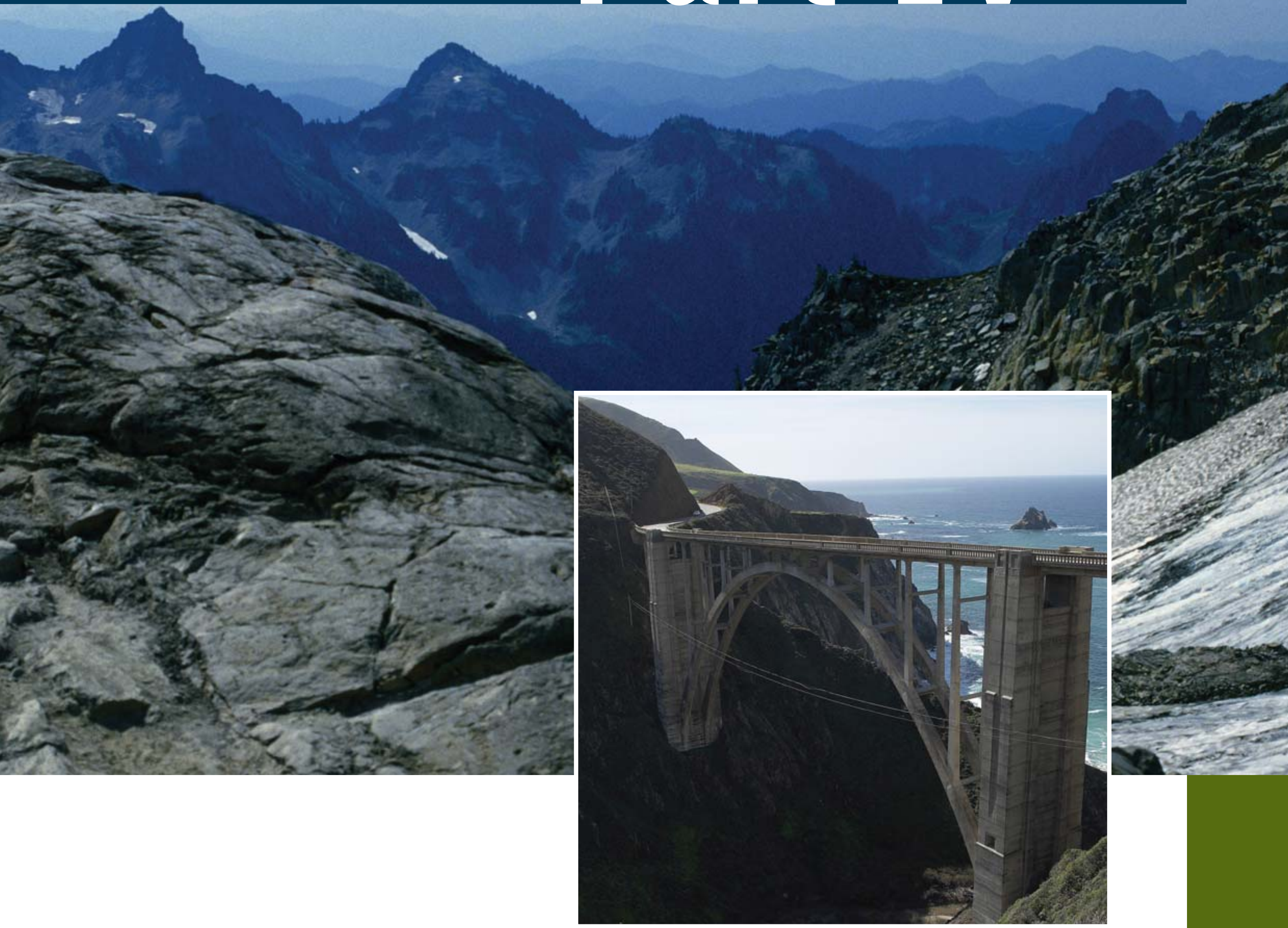
Baseline Emissions – Project Activity Emissions

$= 9{,}004 - 8{,}299$

$= 705 \text{ t } CO_2eq/\text{year}$

Actual GHG reductions will be quantified annually using monitored data, for a period of 3 years.

Part IV



Supplementary Information

A Legal Requirements

Legal requirements are sometimes relevant to determinations about additionality. If laws or regulations require the use of a certain technology or practice utilized by the project activity, and using that practice or technology is the only way to comply with the laws or regulations, then the project activity will probably not be additional. Similarly, any baseline candidates that do not comply with legal requirements will in most cases be rejected as possibilities for the baseline scenario.

This annex provides guidance on the kinds of information that may be needed for assessing the compliance of the project activity and baseline candidates with legal requirements.

A.1 Laws and Regulations to Consider

Laws or regulations may directly affect the GHG emissions of the project activity or a baseline candidate (e.g., a stipulated standard requires the use of more energy-efficient equipment), or may affect GHG emissions indirectly as a consequence of their implementation (e.g., a law that mandates water use reductions may lower the daily water pumping rate—and thereby energy use—at a water treatment plant). Both types of laws or regulations should be considered when assessing if the project activity or baseline candidates comply with legal requirements.

In certain circumstances, a decision on the relevance of laws and regulations and/or their interpretation may be required. The principle of transparency should be used in making these decisions. Cases where interpretations may be necessary include:

1. **Policy versus regulation/legislation.** Some countries may have a declared policy to promote specific technologies or practices that result in GHG reductions (e.g., India's policy of meeting 10 percent of its power generation through renewable energy by year 2012), but do not have any corresponding regulations. Also, regulations are enforceable by law (with penalty for non-compliance), whereas a policy is not always enforceable (and, consequently, there is no penalty for non-compliance). This distinction is important because while GHG projects (and therefore the project activity) may contribute to meeting the policy goals, legal requirements are not relevant because no explicit regulation exists to enforce the policy.
2. **Clarity of the law or regulation.** Where the applicability of a law or regulation is unclear, it may be necessary to interpret the intent of the law or regulation. For instance, stated technology, performance, or management standards may be unclear and difficult to interpret with regard to their relevance to the project activity and baseline candidates. Also, laws and regulations sometimes have conflicting goals. For instance, a country may have a subsidy for fossil fuel used for electricity generation, as well as a national regulation specifying that a certain amount of electricity generation must come from renewable sources. The project developer may need to explain the impact of these two regulations on the development of the GHG project—e.g., low electricity prices due to the subsidy on fossil fuels deter the development of renewable energy projects, despite a national regulation to encourage the development of renewable energy.
3. **Laws or regulations applying to project activities where the affected sites, facilities, production systems, or delivery systems associated with affected GHG sources or sinks are located in different regulatory jurisdictions.** Where a project activity and the affected sites, facilities, production systems, or delivery systems where GHG emissions arise are located in different jurisdictions, the relevant laws or regulations to consider are usually those that apply to the location of the project activity, rather than the location of the sites where GHG emissions are affected. However, it may be useful to consider, if possible, relevant laws in both jurisdictions. For example, a project activity to reduce electricity use takes place at a U.S. company in New York; however, some of the combustion sources feeding the electricity grid are in Canada. The project developer should consider both U.S. and Canadian regulations regarding the project activity and explain why certain regulations may not be applicable.
4. **Pending regulations.** Where pending regulations may affect the GHG project or a project activity in the near future, it may be useful to note their possible impact and to track their development in the monitoring plan.

A.2 Finding Information on Legal Requirements

Locating information on the relevant legal requirements can be time consuming. Possible information sources include:

- public documents listing national, regional, state/provincial, or local mandatory laws, or regulatory standards;
- legal texts;
- local lawyers and legal opinions; and
- local regulators or enforcement bodies.

