The Greenhouse Gas Protocol

WORLD RESOURCES INSTITUTE

Designing a Customized Greenhouse Gas Calculation Tool

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1 Introduction

This guidebook explains how to customize a greenhouse gas (GHG) calculation tool (here referred to as the Tool Guidebook). It is designed to help the technical staff at GHG programs or initiatives such as GHG registries, and the technical staff at other institutions, such as local business or industry associations and/or consultants, adapt existing GHG Protocol calculation tools to use for a specific GHG program or to more closely reflect national and/or regional circumstances. GHG calculation tools are customized to be made more helpful to companies and/or other entities that may use them and to more accurately collect the quality and type of data that a GHG program is seeking. In addition, working with the future users of these tools while customizing them helps create more effective tools, and builds capacity and momentum for their adoption and implementation by companies and other relevant stakeholders.

The following guidance for adapting a GHG Protocol calculation tool (here referred to as GHG calculation tools) for a specific geographic area and/or program is the product of six years of knowledge and experience in the development and customization of GHG Protocol entity-level calculation tools for both U.S. and international businesses and program administrators. The focus of this Tool Guidebook is on adapting GHG calculation tools that are based on the internationally recognized accounting framework provided by the GHG Protocol Corporate Accounting and Reporting Standard (here referred to as the Corporate Standard). The Tool Guidebook also may be used to develop new GHG calculation tools (see box 1). The Corporate Standard provides a consistent and transparent protocol for entities (see box 2) to determine which emission sources to include in their inventory and how to classify (e.g., as direct or indirect sources) and report them. Before customizing a calculation tool, the developers should be familiar with the accounting and reporting concepts in the Corporate Standard, as the Tool Guidebook assumes familiarity with them and so does not describe them in detail.

The GHG calculation tools are used around the world. Industry associations, GHG programs, and governments all recommend them for developing rigorous, consistent, and credible inventories for both internal management and external reporting purposes, such as to participate in market mechanisms, benchmarking, or to comply with regulations. The GHG calculation tools generally are made up of a pdf guidance document and Excel spreadsheets that allow industry and service sector users to easily quantify the GHG emissions from the various sources in their inventory, as defined by the Corporate Standard. The GHG calculation tools also provide more specific information not found in the Corporate Standard, such as which activity data and emission factors are required to quantify emissions from a specific source and how to roll up these data into one inventory.

BOX 1 Developing a New Calculation Tool

The steps for developing a new calculation tool generally are similar to those for adapting an existing tool. If you do not already have an entity-level tool, you may, however, have to consult GHG calculation guidance documents that are intended either for developing national inventories (e.g., the IPCC 2006 Guidelines) or for quantifying emissions from a specific source (e.g., a boiler) (see figure 1). Developing a new tool therefore will take longer, as some national quantification methods may be too broad to produce the level of quantification certainty needed for an entity's inventory, and source-specific guidance must be aggregated for the entity-level tool. Boundaries and conventions for national and entity accounting may differ as well and so must be resolved. For example, national-level accounting does not distinguish between direct and indirect emission sources.

Even when they have been developed for national or unit-level quantification of emissions however, you still can use these documents to develop a new entity-level tool or to enhance a "customization" process. Indeed, the IPCC 2006 Guidelines for developing national inventories is one of the main sources of GHG quantification methods for various emission sources. The higher tiers in the IPCC 2006 Guidelines are especially useful for quantifying entity-level emissions.[1] Other groups with similar resources are national environmental or energy agencies, standards and technical agencies, voluntary and mandatory emission-reporting initiatives, industry association initiatives, and other protocols or tools used to calculate emissions from specific sources.

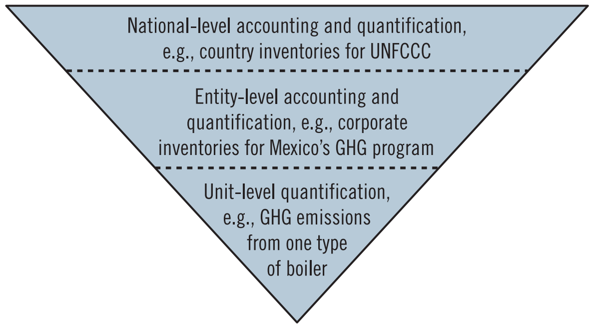
These tools are based on the quantification methods and technical knowledge of the leading national and international initiatives, including the Intergovernmental Panel for Climate Change (IPCC), the UK Department for Environment, Food and Rural Affairs (UK DEFRA), and the U.S. Environmental Protection Agency (US EPA).

The Tool Guidebook describes

- The basic framework and features required for an entity-level GHG calculation tool.
- Ways of enhancing the relevance and utility of the GHG calculation tools for a local business's or program's objectives and applications.
- A stakeholder process to encourage the acceptance of the customized calculation tools by their intended users.

The Tool Guidebook is divided into six chapters after the introduction. Chapter 2, "Elements of an Entity-Level Calculation Tool," is an overview of the existing GHG calculation tools, how they are structured, and how they are related to the Corporate Standard. Chapter 3, "Deciding Which Tool Elements to Customize," explains the reasons for customizing an existing tool for a particular GHG program or initiative, even though the existing GHG calculation tools are free and available to users around the world.

FIGURE 1 Three Levels of Accounting and Quantification Guidance that Can Be Used for Developing New Tools or Customizing Existing GHG Calculation Tools



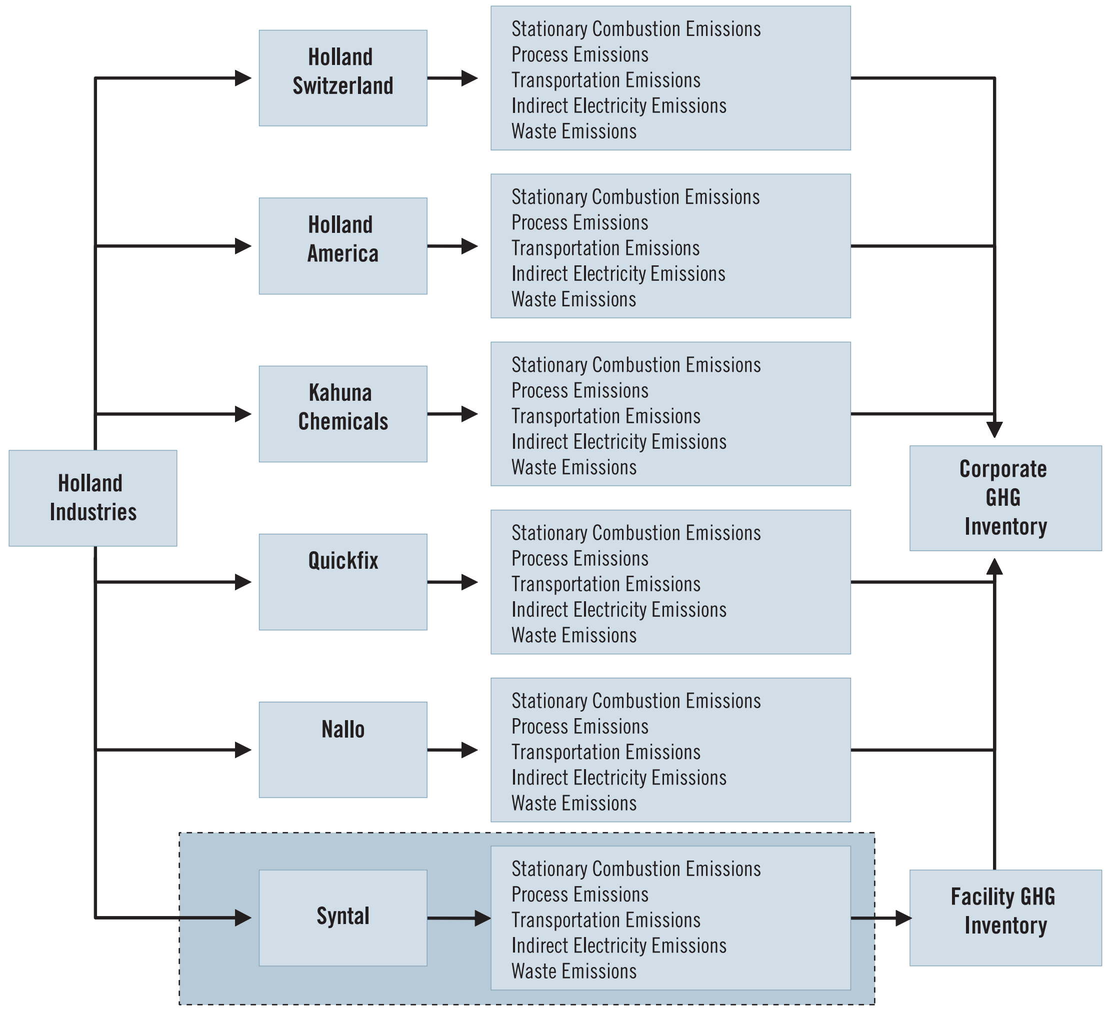
The next two chapters are much more technical. Chapter 4, "Customizing the GHG Accounting Concepts," describes those components of the Corporate Standard that give users some flexibility in implementing them. An example is deciding whether to use an equity or a control approach to define which facilities to include in the inventory. In some cases, a GHG program may allow only one consolidation approach. The customized guidance and spreadsheets would show which approach is used. Chapter 5, "Estimating or Measuring Emissions," examines the various ways in which GHG emissions may be estimated or measured, explains why a GHG program or initiative might want to be more prescriptive than the current GHG calculation tools, and offers guidance on choosing among the options available.