While collecting the information, project developers should ensure that all information is reliable and verifiable.

A.3 Legal Requirements, Enforcement, and Common Practice

In some cases, determining whether possible baseline candidates are compliant with legal requirements may not be useful for identifying a final list of baseline candidates. The enforcement of laws and regulations may be uneven or weak because of financial and/or administrative constraints on enforcement or regulatory agencies. For instance, a regulation may have been promulgated at a national level, but implementation at the provincial or regional level may be weak. In this case, what is common practice may become more important than legal requirements when trying to identify the baseline candidates. Box A.1 provides some possible sources of information for establishing enforcement levels and common practice.

BOX A.1 Information sources for establishing enforcement levels and common practice

Land-Use Projects

- Remote sensing
- Aerial photographs
- Surveys, e.g., U.S. Forest Service surveys
- Random spot-checking on the ground (which can be generalized for the rest of an area). This method is used for forest certification
- Tax records may shed light on a company's activity in a certain area, which can then be compared to any existing laws
- Other records in the public domain that reflect certain land-use activities that do not comport with the law

GHG Emission Reduction Projects

- Regulatory permits to see what companies undertaking similar activities are required to do. In most countries this should be public information
- Number of fines administered for not complying with a given law or regulation
- Surveys of technology penetration or use, compliance action, etc.
- An enforcement agency may acknowledge that certain laws or regulations are not being enforced or are poorly enforced
- Expert opinions

B Illustrative Information Sources for Barrier Categories

Following are some possible information sources for the barrier categories outlined in Chapter 8.

B.1 Financial and Budgetary

Type of Information: Financial or budgetary information (e.g., availability of financing, credit, foreign capital, risk).

Information Sources: Documents prepared by the project developer, contractors, or project partners in the context of the proposed project or similar previous projects; official planning data; public reports or studies (e.g., baseline studies for other projects); lending institution reports; and country-specific laws on foreign investment.

B.2 Technology, Operation, and Maintenance

Type of Information: Locally available fuels, materials, know-how, technology, and other resources.

Information Sources: Technology inventory lists; industry studies or corporate documents; local advisors/experts familiar with the local conditions around the project.

Type of Information: Skill and informational data (e.g., training programs, information dissemination mechanisms).

Information Sources: Sector-level reports of bilateral and multilateral organisations (e.g., Joint Implementation/Clean Development Mechanism); National Strategies Studies; public reports or studies (e.g., baseline studies for other projects); nongovernmental organisations (NGOs); government sources; local advisors/experts familiar with local conditions.

B.3 Infrastructure

Type of Information: Extent of infrastructure (e.g., roads for transporting inputs or products, support companies or personnel for maintaining equipment).

Information Sources: Industry studies or corporate documents; local advisors/experts familiar with the local conditions; public reports or studies (e.g., baseline studies for other projects); infrastructure maps (e.g., road, railways).

B.4 Market Structure

Type of Information: Market information (e.g., product prices, tariffs, import rules, distribution systems).

Information Sources: Industry studies or corporate documents; local advisors/experts familiar with the local conditions; public reports or studies (e.g., baseline studies for other projects).

B.5 Institutional, Social, Cultural, and Political

Type of Information: Institutional, social, cultural, and political conditions.

Information Sources: NGOs; local advisors/experts familiar with the local conditions.

B.6 Resource Availability

Type of Information: Geographic and climatic conditions; availability of natural resources.

Information Sources: Resource maps; NGOs; local advisors/experts familiar with local conditions.

C Assessing Net Benefits Using Investment Analysis

For many types of projects, financial returns (those not related to GHG reductions) will constitute a significant and tangible form of benefits. Thus, in some cases, developing a convincing assessment of the relative net benefits for the baseline scenario alternatives may require some form of investment analysis.[1]

Investment analysis seeks to assess in a detailed and rigorous way one component of the benefits that may arise from implementing the GHG project or a baseline candidate—i.e., expected financial returns—without considering non-revenue benefits, and without accounting for any identified barriers other than cost. To identify the baseline scenario, investment analysis excludes any potential revenues associated with the sale of GHG reductions. The goal is to determine which of the possible baseline scenario alternatives has the highest expected financial benefits—excluding any GHG reduction revenues—and whether the GHG project or any of the baseline candidates would be preferable financially to "doing nothing" (defined as continuing current activities).

There are several methods for conducting investment analysis, and nearly unlimited levels of detail at which these methods can be performed. To identify the baseline scenario, it is generally not necessary to provide a detailed itemization of expected costs and revenues, as long as the overall magnitude of identified cost and revenue streams can be explained. All relevant costs (capital, operations and maintenance, fuel costs, taxes, etc.) and revenues (as appropriate) should be reflected in the analysis.

There are two options for performing an investment analysis:

- Expected Cost Comparison, and
- Financial Benchmark Comparison

C.1 Expected Cost Comparison

This option is only used when the continuation of current activities is not a valid baseline scenario alternative—i.e., there are insurmountable barriers to continuing current activities, or continuing current activities is not a meaningful possibility.

Under this option, the project activity and baseline candidates are compared on the basis of expected costs, without considering any potential revenues.[2] Expected costs may be expressed in terms of:

- Present value, or
- Levelized cost per unit of product or service (e.g., levelized $/kWh).

Comparing expected costs based on their present value is only appropriate when the project activity and all baseline candidates would produce an identical quantity of the same (identical quality) product or service. If the project activity and baseline candidates are of different size (e.g., power plants of differing capacities), compare costs using the levelized cost per unit of product or service.

Although baseline candidates are compared to the project activity, any investment analysis should evaluate costs and/or revenues for an entire GHG project, not a single component project activity. As explained in Chapter 8 (Box 8.3), this is because the decision to implement a particular project activity almost always depends on a decision about implementing the entire GHG project with which it is associated. In some cases, it may be difficult or impossible to meaningfully assign revenues and costs for an entire GHG project to a specific project activity.

Note: If it is not possible to express costs per unit of product or service—or project developers otherwise wish to base a comparison on expected net revenues rather than expected costs—the GHG project and baseline candidates may be compared on the basis of their internal rates of return (IRR). The advantage of this approach is that it is not necessary to identify and defend a particular discount rate (see step (e), below). To do a comparison based on an IRR, follow the steps for doing a Financial Benchmark Comparison, choosing IRR as the financial indicator, but ignore any steps for calculating a benchmark rate of return and exclude "continuation of current activities" from the list of baseline scenario alternatives.

An expected cost comparison analysis should consist of the following basic steps:

a) **Identify the Expected Costs.** For the GHG project and each baseline candidate, identify all relevant costs and classify them according to whether they are: (1) upfront or ongoing; and (2) fixed or variable. Provide a further breakdown and itemization of the costs as desired to enhance the transparency and credibility of the analysis.

In theory, taxes should be included as a cost, even though calculating taxes without any knowledge of revenues is usually not possible. Therefore, tax costs should be estimated, and these estimates should be explained.

b) **Identify the Time Period.** Identify the time period over which costs will be evaluated. In most cases, this should correspond to the expected length or lifetime of the GHG project (not the valid length of the baseline scenario). The GHG project and all baseline candidates should be evaluated over the same time period. (If a particular baseline candidate has an expected lifetime shorter than the identified time period, assume that it is replaced with the same technology or practice at the end of its lifetime, incurring costs for replacement as appropriate, and that it operates until the end of the identified time period).

c) **Present Costs Numerically.** For the GHG project and each baseline candidate, provide numerical estimates of the costs in each category. Ongoing costs should be estimated for discrete time periods (usually one year) until the end of the time period identified in step (b). Cost estimates should be fully explained.

d) **Assess Cost Uncertainties.** For the GHG project and each baseline candidate, provide a qualitative assessment of the uncertainty associated with the cost estimates for each cost category identified in step (a). (These should be the same for the GHG project and all baseline candidates). For example, ongoing variable costs may depend largely on the cost of fuel; therefore, the degree of uncertainty associated with fuel cost projections should be characterized. Any associated uncertainties should not include any risk factors identified as barriers or reflected in the discount rate identified in step (e).

e) **Identify an Appropriate Discount Rate.** Identify an appropriate discount rate to use for calculating either the present value of costs or the levelized cost per unit of service. An appropriate discount rate may be derived from the same sources that would be used to derive a benchmark rate of return (see Financial Benchmark Comparison, step (a)). The discount rate and how it was chosen should be explained for transparency purposes.

The choice of discount rate is not crucial if it can be shown that changing the discount rate (e.g., as part of a sensitivity analysis) does not result in a change in the relative ranking of expected costs for the GHG project and all baseline candidates. This could be the case if the GHG project and all baseline candidates have similar ratios of upfront to ongoing costs, and no major differences in the expected timing of ongoing costs. In such cases, less effort may be required to justify a particular discount rate.

f) **Calculate a (Reasonable) Range of Expected Costs for the GHG Project and Each Baseline Candidate.** Using the discount rate identified in step (e), calculate reasonable low and high estimates of expected costs—present value or levelized—by varying numerical cost estimates according to the degree of associated uncertainty identified in step (d). Estimates of low and high expected costs should also reflect the effects of different discount rate assumptions (if changing the discount rate could result in a different relative ranking of the GHG project and baseline candidates). All assumptions used to generate high and low cost estimates should be explained.

Low and high expected cost estimates should not necessarily reflect "best case" and "worst case" outcomes, as these outcomes may be very unlikely to happen. Rather, they should reflect a range of outcomes that are reasonably likely to occur and indicate a reasonable cost range that reflects the identified levels of uncertainty in underlying cost drivers (construction costs, fuel costs, maintenance costs, etc.).

g) **Rank the Results.** Using the results of step (f), rank the GHG project and baseline candidates from highest to lowest expected cost. (Table C.1 presents one way to express the ranking results). In general, use the midpoint of each cost range to decide the appropriate rank. This ranking is also from lowest to highest net benefits.

OPTIONAL: SENSITIVITY ANALYSIS

In cases where a clear ranking of baseline scenario alternatives using low and high estimates is difficult, it may be desirable to conduct a full sensitivity analysis of expected costs. A sensitivity analysis tests the robustness of the results from the expected cost analysis by varying any external parameters or assumptions that are not in the project developer's control (such as input costs), and key decision-making parameters (such as the discount rate). Sensitivity analyses can be

TABLE C.1 Example of results from expected cost comparison

BASELINE SCENARIO ALTERNATIVES	PRESENT VALUE OF EXPECTED COSTS	EXPECTED COST RANK	RELATIVE RANKING
Baseline Candidate 3	$25-$40 million	1	Lowest Net Benefits
Continuation of Current Activities	N/A	N/A	N/A
GHG project*	$20-$30 million	2	Low Net Benefits
Baseline Candidate 2	$15-$22 million	3	Middle Net Benefits
Baseline Candidate 1	$8-$17 million	4	Greatest Net Benefits

*Investment analysis evaluates costs/revenues for the entire GHG project, not individual project activities.

performed with most financial analysis tools with minimal extra effort. Realistic deviations for assumptions should be used to test if the ranking of baseline scenario alternatives changes as common assumptions change. Choose the ranking that corresponds to the best set of realistic assumptions, and explain why this set of assumptions was chosen.

C.2 Financial Benchmark Comparison

A financial benchmark comparison is performed in cases where the continuation of current activities is a valid baseline scenario alternative. In these cases, a benchmark is identified that represents the benefits decision-makers would expect to realise (e.g., from alternative investments) if they did not invest in the GHG project or any of the baseline candidates. This is usually done by specifying some form of required rate of return for an investment.[3]

A financial benchmark comparison involves an assessment of both expected costs and expected revenues for the GHG project and all baseline candidates (unless a "unit cost of service" benchmark is used, as described below). Under this option, financial returns for the GHG project and baseline candidates are compared with each other and with the benchmark rate of return to determine a relative ranking of baseline scenario alternatives with respect to net benefits.

A financial benchmark comparison should consist of the following basic steps:

a) **Identify a Benchmark Rate of Return.** A benchmark rate of return is required to assess the GHG project and baseline candidates against the possible continuation of current activities. Generally speaking, the benchmark rate of return should reflect standard returns in the market to which the GHG project is providing products or services, considering specific risks for that market and technology sector. It should not reflect the subjective profitability expectation or risk profile of a particular project developer, or risks specific to the GHG project or a particular baseline candidate. The latter types of risk should instead be identified as "financial and budgetary" barriers in the comparative assessment of barriers step of the project-specific procedure (Chapter 8). The choice of benchmark rate of return should be explained for transparency purposes. Some possible sources for benchmark rate of return are listed below:[4]

- Government bond rates, increased by a suitable risk premium to reflect private investment and/or the GHG project type, as substantiated by an independent (financial) expert.
- Estimates of the cost of financing and required return on capital (e.g., commercial lending rates and guarantees required for the country and the type of project represented by the GHG project). These estimates should be based on bankers' views and private equity investors' or funds' required return on investment for comparable projects.
- A company internal benchmark (weighted average capital cost of the company), if the company is the sole project developer (e.g., when the GHG project upgrades or retrofits an existing process). The project developer should demonstrate that this

benchmark has been consistently used in the past—i.e., that projects under similar conditions developed by the same company used the same benchmark.

b) Choose an Appropriate Financial Return Indicator. Choose a financial indicator with which to characterize the returns of the GHG project and baseline candidates, explain the choice, and compare the returns to the continuation of current activities. The appropriate type of financial return indicator may depend on the type of GHG project and conventions within its technology sector. Some common indicators and qualifications on their use for investment comparisons are provided below.[5]