The last two chapters concentrate on process. Chapter 6, "Designing a Comprehensive Stakeholder Process," focuses

BOX 2 Defining an Entity

The Corporate Standard was initially developed for use by companies and corporations and thus uses financial accounting protocols to define the reporting entity's boundaries. This approach determines whether the reporting entity has sufficient control (either financial or operational) or influence over the facilities/plants and their emission sources to be included in the inventory. For some entities this extends to not only the parent company's operations but also those of the group's companies/subsidiaries, associated/affiliated companies, franchises, and the like. A large multinational company may have thousands of facilities, buildings, and so forth, whose GHG emissions should be included in the final inventory. If different types of entities, such as universities, use the GHG calculation tools, the fundamental approach for defining the boundaries would remain the same, although aggregating sources might be less complicated. Likewise, entities reporting at the facility level may use the Corporate Standard's definition of boundaries (i.e., looking at significant influence or control) but would need to define only those emission sources to be included (see figure 2). This Tool Guidebook uses the word entity for reporters of any type, shape, or size.

FIGURE 2 Aggregation of Sources to the Facility or Corporate Level



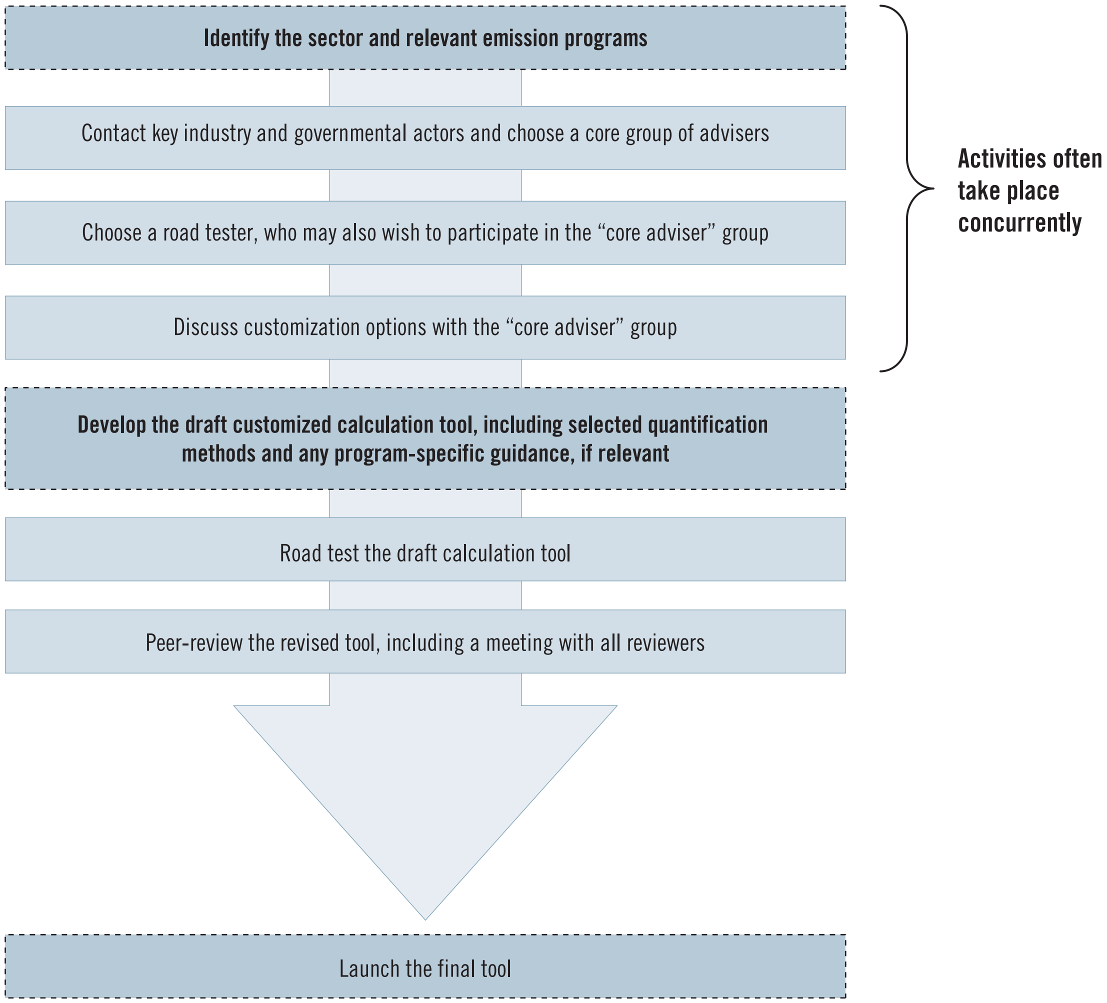
on organizing an open, transparent, and inclusive approach that involves multiple stakeholders in developing and adopting a customized tool. This chapter also describes the various types of stakeholders that should be included, how they can be included, and the value of doing so. Chapter 7, "Launching the Customized Calculation Tool," discusses the various steps of completing the customization process up to finally launching the document. Finally, annex A lists other reference documents that may be helpful during the tool customization process.

Although this Tool Guidebook is not a step-by-step manual, figure 3 shows the general order of the different activities in customizing a calculation tool. Note that the order of the chapters does not necessarily match the order of these activities.

Notes

1. The "higher tiers" refer to the tier 2 and tier 3 methods, which often require plant- or facility-level data.

FIGURE 3 General Order of Activities for Customizing a Calculation Tool



2 Elements of an Entity-Level Calculation Tool

To date, the GHG Protocol Initiative has developed and assembled sixteen cross-sector and sector-specific calculation tools. These tools were peer-reviewed and tested by experts and industry leaders, and they represent "best practice" with regard to inventorying GHG emissions for specific industries.