- ***Internal Rate of Return (IRR).*** The IRR is an intrinsic rate of return for the GHG project or baseline candidate based on expected cost and revenue streams. The higher the IRR, the more desirable the GHG project or baseline candidate will be as an investment. Calculated IRRs must be compared to the benchmark rate of return identified in step (a) to determine whether a particular baseline candidate (or the GHG project) will have positive or negative net financial benefits. Any baseline candidate with an IRR lower than the benchmark rate of return (even if the IRR is positive) will, in effect, have negative net financial benefits relative to the continuation of current activities.
- ***Net Present Value (NPV).*** The NPV expresses future streams of costs and revenues as a single net amount of current dollars relative to the opportunity cost of investment, as represented by the benchmark rate of return. A negative NPV means that a baseline candidate would have negative net financial benefits relative to the continuation of current activities, while a positive NPV indicates positive net financial benefits. However, NPV can only be used to validly compare the GHG project and baseline candidates to each other if they are all of identical size or capacity and will produce identical quantities of a product or service. NPV is not used as a basis for comparison if the GHG project and baseline candidates are of different sizes or capacities (e.g., if the GHG project is a 100-MW natural gas power plant and one of the baseline candidates is a 500-MW coal plant).
- ***Cost-Benefit Ratio.*** A cost-benefit ratio calculates the present value of costs and revenues separately and expresses the results as a ratio. The benchmark rate of return is used as the discount rate to determine present value. A positive cost-benefit ratio means that a baseline candidate would be expected to have negative net financial benefits relative to continuing current activities. Cost-benefit ratios may be used to compare and rank the GHG project and baseline candidates, regardless of their relative sizes and capacities.
- ***Unit Cost of Service.*** The unit cost of service indicator is a levelized cost per unit of product or service produced by the GHG project and baseline candidates (e.g., levelized $/kWh or levelized $/Gigajoule). The benchmark rate of return is used to calculate expected levelized costs for the GHG project and baseline candidates. Expected revenues are not included in this calculation. However, use of this type of financial indicator requires identifying a second benchmark: a benchmark unit cost of service to which the levelized unit costs of the GHG project and baseline candidate may be compared. This second benchmark, in effect, proxies for expected revenues. Baseline candidates with a lower expected unit cost than the benchmark will have positive net benefits relative to the continuation of current activities. Expected unit costs may be used to rank baseline candidates and the GHG project against each other. There may be several ways to specify a benchmark unit cost of service. Standard methods would include the use of historical or projected market prices, or an analysis of long-run marginal costs for the product or service produced by the GHG project and baseline candidates.

c) Identify the Expected Costs. Identify all relevant costs and classify them according to whether they are: (1) upfront or ongoing, and (2) fixed or variable. Provide further breakdown and itemization of costs as desired to enhance the transparency and credibility of the analysis.

d) Identify the Expected Revenues. For the GHG project and each baseline candidate, identify all sources of revenue (other than any revenues that may arise from the GHG reductions themselves—e.g., tradable credit revenues).

e) Identify the Time Period. Identify the time period over which costs and revenues will be evaluated. In most cases, this period should correspond to the expected length or lifetime of the GHG project. The GHG project and all baseline candidates should be evaluated over the same time period. (If a particular baseline candidate has an expected lifetime shorter than the identified time period, assume that it is replaced with the same technology or practice at the end of its lifetime, incurring costs for replacement as appropriate, and that it operates until the end of the identified period).

f) Estimate Costs and Revenues Numerically. For the GHG project and each baseline candidate, provide numerical estimates of the costs and revenues in each identified category. Ongoing costs and revenues should be estimated for discrete time periods (usually one year) until the end of the time period identified in step (e). Cost and revenue estimates should be explained.

g) Assess the Cost and Revenue Uncertainties. For the GHG project and each baseline candidate, provide a qualitative assessment of the uncertainty associated with the cost and revenue estimates for each cost category. For example, ongoing variable costs may depend largely on the cost of fuel; the degree of uncertainty associated with fuel cost projections should therefore be characterized. Any associated uncertainties should not include any risk factors identified as barriers or reflected in the benchmark rate of return identified in step (a).

h) Calculate a (Reasonable) Range of Expected Financial Returns for the GHG Project and Each Baseline Candidate. Using the financial return indicator identified in step (b), calculate reasonable low and high estimates of expected returns (or expected levelized unit costs if using the unit cost of service indicator). Calculate this range by varying numerical cost and revenue estimates according to the degree of associated uncertainty identified in step (g). Explain all assumptions used to generate high and low financial return/unit cost estimates.

Low and high expected financial return/unit cost estimates should not necessarily reflect "best case" and "worst case" outcomes, as these outcomes may be unlikely to happen. Rather, they should reflect a range of outcomes that are reasonably likely to occur and indicate a reasonable range that reflects the identified levels of uncertainty in underlying cost and revenue drivers.

i) Examine Sensitivity to Benchmark Assumptions. If the IRR is not being used as the financial indicator, examine the sensitivity of the results in step (h) to changes in the benchmark rate of return. As appropriate, adjust the ranges identified in step (h) based on the results for a reasonable range of benchmark rates of return. Describe the overall degree of sensitivity to these changes in the benchmark rate of return, and explain the range of benchmark rates of return used to adjust the results in step (h).

j) Rank the Results for the GHG Project and Baseline Candidates. Using the results of step (h), rank the GHG project and baseline candidates from lowest to highest expected returns (IRR, NPV, or Cost-Benefit Ratio), or highest to lowest expected unit cost (Unit Cost of Service). In general, use the midpoint of each cost range to decide the appropriate rank. Include the continuation of current activities in the ranking. The appropriate value for the relative net benefits of continuing current activities will depend on the chosen financial return indicator, as shown in Table C.2.

TABLE C.2 Relationship between financial return indicator and value for continuation of current activities

FINANCIAL RETURN INDICATOR	VALUE FOR CONTINUATION OF CURRENT ACTIVITIES
IRR	Benchmark Rate of Return (+/-)
NPV	$0
Cost-Benefit Ratio	1
Unit Cost of Service	Benchmark Unit Cost of Service (+/-)

TABLE C.3 Example of results from financial benchmark comparison: IRR

BASELINE SCENARIO ALTERNATIVES	IRR	NET BENEFITS	RELATIVE RANKING
Baseline Candidate 3	2 – 5%	Negative	Lowest Benefits
Continuation of Current Activities	9 – 11%*	Zero	Low Benefits
GHG project	10 – 12%	Slightly Positive	Low Benefits
Baseline Candidate 2	13 – 17%	Positive	Medium Benefits
Baseline Candidate 1	17 – 30%	Large Net Benefits	Highest Benefits

*Identified range for benchmark rate of return

TABLE C.4 Example of results from financial benchmark comparison: NPV

BASELINE SCENARIO ALTERNATIVES	NPV	NET BENEFITS	RELATIVE RANKING
Baseline Candidate 3	-$3 to -$1 million	Negative	Lowest Benefits
Continuation of Current Activities	$0*	Zero	Low Benefits
GHG project	-$1 to $4 million	Slightly Positive	Low Benefits
Baseline Candidate 2	$4 to $7 million	Positive	Medium Benefits
Baseline Candidate 1	$9 to $10 million	Large Net Benefits	Highest Benefits

*NPV is defined as zero for continuing current activities for all sensitivity scenarios.

TABLE C.5 Example of results from financial benchmark comparison: cost-benefit ratio

BASELINE SCENARIO ALTERNATIVES	COST-BENEFIT RATIO	NET BENEFITS	RELATIVE RANKING
Baseline Candidate 3	1.2 – 1.5	Negative	Lowest Benefits
Continuation of Current Activities	1*	Zero	Low Benefits
GHG project	0.8 – 1.1	Slightly Positive	Low Benefits
Baseline Candidate 2	0.6 – 0.9	Positive	Medium Benefits
Baseline Candidate 1	0.2 – 0.5	Large Net Benefits	Highest Benefits

*Cost-benefit ratio is defined as 1 for continuing current activities for all sensitivity scenarios.

Examples of how to present the possible final rankings in a matrix format are provided in Tables C.3 through C.6. Other presentation formats may also be used.

OPTIONAL: SENSITIVITY ANALYSIS

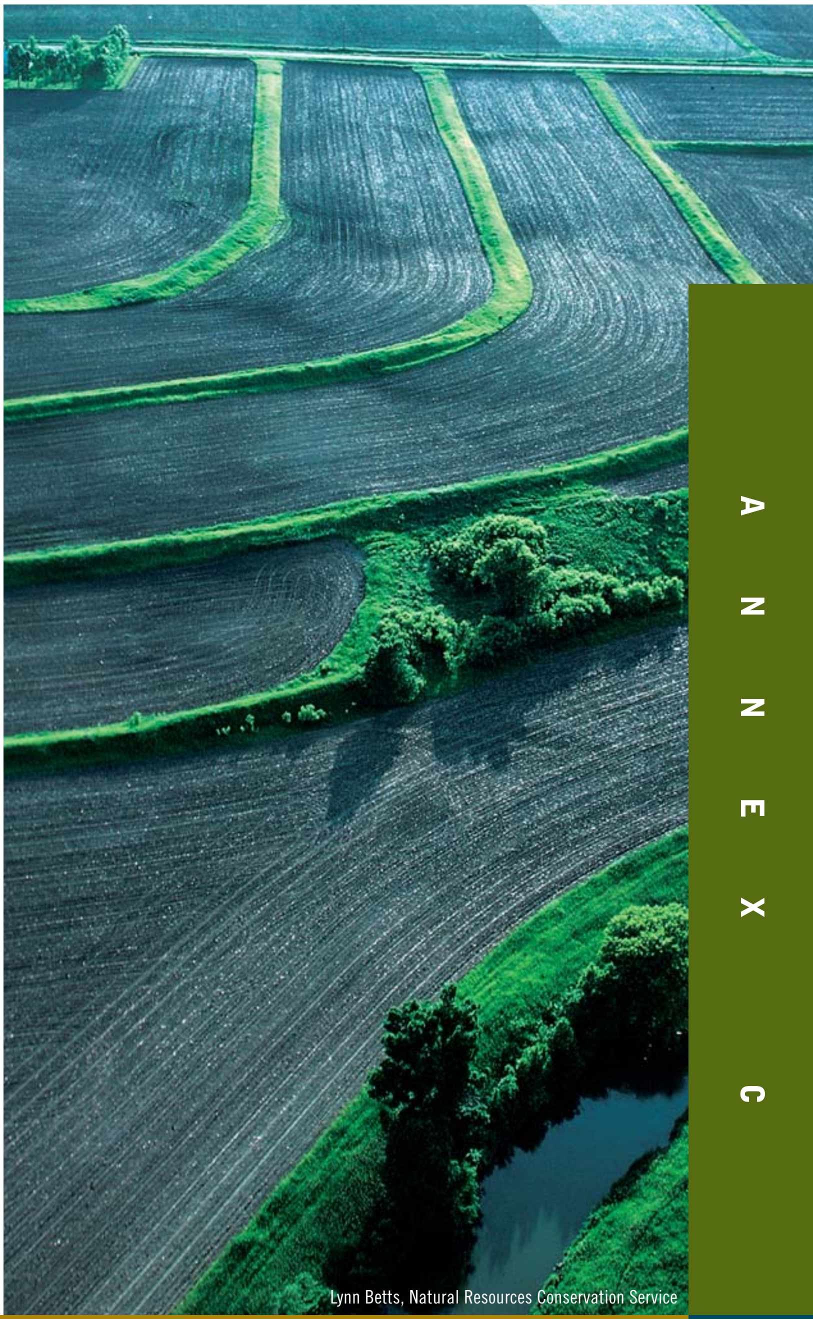
In cases where a clear ranking of baseline scenario alternatives using low and high estimates is difficult, it may be desirable to conduct a full sensitivity analysis of financial benchmark results. A sensitivity analysis tests the robustness of the results by varying any external

TABLE C.6 Example of results from financial benchmark comparison: unit cost of service

BASELINE SCENARIO ALTERNATIVES	UNIT COST OF SERVICE (e.g., $/KWH)	NET BENEFITS	RELATIVE RANKING
Baseline Candidate 3	$0.09 - $0.12	Negative	Lowest Benefits
Continuation of Current Activities	$0.03 - $0.05*	Zero	Low Benefits
GHG project	$0.03 - $0.04	Slightly Positive	Low Benefits
Baseline Candidate 2	$0.025 - $0.035	Positive	Medium Benefits
Baseline Candidate 1	$0.02 - $0.025	Large Positive	Highest Benefits

*Identified range for benchmark unit cost of service

parameters or assumptions that are not in the project developer's control (such as input costs and output prices), and key decision-making parameters (such as the discount rate). Sensitivity analyses can be performed with most financial analysis tools with minimal extra effort. Realistic deviations for the assumptions should be used to test if the ranking of baseline scenario alternatives changes as common assumptions change. Choose the ranking that corresponds to the best set of realistic assumptions, and explain why this set of assumptions was chosen.


Lynn Betts, Natural Resources Conservation Service

NOTES

[1] Investment analysis may not be required or appropriate for GHG projects where the primary non-GHG benefits to decision-makers are not financial.

[2] In other words, this option is analogous to a cost-effectiveness analysis.

[3] The required rate of return essentially represents the "opportunity cost" of an investment. In the very broadest terms, it represents the return decision-makers could expect if they put their money into a standard set of investment options unrelated to the GHG project or any of the baseline candidates.

[4] From the CDM "Tool for the Demonstration and Assessment of Additionality," EB 16 Report Annex 1, United Nations Framework Convention on Climate Change.

[5] In some cases, examining more than one indicator will provide greater insight into the relative ranking of baseline scenario alternatives from a decision-maker's perspective. For example, if two baseline candidates have very similar IRRs, the one with the higher expected NPV (if there is one) will generally be preferred.

D Glossary

Additionality	A criterion often applied to GHG projects, stipulating that project-based GHG reductions should only be quantified if the project activity "would not have happened anyway"—i.e., that the project activity (or the same technologies or practices it employs) would not have been implemented in its baseline scenario and/or that project activity emissions are lower than baseline emissions.
Allowances	The basic tradable commodity within GHG emission trading systems. Allowances grant their holder the right to emit a specific quantity of pollution once (e.g., one tonne of CO_2eq). The total quantity of allowances issued by regulators dictates the total quantity of emissions possible under the system. At the end of each compliance period, each regulated entity must surrender sufficient allowances to cover their GHG emissions during that period.
Barriers	Any factor or consideration that would (significantly) discourage a decision to try to implement the project activity or its baseline candidates.
Base Year	A historic datum (a specific year or an average over multiple years) for tracking corporate GHG emissions over time. This term applies only to corporate or entity-wide GHG accounting, not to project-based GHG accounting.
Base Year Emissions	GHG emissions in the base year. This term applies only to corporate or entity-wide GHG accounting, not to project-based GHG accounting.
Baseline Candidates	Alternative technologies or practices within a specified geographic area and temporal range that could provide the same product or service as the project activity.
Baseline Emissions	An estimate of GHG emissions, removals, or storage associated with a baseline scenario or derived using a performance standard (see baseline procedures).
Baseline Parameter	Any parameter whose value or status can be monitored in order to validate assumptions about baseline emissions estimates or to help estimate baseline emissions.
Baseline Procedures	Methods used to estimate baseline emissions. The Project Protocol presents two optional procedures: the project-specific procedure and the performance standard procedure.
Baseline Scenario	A hypothetical description of what would have most likely occurred in the absence of any considerations about climate change mitigation.
Benefits	The benefits that would be expected to accrue to decision-makers involved with the activities in each baseline scenario alternative, excluding all potential benefits resulting from GHG reductions.
Carbon Dioxide Equivalent (CO_2eq)	The universal unit of measurement used to indicate the global warming potential of greenhouse gases. It is used to evaluate the impacts of releasing (or avoiding the release of) different greenhouse gases.
Carbon Stock	The absolute quantity of carbon held within a GHG sink at a specified time (see GHG sink).
Common Practice	The predominant technology(ies) implemented or practice(s) undertaken in a particular region or sector.
Decision-Makers	Any parties who might be involved in the decision to implement a project activity or one of its baseline candidates. In most cases, the project developer will be the sole "decision-maker" with respect to the project activity. However, other parties could be the "decision-makers" for baseline candidates.
Direct GHG Emissions	Emissions or removals from GHG sources or sinks that are owned or controlled by the project developer.
Dynamic Baseline Emissions	Baseline emission estimates that change over the valid time length of the baseline scenario. Dynamic baseline emissions are often estimated for land-use and forestry projects.