The two main categories of calculation tools are

- Cross-sector tools that can be used for a variety of sectors. These include tools for calculating GHG emissions from stationary combustion, mobile combustion, and the use of HFCs (hydrofluorocarbons) in refrigerators and air conditioners, as well as a tool to measure and estimate uncertainty.
- Sector-specific tools that are designed to calculate emissions in sectors such as aluminum, iron and steel, cement, oil and gas, and pulp and paper.

The tools may overlap when cross-sector emission sources are covered in sector-specific tools. Table 1 lists the sixteen GHG calculation tools provided by the GHG Protocol.

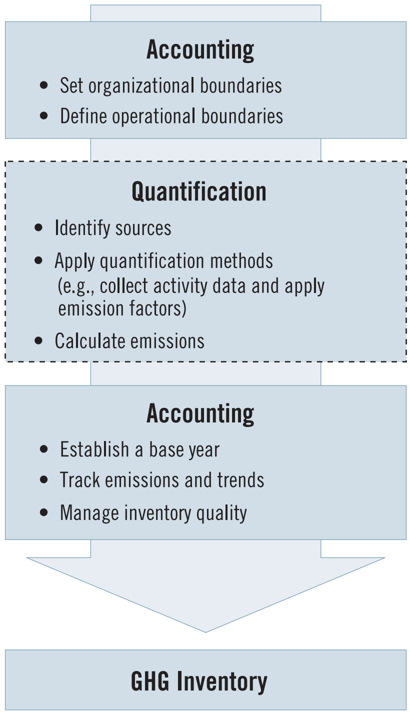
Various GHG initiatives around the world have already adopted or customized these calculation tools for their own entity-level programs, including voluntary GHG programs like the Mexico GHG Program, the US EPA Climate Leaders (Climate Leaders) program, and the California Climate Action Registry (California Registry); and mandatory

TABLE 1 GHG Protocol Calculation Tools

Cross-sector protocols/tools	• Calculating GHG emissions from ***stationary combustion.*** • Calculating CO_2 emissions from the consumption of ***purchased electricity, heat,*** and ***steam.*** • Calculating CO_2 emissions from the combustion of ***mobile source*** fuels. • Calculating HFC emissions from the use of ***air conditioning*** and ***refrigeration***. • Measuring and estimating ***uncertainty*** for GHG emissions.
Sector-specific protocols/tools	• Calculating CO_2 emissions from the production of ***iron and steel.*** • Calculating CO_2 emissions from the manufacture of ***nitric acid***. • Calculating CO_2 emissions from the production of ***ammonia***. • Calculating N_2O emissions from the production of ***adiptic acid***. • Calculating CO_2 emissions from the manufacture of ***cement***. • Calculating CO_2 emissions from the manufacture of ***lime***. • Calculating HFC-23 emissions from the production of **HCFC-22.** • Calculating GHG emissions from the production of ***pulp and paper***. • Calculating PFC emissions from the production of ***semiconductors***. • Calculating GHG emissions from the production of ***aluminum***. • Calculating CO_2 emissions for ***service-sector companies*** and ***office-based organizations***.

programs like the European Union's Emission Trading Scheme (EU ETS). In addition, other programs and/or initiatives may have devised useful tools. For more sources of information, see annex A.

FIGURE 4 Key Steps in Developing an Entity-Level GHG Inventory



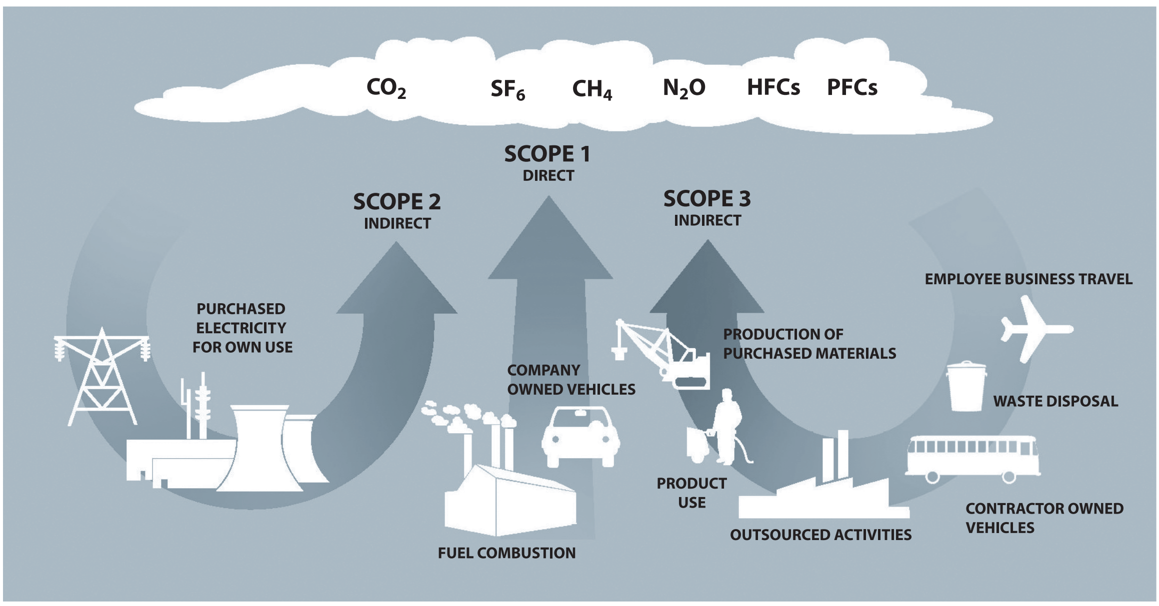
Steps in Creating an Entity-Level Calculation Tool

Accounting and quantification are the two steps in creating an entity-level GHG inventory. In the accounting step, the user defines those emission sources that will be included in the inventory and decides how to classify and report them. In the quantification step, the user estimates the actual emissions from the various sources. Figure 4 is an overview of these steps and the decisions related to them.

ACCOUNTING

The Corporate Standard provides accounting standards and guidance for preparing a GHG inventory for companies or other entities (e.g., universities). The Corporate Standard addresses such issues as determining the inventory's boundaries, establishing and adjusting a base year, and deciding on the information to include in a public GHG report. Often the calculation tools initially developed by industry associations provide information about such accounting issues as defining organizational and operational boundaries in order to help their member companies draw up an inventory with guidance more specific to their sector. Although they were created outside a particular GHG program, many of these tools do identify sector-specific characteristics that may help resolve accounting issues in future programs, like whether to use a single base year or multiple base years and which emission sources to track in the optional scope 3 category. (Scope 3 emissions are all indirect emissions from the entity's operations, except those from the consumption of purchased electricity, heat, or steam, which are classified as scope 2. See figure 5.) Chapters 3 and 4 discuss the various elements of accounting guidance that might be included in a customized calculation tool.

FIGURE 5 Scopes



QUANTIFICATION

Once the reporting organization has addressed the main accounting questions, the entity applies the GHG calculation tools required to address all emission sources within its boundaries. During the quantification step, many companies will need to use more than one GHG calculation tool to cover all the GHG emission sources identified in their boundaries (see box 3).

Each of the GHG Protocol's cross-sector and sector-specific calculation tools contains a step-by-step guide to quantifying emissions data as well as several automated Excel-based worksheets with instructions.