Emission Factor	A factor relating GHG emissions to a level of activity or a certain quantity of inputs or products or services (e.g., tonnes of fuel consumed, or units of a product). For example, an electricity emission factor is commonly expressed as t CO_2eq/megawatt-hour.
Fuel Switching	Using an alternative fuel (usually of lower carbon intensity) to produce required energy.
Geographic Area	A physical area that helps define the final list of baseline candidates. The area can be defined by a number of factors including sociocultural, economic, or legal factors; the availability of necessary physical infrastructure; and/or biophysical characteristics.
GHG Assessment Boundary	Encompasses all primary effects and significant secondary effects associated with the GHG project. Where the GHG project involves more than one project activity, the primary and significant secondary effects from all project activities are included in the GHG assessment boundary.
GHG Emissions	GHGs released into the atmosphere.
GHG Program	A generic term for: (1) any voluntary or mandatory, government or non-government initiative, system, or program that registers, certifies, or regulates GHG emissions; or (2) any authorities responsible for developing or administering such initiatives, systems, or programs.
GHG Project	A specific activity or set of activities intended to reduce GHG emissions, increase the storage of carbon, or enhance GHG removals from the atmosphere. A GHG project may be a stand-alone project, or a component of a larger non-GHG project.
GHG Protocol Initiative (GHG Protocol)	A multi-stakeholder partnership of businesses, nongovernmental organisations, governments, academics, and others convened by the World Business Council for Sustainable Development and the World Resources Institute to design and develop internationally accepted GHG accounting and reporting standards and/or protocols, and to promote their broad adoption.
GHG Reductions	A decrease in GHG emissions or an increase in removal or storage of GHGs from the atmosphere, relative to baseline emissions. Primary effects will result in GHG reductions, as will some secondary effects. A project activity's total GHG reductions are quantified as the sum of its associated primary effect(s) and any significant secondary effects (which may involve decreases or countervailing increases in GHG emissions). A GHG project's total GHG reductions are quantified as the sum of the GHG reductions from each project activity.
GHG Sink	Any process that removes GHG emissions from the atmosphere and stores them.
GHG Source	Any process that releases GHG emissions into the atmosphere.
Greenhouse Gases (GHGs)	Greenhouse gases are gases that absorb and emit radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere, and clouds. The six main GHGs whose emissions are human-caused are: carbon dioxide (CO_2); methane (CH_4); nitrous oxide (N_2O); hydrofluorocarbons (HFCs); perfluorocarbons (PFCs); and sulphur hexafluoride (SF_6).
Indirect GHG Emissions	Emissions or removals that are a consequence of a project activity, but occur at GHG sources or sinks not owned or controlled by the project developer.
Legal Requirements	Any mandatory laws or regulations that directly or indirectly affect GHG emissions associated with a project activity or its baseline candidates, and that require technical, performance, or management actions. Legal requirements may involve the use of a specific technology (e.g., gas turbines instead of diesel generators), meeting a certain standard of performance (e.g., fuel efficiency standards for vehicles), or managing operations according to a certain set of criteria or practices (e.g., forest management practices).

Market Response	The response of alternative providers or users of an input or product to a change in market supply or demand caused by the project activity.
One-Time Effects	Secondary effects related to the construction, installation, and establishment or the decommissioning and termination of the project activity.
Performance Metric	A rate that relates the level of consumption of relevant inputs to the level of production for different baseline candidates, or that relates GHG emissions to the size or capacity of different baseline candidates. Performance metrics are used in developing performance standards.
Performance Standard	A GHG emission rate used to determine baseline emissions for a particular type of project activity. A performance standard may be used to estimate baseline emissions for any number of similar project activities in the same geographic area.
Performance Standard Procedure	A baseline procedure that estimates baseline emissions using a GHG emission rate derived from a numerical analysis of the GHG emission rates of all baseline candidates. A performance standard is sometimes referred to as a multi-project baseline or benchmark, because it can be used to estimate baseline emissions for multiple project activities of the same type.
Primary Effect	The intended change caused by a project activity in GHG emissions, removals, or storage associated with a GHG source or sink. Each project activity will generally have only one primary effect.
Production-Based Performance Standard	A performance standard defined as a rate of GHG emissions per unit of a product or service produced by all identified baseline candidates. This type of performance standard will generally apply to energy efficiency, energy generation, and industrial process project activities.
Project	See GHG project.
Project Activity	A specific action or intervention targeted at changing GHG emissions, removals, or storage. It may include modifications or alterations to existing production, process, consumption, service, or management systems, as well as the introduction of new systems.
Project Developer	A person, company, or organisation developing a GHG project.
Project-Specific Procedure	A baseline procedure that estimates baseline emissions through the identification of a baseline scenario specific to the proposed project activity.
Relevant Input	Any kind of material or energy that is: (1) required to produce the product or service common to all baseline candidates, and (2) related to the project activity's primary effect.
Retrofit Project	Any GHG project that involves modifying existing equipment, or replacing existing equipment with new parts, devices, or systems.
Secondary Effect	An unintended change caused by a project activity in GHG emissions, removals, or storage associated with a GHG source or sink. Secondary effects may be "positive" (i.e., resulting in GHG reductions) or "negative" (i.e., resulting in GHG emissions).
Sequestration	The uptake and storage of CO_2, which can be sequestered by plants or in underground or deep-sea reservoirs.
Static Baseline Emissions	Baseline emission estimates that do not change over the valid time length of the baseline scenario.

Stringency Level	A GHG emission rate that is more restrictive than the average GHG emission rate of all baseline candidates. Stringency levels may be specified as a GHG emission rate corresponding to a certain percentile (better than the 50th percentile) or to the lowest-emitting baseline candidate. Stringency levels are defined in the course of developing a performance standard.
Temporal Range	A contiguous time period that helps define the final list of baseline candidates. The temporal range can be defined by a number of factors, such as the dominance of a single technology for an extended period of time, the diversity of options in a sector or region, and/or a discrete change in an area's or a region's policy, technology, practice, or resource.
Time-Based Performance Standard	A performance standard defined as a rate of GHG emissions per unit of time and unit of size or capacity of the baseline candidates. This type of performance standard will generally apply to project activities involving storage or removals of CO_2 by biological processes, fugitive emissions and waste emissions.
Upstream/Downstream Effects	Secondary effects associated with the inputs used (upstream) or the products produced (downstream) by a project activity.
Valid Time Length for the Baseline Scenario	The time period over which baseline emission estimates, derived from a baseline scenario or performance standard, are considered valid for the purpose of quantifying GHG reductions. Once the valid time length for the baseline scenario expires, either no further GHG reductions are recognized for the project activity, or a new (revised) baseline scenario or performance standard must be identified.

Courtesy of World Bank

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Contributors

GHG Project Case Study Contributors

Architrandi Priambodo, URS (Example 1: Cement Project) (Heidelberg Cement, Indocement and Lafarge kindly permitted the use of some data to support this example)

Maurice LeFranc and Lisa Hanle, United States Environmental Protection Agency (Example 2: Compressor Project)

Consistency and Verifiability Check

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Taskforce Members & Writing Team

Ingo Puhl, 500ppm (Taskforce Leader)

Stirling Habbitts, Anglo American/KPMG

David Evans, BP

Tamsin Lishman, BP

Andrzej Blachowcz, Center for Clean Air Policy (CCAP)

Karen Lawson, CCAP

Mike Burnett, Climate Trust

Sonal Pandya, Conservation International

Jesse Uzzell, DNV (Taskforce Leader)

Ben de Jong, El Colegio de la Frontera Sur

Peter Haenke, Energetics

John Palmisano, Energy and Communications Solutions

John D. Cowan, Environmental Interface Limited

Tatiana Bosteels, Environmental Resources Management (ERM)

Samy Hotimsky, ERM/University of East Anglia

Malik Amin Aslam, ENVORK

Paul Norrish, Future Forests

Marc Lemieux, Gaz Metropolitan

Liu Deshun, GCCI/INET, Tsinghua University

Jeffrey Frost, GHG Spaces Ltd.

Axel Michaelowa, Hamburg Institute of International Economics

Stephen Kenihan, ICLEI

Naoki Matsuo, Institute for Global Environmental Strategies/Climate Experts Ltd.

Martina Bosi, International Energy Agency

Dwight Demorais, Lafarge

Scott Murtishaw, Lawrence Berkeley National Laboratory (LBNL)

Jayant Sathaye, LBNL (Taskforce Leader)

Edward Vine, LBNL

Erik Haites, Margaree Consultants Inc

Marybeth Parker, Mirant

Reid Miner, National Council for Air and Steam Improvement

Karl Hausker, PA Consulting Group

Mariko Fujimori, Pacific Consultants

Kazuhito Yamada, Pacific Consultants

Michelle Passero, Pacific Forest Trust

Agus Sari, Pelangi

Michael Molitor, PricewaterhouseCoopers (PwC)

Laurent Segalen, PwC

Toby Campbell-Colquhoun, Royal Dutch Shell

Will Gibson, Tetra Tech

Ellen Hawes, The Nature Conservancy (TNC)

Tia Nelson, TNC

Paul Steenhof, Torrie Smith Associates

Ralph Torrie, Torrie Smith Associates

Manuela Ojan, Toyota

Jackie Jones, UK DEFRA

Michelle Manion, Union of Concerned Scientists

Kai-Uwe Schmidt, United Nations Framework Convention on Climate Change

Ken Andrasko, USEPA

Ben DeAngelo, USEPA

Paul Gunning, USEPA

Robert Prolman, Weyerhaeuser Company

Venkata Ramana, Winrock International

Sandra Greiner, World Bank

Johannes Heister, World Bank

Samrat Sengupta, World Wildlife Fund

Kevin Baumert, WRI

Contributors

Road Testers

The list below reflects the companies/organisations that volunteered to road test this document; names in brackets are the person(s) responsible for this effort.

Ademe, France (Boris Bailly and Fredric Gal)

Applied Ecological Services (Steve Apfelbaum and Cheryl Miller)

BP (Mark Akhurst and Jane Scott-Gall)

Chevron Corporation (Jonathan Grant and Arthur Lee)

Climate Neutral Network (Sue Hall)

Dow Chemical Company (Jorma Salmikivi)

Energetics Pty Ltd and Sydney Water (Peter Haenke)

Environmental Interface Limited (John D. Cowan)

Florida Light and Power (Mary Archer and Lynn Smallridge)

Independent Consultant (Walker Lunn)

Indian Council of Forestry Research & Education (Neeta Hooda and Promode Kant)

Indocement/Heidelberg Cement (Oivind Hoidalen

and Clemens Huetter)

Interface Inc. (Melissa Vernon)

International Paper (Adam Costanza)

LBNL (Satish Kumar and Edward Vine)

Louis Berger Group (Subrata Mazumder)

Natural Resources Canada (Tom Baumann and Partrick Hardy)

Oregon Department of Energy (Sam Sadler)

Pacific Forest Trust (Michelle Passero and Jon Remucal)

Priestley Consulting (Janice Priestley)

Research Triangle Institute (Brian Murray and Allan Sommer)

Saskatchewan Research Council (Mark Johnston)

State Forests of NSW (Penny Baalman and Nick O'Brien)

TEPCO (Yasushi Hieda and Hiroyuki Takahashi)

URS (Architrandi Priambodo)

USEPA (Ken Andrasko and Ben DeAngelo)

Woodrising Consulting Inc. (Neil Bird)

Road Test Draft and Final Reviewers

This list reflects the names of persons who provided feedback to the road test and pre-publication drafts.

Karin Ritter, American Petroleum Institute

Marina Alvaro, Anglo American

Ian Emsley, Anglo American

John Roberts, Anglo American

Christopher Loreti, Battelle

Jim Qin, Borax

John Yong, Brown University

Jill Gravender, California Climate Action Registry

Geoff Styles, Capacity Building, Leadership & Action

Lisa Nelowet Grice, CH2M Hill

Karen Meadows, Climate Neutral Network

Hennie Conradie, Deloitte & Touche

Michael Lehmann, DNV (also on the DNV review team)

Ramesh Ramachandran, DNV (also on the DNV review team)

Veena Vadini, DNV

Heather McGray, ECOLOGIA/WRI

Justin Guest, EcoSecurities

Eric Holdsworth, Edison Electric Institute

Bruce Maillet, EMCON

David Corregidor Sanz, ENDESA

Gustavo Silva-Chavez, Environmental Defense

Marguerite Barenbrug, Environmental Impact Management Services

Michael Gillenwater, Environmental Resources Trust

Peter Nelson, Eskom

Wendy Poulton, Eskom

Mandy Rambharos, Eskom

Clive Turner, Eskom

Atul Kumar, Gujarat Ambuja Cement

Y.K. Saxena, Gujarat Ambuja Cement

Werner Heck, Heck Associates

N.K. Verma, Indian Farmers Fertilizer Cooperative Limited

Itaru Watanabe, Japan Quality Assurance (JQA)

Shigenari Yamamoto, JQA

Chris Hunter, Johnson & Johnson

Satoshe Takase, Kansai Electric Power Company (KEPCO)

Shintaro Yokokawa, KEPCO

Tom Frost, KPMG

Anna Greenshields, KPMG (also on the KPMG review team)

Henk Harmsen, KPMG

Andrew Howard, KPMG

Donna Boysen, Louis Berger Group

Vinay Deodhar, Louis Berger Group

Zoe Budnik-Lees, National Business Initiative (NBI)

Andre Fourie, NBI

Charlotte Middleton, NBI

Dan Bilello, National Renewable Energy Laboratory

Neil Cohn, Natsource

Dale Bryk, Natural Resources Defense Council

Sanjeev Raghubir, Nestle

Mikako Kokitsu, Osaka Gas

David Sumi, PA Consulting

Greg San Martin, Pacific Gas & Electric

Lance Moodley, Palabora Mining

S.K. Bajaj, Phillips India

G.P. Singh, Phillips India

Kyle Tanger, Project Performance Corporation

Harmke Immink, PwC

Joe Kruger, Resources for the Future

Kaj Embern, Respect Europe

Mei Li Han, Respect Europe

Gerrit Kornelius, SASOL

Steven R. Schiller, Schiller Consulting

Pancho Ndebele, South African Breweries

Lee Ann Kozak, Southern Company

Hiroyuki Takahashi, TEPCO

Dinesh Babu, The Energy and Resources Institute (TERI)