Although the format of the guide in each GHG calculation tool varies, it always contains the following information:

- *Overview:* The guide's introduction describes the guide's purpose and contents, the Excel spreadsheets, the sources of emissions, and, often, the way or ways in which the GHG emissions are created.
- *Quantification methods:* GHG emissions are quantified by either direct measurement or calculations. Directly measuring GHG emissions by monitoring their concentration and flow rates from a stack is not common and is generally limited to stationary combustion sources. GHG emissions are more often derived from a calculation-based approach, using either a mass balance basis specific to a source or process or, more commonly, documented emission factors. These factors are calculated ratios relating GHG emissions to a measure of activity at an emissions source, for example, a vehicle's carbon dioxide (CO_2) emissions per mile driven. Many tools provide a hierarchy of quantification methods, ranging from applying general emission factors to direct measurements. Several sections of the guide accompanying the Excel spreadsheet tool may describe different ways of quantifying the emissions for a particular source or process. These sections may be subdivided by type of emission source (e.g., stationary combustion, fugitive emissions), by their categorization in a GHG inventory (e.g., scope 1, scope 2), or sometimes by both.
- *Quality control:* The guide includes a section on good practices to ensure the quality of the inventory and inventory management, for example, creating and maintaining internal documentation to support emission calculations.

The Excel workbook is made up of several spreadsheets, some pertaining to what is being reported, some on the actual calculations and aggregation of data, and several on default emission factors, unit conversion information, and other important and basic data. The calculation tool may also have instructions for filling out the worksheets both directly in the workbook and in the guidance document.

The spreadsheets are for those using one of the calculation approaches and are set up so that users need only insert the activity data and an appropriate emission factor or other information required to quantify the GHG emissions. Although default emission factors are provided, it also is possible to insert customized emission factors that better represent the reporting company's operations. The emissions of each GHG (CO_2, methane [CH_4], nitrous oxide [N_2O], etc.) are calculated separately and then converted to CO_2 equivalents on the basis of their global warming potential.[1]

A customized tool may offer different options to make it easier to use the spreadsheet, such as automatic links between spreadsheets requiring similar data and Visual Basic to simplify using the Excel spreadsheets. Mexico's pulp and paper tool is an example of a tool customization process in which a more sophisticated use of Excel offers additional functionality.

Some tools such as the iron and steel–sector tool and the HFC cross-sector tool offer a choice between simple and more advanced quantification methods. The more advanced methods are expected to increase the certainty of the emission estimates but usually require more detailed data and a more thorough understanding of the company's technologies. Depending on how the calculation tool will be used, the more accurate methods may be required to comply with certain GHG programs.

When the accounting and quantification steps have been completed, the GHG inventory is ready.

BOX 3 Building an Inventory with Multiple Calculation Tools

The International Aluminum Institute (IAI) developed a calculation tool that was adopted by the GHG Protocol and that quantifies carbon dioxide and perfluorocarbon (PFC) emissions resulting from the primary production and supporting processes of aluminum. This tool is not sufficient, however, to complete a full GHG inventory for an aluminum company. For example, the GHG Protocol's stationary combustion tool is required to quantify the GHG emissions from the combustion of fossil fuels associated with electricity production, primary aluminum production, bauxite mining, bauxite ore refining, and aluminum production from recycled sources. To calculate CO_2 emissions from the consumption of purchased electricity, the "indirect CO_2 emissions from the consumption of purchased electricity, heat, and/or steam" tool is used. To calculate GHG emissions from trucks owned by the company, the mobile combustion tool is used.

Notes

[1] The global warming potentials from the second IPCC assessment report are currently being used in the GHG calculation tools because they have been agreed on as the basis for national inventories for the UNFCCC through the end of the first commitment period. Other GHG programs, however, may not follow the same convention.

Deciding Which Tool Elements to Customize

3

Before customizing a GHG calculation tool, the users of this Tool Guidebook should agree on their objectives for customizing the tool, for example, the uses of the tool and the activities it will be supporting. These objectives will influence the tool's design. Some of the objectives for customizing a calculation tool are

1. Improving the data in a sector of interest and their capacity to collect it.
2. Increasing the tool's accuracy and relevance for use in a specific geographic context.
3. Increasing the tool's relevance to and guidance for a GHG program's specifications.

This chapter discusses these three objectives in relation to how they affect the customization of the calculation tool, as well as the customization process itself. Each section of this chapter begins with questions that the tool's developer should consider during the customization process. Because answering these questions is part of the tool customization, not all the answers may be apparent at the outset of the process.

A Sector of Interest

To decide which sectors (e.g., cement, aluminum) may be of interest from the perspective of GHG emissions and which may benefit from having a customized entity-level tool, consider the following questions:

a. Which sectors are principal sources of GHG emissions in this country?[1] Which sectors are important or influential economically?

b. Which sectors are eligible to participate in the program(s)/initiatives for which the tool is likely to be used?

c. Which sectors have expressed an interest in the customization project? Do they already have their own internal management tools, or are they interested in adopting a tool for their use? Are any tools currently being widely used? Are these tools relevant to the geographic context?

d. Are other stakeholders (e.g., external observers) interested in the tool?

e. Do the tool's customizers already have a close relationship with the stakeholders that could facilitate or improve the customization process?

IDENTIFYING SIGNIFICANT SECTORS

Many GHG programs and/or initiatives look first to emission sources or sectors where the GHG emissions are likely to be large and significant. If available, a national inventory supplied to the United Nations Framework Convention on Climate Change (UNFCCC) is helpful for identifying such sectors.[2] For some countries, a sector that is GHG intensive owing to energy use may be the most relevant, whereas other countries may list GHG emissions from agricultural activities or changes in land use as being the most significant. GHG programs then may want to determine which sectors and companies could provide leadership for the project and influence others to take similar action.

IDENTIFYING RELEVANT PROGRAMS

More and more companies around the world are creating GHG emission inventories voluntarily, and having a GHG program in which to participate is often an important impetus for those companies needing more help to develop their inventory. Customizing tools to meet the needs of a sector eligible to participate in a GHG program, and perhaps other air-emission inventory programs, either in the country or internationally, increases the likelihood that the tools will be useful. Program administrators also may be interested in a specific sector in order to identify mitigation opportunities or, if a program already is in place, to support that sector in the GHG program.

IDENTIFYING GAPS

Industry associations in some sectors already have developed GHG calculation tools that are used by companies around the world. The tool developed by the Cement Sustainability Initiative at the World Business Council for Sustainable Development (WBCSD), for example, is being used globally.[3] Despite the availability of this tool, however, companies in India still were interested in customizing it to better fit their practices and technologies (see box 4).

OTHER INTERESTED STAKEHOLDERS

In addition to the companies and the tool's developer, other stakeholders may be interested in the tool, such as government bodies (if they are not already involved), industry associations, and not-for-profit groups. These stakeholders may be able to offer a useful perspective in the tool customization process, may have contacts or expertise that can help the tool-customizing partners, and may provide resources for outreach and training on the tool.

RELATIONSHIPS AND CONNECTIONS

A significant portion of the tool customization is interacting with the stakeholder group, for example, different companies in the sector chosen. Having good relationships already in place with at least some of the stakeholders can facilitate the process, although the goodwill of new participants is needed as well. In general, selecting a sector in which a number of different stakeholders are interested in providing leadership makes customizing the calculation tool easier and also helps with the project's outreach and the final use of the customized calculation tool (see box 5).

BOX 4 A Road Tester's Perspective

"Initially, when I started to work with WRI to develop a GHG Inventory for our Himachal Unit, I thought that this would be a tedious exercise," admits Dr. Y. K. Saxena, vice president of Environment Health and Safety Corporate at Gujarat Ambuja Cements Limited. "But with the inputs provided by India's The Energy and Resources Institute (TERI), WRI, and US EPA, it turned out to be a very useful exercise, and our participation was appreciated by the Indian Cement Industry and Indian Government Regulatory Institution, which was important. My role while working for this project with TERI, US EPA, and WRI was that of a catalyst for these institutions as well as for my own organization."

Since the road test, a full corporate inventory has been developed, and Dr. Saxena says that the company now is using its inventory to better manage its operations and minimize its carbon footprint by using pollution control measures, employing fly ash for cement manufacturing, and restoring mined areas, mainly through forest plantations.

A Specific Geographic Context

Customizing a tool to increase its accuracy and relevance to users in a specific country or region is a significant objective of many tool customization projects. Geographic circumstances can affect a number of elements in a calculation tool, such as which quantification methods and/or emission factors are used, which gases and emission sources are included, and whether and how compatibility with existing local programs and regulations is addressed. The following questions concerning geographic context are important to consider:

a. Do the quantification methods or emission factors and other data in the tools being used need to be adjusted to better reflect the geographic context in which the customized tool will be used? For example, do the companies in this country already use technologies, monitoring or measurement methods, and/or equipment that should be considered?

b. Given the geographic context of the customized tool, should it track other air emissions as well? Should any local, state, regional, or national air quality programs, initiatives, or regulations planned or already in place be considered? Would the tool help its users fulfill current or upcoming regulatory needs, or help educate them about these other emissions and their relationship with GHG emissions?[4]

c. Does the tool's geographic context offer any ways to simplify or specify elements of the tool to make it more user-friendly? Examples are adding country-specific defaults and focusing on only those technologies that the country now uses.

d. Do any of the programs, such as for wastewater regulations and energy efficiency, which focus those sources that the tool would include, offer data that could be relevant to the quantification of GHG emissions?

BOX 5 Deciding on a Sector for the Mexico Power Tool Customization

After completing the customization of the pulp and paper tool for Mexican companies, SEMARNAT, FUMEC, US EPA, CESPEDES, and WRI discussed which sector should be the basis of the next tool. Although several sectors were considered, the iron and steel and the power sectors dominated the conversation. The group had seven criteria for its decision:

1. Is the sector required to report to the RETC (Registry of Emissions and Pollutant Transfer) program?
2. Is this sector a key source of emissions?
3. What is the government's or program's interest in the tool?
4. Does this sector have broad domestic relevance?
5. What is the core advisory team's relevant expertise in this sector?
6. What tools does the sector currently use?
7. What is the sector participants' level of interest?

Although the team used the first six criteria to settle on the power and the iron and steel sectors as the most interesting, it was the seventh criterion that swayed the team toward developing a power-sector calculation tool. The interest of Mexico's Federal Electricity Commission (CFE) in helping the team develop the tool, its openness to sharing data and ideas, and its desire to improve its current procedures meant that the CFE would be a good partner.

QUANTIFICATION METHODS

GHG Protocol calculation tools often use an emission factor–based approach to quantifying entity-level emissions. Although other calculation-based methods or direct measurement sometimes may be preferable and more accurate, these methods often are more expensive to apply. But if the technology for a more advanced quantification method already is available, for example, when it is being used to collect information about other types of gases, and it is not too difficult to collect the new GHG data, then it may be easier to encourage or require these approaches. For example, in the United States and Mexico some companies with large stationary combustion units already use direct measurement emission monitors to estimate their emissions of SO_2 and NO_x. Collecting CO_2 data from these monitors therefore makes sense for these companies, and using the data gathered from these measurements is one way for Mexican and U.S. companies to improve their GHG emissions inventories. Users of this guide should determine which quantification methods apply to the GHG sources covered by their tool and, of these, which provide the best combination of accuracy and practicality for their intended users. For more technical information on various types of quantification methods and their uses, see chapter 5.

EMISSION FACTORS

An *emission factor* is a unit (e.g., a ton) of a greenhouse gas (e.g., CO_2) produced per unit of activity (e.g., miles driven). Emission factors may be based on data collected, averaged, or aggregated differently depending on the intended use of the emission factor and the availability of the data. GHG Protocol calculation tools provide default emission factors from several sources, for example, the IPCC, US EPA, and UK DEFRA.

Both the level and/or geographic area of the data collected to create the emission factor and the types of activity data that the emission factor requires for the calculation should be considered when deciding on the emission factors to include in the customized calculation tool. IPCC emission factors are based on literature from various sources and countries and assumptions about commonly used types of fuel and technologies, whereas the US EPA, UK DEFRA, and other national agencies look at national data. But emission factors can be developed on an even finer scale. Using an emission factor based on more country- or region-specific or even company- or site-specific data increases the certainty of the GHG emission estimations. In some cases, however, if collecting more site-specific data is being considered, different quantification methods become possible and more reasonable (see box 6). For example, a mass balance approach to calculating CO_2 emissions from stationary combustion can be more accurate than an emission factor method if the carbon content of the fuels at the company- or site-specific level is known.

For some sources—for example, fugitive emissions from the transmission and distribution of natural gas—several emission factor approaches are currently available. Depending on the activity data used, the approaches provide more or less certain estimations. For example, emission factors using activity data that focus on fuel quantity provide better estimates than do those emission factors using a proxy for spent fuel, such as miles driven for mobile combustion. Understanding what the best data available in the geographic region are, as well as the technical components, allows tool-customizing partners to choose the best approaches. Chapter 5 provides more information about emission factors and describes their uses in greater detail.

OTHER GASES AND/OR AIR POLLUTANTS

Greenhouse gases are often not the only air emissions that countries or regions are tracking. In some cases, programs tracking criteria air pollutants (i.e., SO_2, NO_x, O_3, VOC, CO, particulate matter, lead) already exist and have their own calculation tools. When no such programs or calculation tools are available, however, customizing the GHG tools to include these other air emissions may increase the tool's value to its users. Because similar information (see table 2 for examples) often is required for estimating both GHG emissions and other criteria air pollutants, it makes sense to customize the GHG tools to include these other emissions, especially for certain sources such as the stationary and mobile combustion sources for which the data needs are very similar.

BOX 6 Using the Best Data: The Case of Mexico

During discussions with Mexico's Federal Electricity Commission (CFE), it became clear that it wanted one outcome of the project to be a more accurate emissions inventory while at the same time considering the diverse facilities under the CFE umbrella. Initially the CFE hoped that the partners would develop Mexico-specific stationary combustion emission factors to replace the AP-42 factors (developed for U.S. companies) currently being used. But when the partners looked at the technologies and information available at the various CFE plants, it quickly became apparent that except for the CFE's smallest sources, default "emission factors" (in this case, carbon content factors, since a mass balance approach is being used) were not needed, and that site-specific data could be used instead.

Therefore, instead of developing emission factors, the partners presented four methods for calculating emissions that could use the data usually already available at the different plants and provide the most accuracy, given current conditions.

Tier 1: Default Mass Balance

Tier 1 is recommended for small units (<100 MW) and applies a mass balance approach with default factors. This approach should be used only when no other is possible. It requires the following for each source category and fuel:

- Data on the amount of fuel combusted in the source category (mass balance).
- Default carbon content factors (country-specific, IPCC, AP-42, etc.).
- Control device removal rate.

Tier 2: Plant/Facility Specific Mass Balance

Tier 2 is recommended for small units (<100 MW) and applies mass balance with plant facility–specific data. This approach is used for the small units when possible, that is, when information is available or easily obtained, and especially if facilities wish to include more than carbon dioxide emissions in their inventory. It requires the following for each source category and fuel:

- Data on the amount of fuel combusted in the source category (mass balance).
- Pollutant content (i.e., carbon and sulfur) of the fuels used.
- Applicable oxidation factors.
- Control device removal rates.

Tier 3: Plant-Specific Load-Based Mass Balance

Tier 3 applies to units of between 101 and 300 MW. Using tier 3, facilities derive specific emission rates for different pollutants (NO_X, CO_2, and SO_2). In conjunction with the fuel's heat input (HI), a correlation curve of gas emission rate versus the HI is used to estimate the hourly gas emission rates.