Preety Bhandari, TERI

Ulka Kelkar, TERI

Parikshit Srivastava, TERI

Sean Clark, The Climate Trust

Miriam Lev-On, The LEVON Group

Satoshi Yoshida, Tokyo Gas Company

Werner Betzenbichler, TÜV Süddeutschland

Sandeep Tandon, United States Agency for International Development

Anthony Dinicola, Unocal

Terri Shires, URS Corporation

Cynthia Cummins, USEPA

Evan Jones, VCR-MVR

Eric Lesueur, Veolia Environment

John Sebastian, Veolia Environment

Amanda Stobart, Webber Wentzel

Sandra Brown, Winrock International

Tim Pearson, Winrock International

Sudhir Sharma, Winrock International India

Rob Bradley, WRI

Maria Cordeiro, WRI

Taryn Fransen, WRI

David Jhirad, WRI

Rebecca Eaton, WWF

Contributors

General Contributors

Heather Tansey, 3M

Alain Bill, ALSTOM Power

Charles Eyre, Aon Risk Consulting

Danielle Cesano, ARUP

Anne Boucher, Baseline Protection Initiative

Simon Worthington, BP

Adolfo E. Silva, Canadian Petroleum Products Institute

Kevin Boehmer, Canadian Standards Association

Greg Kats, Capital E

Fred J. Keller, Carrier Corporation

Jake Schmidt, CCAP

Alexander Roeder, CEMEX

Gerard Alleng, Center for Energy and Environmental Policy, University of Delaware

Donald Goldberg, Center for International Environmental Law

Alice LeBlanc, Chicago Climate Exchange

John O. Niles, Climate, Community & Biodiversity Alliance

Michael Totten, Conservation International

John Kessels, CRL Energy

Harold Belore, Cumming Cockburn Limited

K. C. Narang, Dalmia Cement

Robert Casamento, Deloitte

Aditi Haldar, Development Alternatives

Dale Didion, ISG Resources

Simon Dawes, DNV

Trygve Roed-Larsen, DNV

Neil Kolwey, E Source

Bill Kyte, E.ON UK

Louise Aukland, EcoSecurities

Crosbie Baulch, Energetics

David Crossley, Energy Futures Australia

Xu Huaqing, Energy Research Institute

Pierre Boileau, Environment Canada

Juerg Fuessler, Ernst Basler & Partners Ltd.

Richard Ney, Essential Science

Thomas Sylvester, Exelon Power

Wendel Dreve, Farmer's Ethanol LLC

Bhanu Swaminathan, Fertiliser Association of India

Lauren Sandler, First Environment

Duncan Noble, Five Winds International

Hans Buwalda, Fletcher Building Limited

Cesar Munoz, Fundacion Entorno

George Fowkes, Future Forests

Aldyen Donnelly, Greenhouse Emissions Management Consortium

Michael Dutschke, Hamburg Institute of International Economics

David Brand, Hancock Natural Resource Group

Mihir Moitra, Hindalco Industries Limited

Anne Choate, ICF Consulting

Abyd Karmali, ICF Consulting

Jim McConnach, IEEE

Kim Maloney, Independent consultant

V. Ranganathan, Indian Institute of Management

Jerry Marks, International Aluminium Institute

Fraser Thomson, International Aluminium Association

Robert Dornau, International Emissions Trading Association

Tony Irwin, IRM Consulting

Koichi Kitamura, KEPCO

Koji Toyama, KEPCO

Chi Mun Woo, KPMG

Naseem Pankhida, KMPG

Bertrand Gaillard, Lafarge

Simon Rice, Lafarge

Lenny Bernstein, L.S. Bernstein & Associates

David Lesolle, Ministry of Environment, Wildlife, and Tourism, Botswana

Xuedu Lu, Ministry of Science and Technology of China

Indrani Kowlessar, NRCan

Stephen Seres, NRCan

David Howard, NREL

Mary Quilliam, Nuclear Energy Institute

Laurie Wayburn, Pacific Forest Trust

Matthew McCulloch, Pembina Institute

Kristian Rajakaltio, PwC

Neil Rein, Resource Recovery Systems

Neil Sampson, Sampson Group

Doug Howell, Seattle City Light

Gerhard Mulder, SENTER

Gareth Phillips, SGS

Roon Osman, Shell

Tony O'Hara, State Forests of NSW

Malte Meinhausen, Swiss Federal Institute of Technology

G. S. Basu, Tata Steel

R. P. Sharma, Tata Steel

Midori Sasaki, TEPCO

Yoshiyuki Tsuji, TEPCO

Leena Srivastava, TERI

Mark Jackson, The Carbon Store

Eric Firstenberg, TNC

Patrick Gonzalez, TNC

Zoe Kant, TNC

Bill Stanley, TNC

Kentaro Suzawa, Tokyo Gas Company

William Hohenstein, United States Department of Agriculture

Gary Bull, University of British Columbia

Katie Begg, University of Surrey

Mahesh Gundappa, URS Corporation

Gloria Godinez, WBCSD

Susanne Haefeli, WBCSD

Simon Schmitz, WBCSD

Ian Noble, World Bank

Lasse Ringius, World Bank

Sebastian Scholz, World Bank

Pankaj Bhatia, WRI

Liz Cook, WRI

Anthony Dvarskas, WRI

Peter Gage, WRI

Ryan Levinson, WRI

Jennifer Layke, WRI

Jonathan Pershing, WRI

Anand Rao, WRI

Emily Weninger, WRI

Manmitta Dutta, Yale Univerisity

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Ordering publications

WBCSD
WBCSD, c/o Earthprint Limited
Tel: (44 1438) 748 111
Fax: (44 1438) 748 844
wbcsd@earthprint.com

Publications are available at:
www.wbcsd.org
www.earthprint.com

WRI
Hopkins Fulfillment Service
Tel: (1 410) 516 6956
Fax: (1 410) 516 6998
e-mail: hfscustserv@press.jhu.edu

Publications can be ordered from WRI's secure online store: http://www.wristore.com

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The World Business Council for Sustainable Development (WBCSD) is a coalition of 175 international companies united by a shared commitment to sustainable development via the three pillars of economic growth, ecological balance and social progress. Our members are drawn from more than 30 countries and 20 major industrial sectors. We also benefit from a Global Network of 50+ national and regional business councils and partner organizations.

Our mission is to provide business leadership as a catalyst for change toward sustainable development, and to support the business license to operate, innovate and grow in a world increasingly shaped by sustainable development issues

Our objectives include:

- **Business Leadership**—to be a leading business advocate on sustainable development.
- **Policy Development**—to participate in policy development to create the right framework conditions for business to make an effective contribution towards sustainable development.
- **The Business Case**—to develop and promote the business case for sustainable development.
- **Best Practice**—to demonstrate the business contribution to sustainable development solutions and share leading edge practices among members.
- **Global Outreach**—contribute to a sustainable future for developing nations and nations in transition.

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- **To avert dangerous climate change.** We promote public and private action to ensure a safe climate and sound world economy.
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World Business Council for
Sustainable Development

4, chemin de Conches
1231 Conches-Geneva
Switzerland

Tel: (41 22) 839 31 00
Fax: (41 22) 839 31 31
E-mail: info@wbcsd.org
Web: www.wbcsd.org

WORLD
RESOURCES
INSTITUTE

10 G Street, NE (Suite 800)
Washington, DC 20002
USA

Tel: (1 202) 729 76 00
Fax: (1 202) 729 76 10
Web: www.wri.org

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