The unit load, or operating capacity, can affect emission rates of NO_X, SO_2, CO_2, and PM, for two reasons: (1) higher loads require more fuel, and (2) unit efficiency can depend on the unit load level. For example, at certain load levels (typically, lower load levels), boilers are less efficient and thus need to consume more fuel than a simple linear relationship of load to fuel required. As another example, the specific unit load can affect the concentration of CO_2 at the time of sampling. CO_2 and SO_2 are simpler cases because their concentrations or emissions are more directly related to the quantity of fuel consumed. Other pollutants, such as NO_X, are more affected by unit load (load affects the amount of air in the combustion process, which directly affects the formation of NO_X). Thus, load-based estimates of emissions should be more accurate than a tier 1 or tier 2 method (given the same accuracy of the sampled data). A tier 3 emission estimate requires the following for each source category and fuel:

- Data on the amount of fuel combusted in the source category (mass balance).
- Hourly MW data for the unit's operating load.
- Emission rates at three different unit operating loads (low, medium, and high).

Tier 4: Direct Measurement for Large Units

Tier 4 applies to large units (LU) with name plate generation greater or equal to 300 MW. This tier must use a continuous emission monitor system (CEMS) to estimate the concentration of the pollutant and stack gas flow. A tier 4 emission estimate requires the following for each source category and fuel:

- Data on the amount of fuel combusted in the source category (mass balance).
- A continuous emission monitor system (CEMS).

The equipment data required to launch CEMS are the following:

- Pollutant concentration monitors (e.g., SO_2, NO_X).
- Diluent gas monitors to measure the percentage of O_2 or CO_2.
- Volumetric flow monitors.
- Sample probes.
- Sample ("umbilical") lines.
- Sample pumps.
- Sample conditioning equipment (e.g., heaters, condensers, gas dilution equipment).
- Data loggers or programmable logic controllers (PLCs).

TABLE 2 Source Types, Gases, and Data Requirements

SOURCE TYPE	COMMON GAS EMISSIONS	EXAMPLES OF SIMILAR TYPES OF DATA REQUIRED[a]
Stationary Combustion	CO_2, CH_4, N_2O, CO, VOC, SO_2, and NO_x.	Equipment capacity and fuel type, fuel quantity, and other operational information (i.e., quantity of heat/power generated) or direct measurements from stacks (e.g., PEMS or CEMS).
Highway Vehicles (mobile combustion)	CO_2, CH_4, N_2O, CO, VOC, SO_2, and NO_x.	Type of vehicle and fuel combusted, miles that vehicle was driven.
Sinter Pellets Process	CO_2, CH_4, CO, VOC, SO_2, and NO_x.	Mass of sinter produced with emission factors, or direct measurements of emissions.
Manufacture of Nitric Acid	N_2O and NO_x. Also NH_3 and VOC.	With CEMS data, all gases may be monitored. For calculation approaches, data commonly needed are quantity of nitric acid produced, N2O destruction factor (fraction of emissions abated by reduction technologies), and abatement system utilization factor (fraction of time the abatement system was in use).
Aluminum Production (electrolysis)	CO_2, CO, SO_2.	Process type (prebake or Soderberg), weight of aluminum produced, and net anode consumption.

Note: [a] Additional information may be required to complete some of the calculations. Only the similar information points are listed in this table.

COUNTRY- OR REGION-SPECIFIC OPERATIONS, PROCESSES, OR SOURCES

Some industrial processes specific to a country or region should be included in a customized tool (see box 7). For example, although the dry-cement process has been broadly adopted around the globe, some countries still commonly use a wet-cement process. Further guidance on the issues specific to this process may be helpful to companies developing an emissions estimate for their inventory. Likewise, some emission sources might be excluded if they are not relevant to the region.

EXISTING PROGRAMS

If the intended users of the calculation tool already calculate GHG emissions (or collect information that can be used to calculate GHG emissions) as part of an existing local program, the local program methods should be taken into account when the tool is customized. As noted earlier, information about the quality and quantity of fuel being burned may be useful for many different emission calculations, and it may be possible to use this information to calculate CO_2 without significant additional work. In the United States, for example, under the Clean Air Act, SO_2, NO_x, O_3, VOC, particulate matter, lead, and CO are tracked from multiple sources, including stationary combustion, mobile combustion, and industrial sources. For many of these sources, the information needed to estimate GHG emissions is already being collected and available at the unit or facility level. In other cases, activity data may already be collected for other reasons, such as the quantity of wastewater treated for water quality regulations, and can be used to calculate GHG emissions. These so-called shortcuts can help when writing the guidance, identifying local emission factors, or simplifying the reporting for companies that may already have collected some of the data required for their inventory.

BOX 7 Cement Technologies in India

During the customization of the cement tool in India, the tool developers at The Energy and Resources Institute (TERI) noted that many different vintages of various technologies could be found not only within the country but also within the companies themselves as plant managers modernized or experimented with new technologies. The partners realized that in this situation, site-specific and measured data would substantially refine inventory estimates and accordingly provided the guidance required to do so.

Relevance to a GHG Program's Specifications

Participating in a voluntary or mandatory GHG reporting program can be the deciding factor for some companies developing a GHG inventory. Therefore, if they are to use a customized calculation tool, it should be made consistent with the specifications of the programs for which it might be used. When the tool's geographic context is identified, the relevant GHG or other emission programs are identified as well. This section of the Tool Guidebook looks at which elements of those programs will affect the tool's customization. The GHG program questions to consider are

a. Which, if any, programs in the tool's geographic context should be considered when providing guidance to users?

b. Should more specific program guidance be included, for example, accounting guidance, gases included, and principles?

c. What types of GHG programs or initiatives would the customized tool serve, and what are the quantification methods being considered, given the programs' aims?

The following sections look at possible considerations when asking questions b and c.

MULTIPLE GHGS OR OTHER AIR POLLUTANTS

Not all GHG programs address all six GHGs included in the UNFCCC agreements. (In fact, the six gases chosen by the UNFCCC are themselves a subset of GHGs.) In some cases, the GHGs are phased in over time. For example, the EU ETS initially chose CO_2 from a limited number of sectors because it is the dominant GHG and to simplify the initial stage of the program. Additional sources and gases will be added in subsequent stages.

Some programs address both GHGs and criteria air pollutants. For example, Mexico's mandatory RETC program includes some GHGs, such as CO_2, CH_4, and N_2O, as well as criteria air pollutants and a range of other substances like toxic waste. Users of the Tool Guidebook therefore may wish to add or subtract gases from existing calculation tools to match the program(s) with which they are intended to be used.

ORGANIZATIONAL AND OPERATIONAL BOUNDARIES

The *organizational boundaries* of GHG accounting specify which parts of an organization's emissions are included in its inventory, and the *operational boundaries* divide the entity's sources into different types of direct and indirect emissions, or scopes.[5] Different GHG programs take different approaches to setting organizational boundaries, and they also vary with regard to which scopes the reporters must include. Customized calculation tool guidance should observe the accounting approaches of relevant programs. In the case of operational boundaries, for example, customized calculation tools might provide detailed guidance on which emission sources are likely to be in the scopes that are required by local programs but provide only limited guidance on the scopes that are optional. For countries with more than one GHG reporting program, guidance on any differences in the treatment of organizational boundaries may be very useful (see box 8). Information about organizational and operational boundaries usually is available as part of the GHG program or initiative specifications.[6] Other accounting considerations are listed in chapter 4.

ACCEPTED QUANTIFICATION METHODS

The primary purpose for a GHG program or initiative to provide a calculation tool is to ensure consistency and credibility in the calculation of emissions for a specific use and to clarify the methods needed to quantify the GHG emissions. The intended use and context of the calculation tool customization (e.g., the type of program and whether it is voluntary, mandatory, or for internal management purposes) determines which quantification methods are relevant. The following are three kinds of uses for a calculation tool and the general quality of data required. (Chapter 5 discusses at length the different quantification methods and the level of quality that they provide.)

1. *Mandatory Programs*
   Regulatory programs have the ability to demand the most rigorous quantification methods and enforce compliance. The following three types of programs are the most likely structures and are listed in order of most to least need for accuracy:

- *Market-based programs* are essentially cap-and-trade programs in which a cap is placed on the overall emissions for an entity, where an entity may be a facility or a unit, and each entity is allocated a certain number of emission "permits" or "allowances" for a particular year. The total number of permits can be no greater than the total cap. The entity may choose to meet their emission limits either through internal measures or by buying allocations from other companies. Market-based programs require more accurate emission estimates or measurements to ensure their environmental success and public acceptance. Regulated sources also have a vested interest in the accuracy of emissions data so as to ensure a fair of distribution of allocations. Examples of market-based air emissions programs are the EU ETS and the U.S. Acid Rain Program.
- *Command-and-control programs* generally require entities or sources to meet specific emission or operational limits. They may impose a technology standard, a specific emission standard (e.g., a CO_2 emissions limit per mmBtu), a limit on operation hours, or the like. Generally such programs require high-quality data to ensure that compliance is being fairly determined.
- *Emissions inventories* are required emissions reports over a specific period of time (e.g., one year). The data produced by an emissions inventory can be a major

BOX 8 Customizing Organizational Boundary Guidance for Mexico

In Mexico, companies report GHG emissions to the Mexico GHG Program[8] and the Registry of Emissions and Pollutant Transfer (RETC), which have different ways of defining organizational boundaries. When developing a customized tool for the pulp and paper sector in Mexico, the ramifications for the GHG inventories due to this difference became clear. The Mexico GHG Program follows the GHG Protocol Corporate Standard consolidation approaches; that is, it uses either a control or an equity approach. The RETC program uses the physical site as its reporting boundary. Mexico's pulp and paper plants often have wastewater treatment facilities on-site, although they may not be owned and/or controlled by the pulp and paper company. Because the Mexico GHG Program would categorize the GHG emissions from these installations as scope 3, they would not need to be included in the inventory. The RETC program, however, does require that the GHG emissions from this installation be included in the inventory. To ensure that companies can use the customized calculation tool for both programs, the sector-specific guidance distinguishes between the two methods for defining boundaries and stipulates which installations/emissions must be included in each program's inventory.

building block for a variety of uses. Often the data are used as a preliminary step to developing specific emission reduction programs. Accordingly, if emissions statements are being used for data collection or information for future programs, rather than directly in a command-and-control or market-based program, the highest level of data quality may not be required. Knowing the future uses of the data is necessary to ensure that the data are sufficiently accurate to meet the GHG program's ultimate objectives. Frequently, even if the most stringent approaches are not used at the outset, the infrastructure permitting a rise in the quality of the inventory for future programs is nonetheless established at the beginning. Among the numerous examples of emission inventory programs is the Mexican RETC program.

2. *Voluntary Programs*
   Like mandatory programs, voluntary programs have various structures and often are created to prepare entities for future regulations. Currently there are voluntary entity-level emission inventory programs, technology standards, and market-based programs. Selecting the appropriate estimation or measurement approach for such programs often means a balance among ensuring business participation, measuring the program's GHG effects, and meeting the program's long-term objectives, including future data quality needs. Often the approaches presented to users are more flexible for voluntary programs, allowing them to decide whether greater rigor in estimation or measurement approaches may be appropriate, especially if users will use the data in a future mandatory program.

3. *Internal Business Management*
   Many companies have chosen to develop internal mechanisms to track their emissions even when they are not reporting them under a voluntary or mandatory program. Here again, flexible estimation or measurement approaches allow users to decide whether more rigorous estimation or measurement approaches may be appropriate.

THE PROGRAM'S PRINCIPLES

The GHG Protocol Corporate Standard lists five principles: relevance, completeness, consistency, transparency, and accuracy. Many GHG programs adhere to only these principles, but others add principles of their own. Principles are the general guidance for the "spirit" to be followed in developing an inventory when the exact "letter" is unclear. Issues such as materiality thresholds and uncertainty are examples of when such principles may need to be considered. Sector-specific guidance can help in developing an inventory by addressing a corporate inventory's specific emission sources (e.g., lawn mowers) that are difficult or expensive to quantify compared with the level of GHG emissions (e.g., their materiality). Guidance on "back of the envelope" (i.e., quick and rough) estimations may be helpful when deciding whether or not a source will be material and should be included in the inventory. Likewise, emission sources that are reliably below the materiality threshold may be highlighted. When a program wants to emphasize certain principles, for example, completeness more than accuracy, the sector-specific guidance may discuss the actual impact regarding the sources to be included.

Notes

[1] The IPCC defines a key source category as one that has a significant influence on a country's total inventory of direct greenhouse gases, based on the absolute level of emissions or the trend or both. By definition, key source categories are those sources that contribute the most to the absolute overall level of national emissions.

[2] These can be found at http://unfccc.int/national_reports/items/1408.php.

[3] See the WBCSD cement-sector tool at www.ghgprotocol.org.

[4] For example, the installation of certain NO_x abatement technologies increases N_2O emissions. See M. Takeshita, L. Sloss, and I. Smith, N_2O Emissions from Coal Use. IEA Perspectives, 1993.

[5] See The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard (rev. ed.), 2004 (www.ghgprotocol.org), chapters 3 and 4.

[6] See http://www.geimexico.org/.

4 Customizing the GHG Accounting Concepts

After defining the objectives of the tool and the main stakeholders (at least the core advisory team and a road tester, see chapter 6), the next step in customizing a tool is deciding on the guidance to be provided for accounting and quantification. This chapter describes the accounting elements that the tool may cover, and chapter 5 examines the possible quantification methodologies.

The corporate reporting calculation tools currently available (e.g., on the GHG Protocol Initiative website)[1] can be divided into two broad categories:

1. Tools with extensive guidance on both general accounting considerations (e.g., organizational boundaries) and quantification methods.[2]
2. Tools that focus on the quantification methods only.[3]

Both types of tools can be customized, and guidance on GHG accounting concepts may be added to the tool as well. This allows its developer to explain how the sector would apply the GHG accounting concepts in accordance with specific information about the industry in the context of the customization. In addition, this guidance may offer information about how relevant program requirements would affect the specific sector within the boundaries for which the tool is being developed. In sum, a discussion of the broader GHG accounting issues in the guidance portion of the calculation tool can simplify the development of a company's GHG inventory by consolidating all the information in one document. The tool also can offer more sector-specific guidance on issues that the GHG program has not specifically addressed, for example, which sources can probably be disregarded if the GHG program has set a "de minimus" level (e.g., 5% of total GHG inventory emissions) of emissions that do not need to be included in the inventory.

If the customized tool offers accounting guidance, the developers should be sure to list any requirements specific to the relevant GHG program(s) identified in chapter 3 and how the tool will implement them. For any accounting concepts, either outlined in the GHG Protocol or in GHG programs, for which the implementation of certain components is flexible (e.g., whether or not to develop an inventory using both a control and an equity approach) guidance should also be included on implementing these components. This is especially useful when additional sector-specific considerations may affect the development of an inventory, for example, by including scope 3 emission sources that the sector might want to track, even when they are not required by the Corporate Standard or the GHG program in question.

This chapter discusses guidance on the major accounting components that could be added, as well as the main issues to consider for guidance on the various components. The main accounting concepts are

- Setting organizational boundaries.
- Defining operational boundaries.
- Tracking emissions over time.
- Identifying and calculating emissions.
- Managing inventory quality.
- Reporting emissions.

Reporting Organizational Boundaries

A reporting entity must define how boundaries will be determined in order to decide which units (e.g., boilers), facilities/plants (e.g., and iron and steel plants), and/or companies (e.g., subsidiaries, joint ventures) will be rolled up into the inventory.

The three questions to ask regarding a tool's boundaries are

a. What type of boundary approach(es) does the GHG program(s) or initiative(s) require?

b. When using a corporate or facility approach, how should ownership be defined?

c. At what level will the data be collected?

IDENTIFYING THE RELEVANT BOUNDARY TYPES

To date, GHG programs and initiatives have chosen three main approaches to defining boundaries and consolidating emission sources into one inventory:

- *Corporate approach:* In corporate GHG accounting, businesses must select an approach to defining those businesses and operations making up the company so that they may consolidate their GHG emissions. Consolidation is based on ownership, which is defined in either financial or operational control terms, or even in equity share terms.[4]
- *Facility approach:* Facilities also must define how their different operations will be consolidated. Equity ownership may be the deciding factor, but more often either operational or financial control is used.
- *Physical site:* Some GHG reporting programs require that any unit emitting GHGs within a defined physical site be included, regardless of the corporate- or facility-level ownership of that source.

In addition to the boundaries defining the reporting entity, many GHG programs using the corporate approach also define the reporter's geographic boundaries. Most voluntary GHG initiatives require participants to develop at least a national corporate inventory, that is, one including any business units or operations within the country's national boundaries. Some programs, however, require either smaller (state) or larger (international) geographic boundaries.

When using the other two approaches (facility and physical site), it is not necessary to define geographic boundaries, since various facilities are not aggregated into one inventory and therefore are not likely to be spread out across geographic boundaries.

Some entities may need to report GHG emissions to more than one program, and these programs may have different boundary definitions, depending on their particular objectives (see box 8). In this case, the calculation tool should clearly explain the difference between the two programs and how the calculation tool can be used for both.

CHOOSING THE EQUITY SHARE, FINANCIAL, OR OPERATIONAL CONTROL APPROACH

Whether a corporate- or a facility-level inventory is used or required, companies still may need to decide whether to use the equity share, financial, or operational control approach to develop their inventory. Actors in the same sector often use the same consolidation approach if the GHG program does not already specify one, so as to avoid the double counting of GHG emissions within the sector. Which approach is recommended often depends on the structure of the industry and the objective of the GHG inventory. Companies operating GHG-intensive units and facilities often prefer one of the control approaches (operational or financial) because with this approach, most of their relevant GHG emissions are included in the inventory and it provides the clearest indication of where they can most effectively reduce GHG emissions. Sectors with complex upstream and downstream supply chains that represent a significant portion of the GHG emissions and in which they often hold extensive equity investments and have significant influence—but not control of operations—may prefer the equity share approach. This allows them to think about their GHG emissions and ways of reducing emissions more broadly. The oil and gas industry is a sector that for this reason sometimes uses the equity share approach.

COLLECTING AND ROLLING UP DATA

Data may be collected at various levels, depending on the approach used to define the organizational boundaries:

- *Unit;* for example, fuel data are collected for individual boilers (can be used in all three boundary approaches).
- *Facility;* for example, data on all fuel of a specific type are collected for the facility, with no information about where the fuel is used (can be used in all three boundary approaches but may mean that slightly less specific data are collected).
- *Corporate;* for example, fuel data for the entire company are collected, without specifying the facility or unit where the fuel is used (can be used only if a corporate boundary is used. The data collected will be still less specific, although for some sources and gases, this may not significantly increase the uncertainty of the emissions estimation).

GHG programs or initiatives may already have specific requirements regarding how data must be collected. If not, additional guidance can be provided in the customized tool. This guidance should specify the level at which data are best collected for various elements of the inventory. An example is activity data for mobile combustion emissions. If they are from a company moving vehicles from one facility to the next in accordance with the operation's needs, the data may be easier to track at the corporate level. Moreover, if enough information about the vehicle types and fuels used is collected, the estimate may be equally accurate to a facility-level data collection exercise.

In some cases, data may be difficult to collect at a particular level. For example, some lower-tier methods look at the length of pipeline to quantify fugitive emissions from natural gas transmission and pipelines. This, however, makes collecting data more difficult when using the typical facility-level definition, as it is unclear with which facility (e.g., compressor station) the pipeline should be associated.

The customized tool's guidance may also point out where the method of collecting data itself may increase the accuracy of the estimation. For example, when more detailed information is required (e.g., about N_2O, CH_4, NO_x, and SO_2 emissions from stationary combustion sources) for more accurate estimates, collecting data at the finest level of granularity (unit or facility) makes it easier to calculate certain GHG and other air emissions. Businesses making a corporate inventory often gather more precise data for those units (e.g., boilers) representing a larger percentage of their total GHG emissions but may gather corporate-level data for smaller sources (e.g., company lawnmowers).

Finally, the customized tool's guidance also can help determine when more detailed data would lead to opportunities for mitigation.

Setting Operational Boundaries

After reporting the organizational boundaries, the operational boundaries are set. To do this, the company identifies all relevant sources within its organizational boundaries, classifies them as either direct or indirect emissions based on ownership, and allocates the indirect emissions to either scope 2 or scope 3. The Corporate Standard has three scopes:

Scope 1: Direct emissions.

Scope 2: Indirect emissions from the consumption of purchased electricity, heat, or steam.

Scope 3: All other indirect emissions.

Most voluntary corporate accounting initiatives or programs require that the GHG inventory include all scope 1 and scope 2 emissions. The Corporate Standard also recommends this approach, and for a more complete inventory, some industry associations have advised their members to track specific scope 3 emissions (see box 9). A customized sector-specific tool can provide guidance on those sources likely to be significant, including the scope 3 emissions that may be useful to track.

BOX 9 Wastewater Treatment and Pulp and Paper Companies

The pulp and paper tool developed by the Climate Change Working Group of the International Council of Forest and Paper Associations (ICFPA) recommends that pulp and paper companies track in scope 3 any wastewater facility located on the company's physical site. The stakeholders recommended this when they recognized that

1. Even though the company may not own or run the wastewater facility, a significant proportion of, if not all, the wastewater is a direct result of the company's operations and therefore internal company action should reduce the amount of wastewater as much as possible.
2. Any program looking at a physical site boundary should include this source, as it could have a significant impact on the overall inventory.

Therefore, the tool developers track wastewater units to ensure that the tool's users have a full picture of the sources to which they might be linked by either reputation or regulation. As it turns out, this guidance was particularly helpful in Mexico.

Tracking Emissions over Time

To track emissions (and reductions) over time, an entity needs to (1) choose a base year and (2) draw up a base year emissions recalculation policy.

A customized sector-specific tool can provide significant guidance on both, especially if a company is making an inventory outside a GHG program or initiative and wants only internal consistency. Or if the GHG program has any specifications, the directive can be clarified in the sector-specific document and may also be included in the functions of the tool itself.

CHOOSING A BASE YEAR

If a GHG program requires a specific approach that is relevant to the tool, the guidance should explain how it is applied. If the GHG initiative or program does not require using a single year or an averaging approach for choosing a base year, additional information about the sector's general year-to-year GHG emissions stability may help companies make a more informed decision.

A BASE YEAR RECALCULATION POLICY

Most GHG programs have broad guidelines for recalculating the base year according to significant structural changes in the company. But helping companies understand how best to define a "significance threshold" based on the relevant structural changes most likely to affect the sector may be useful. For more information about choosing and recalculating a base year, see chapter 5 of the GHG Protocol Corporate Standard.

Identifying and Calculating Emissions

Most of a customized calculation tool's guidance pertains to identifying and calculating emissions. Chapter 5 outlines the different ways in which GHG emissions can be calculated, their relationship to data collected for other pollutants, and the various choices made while customizing a sector-specific tool based on the users' needs.

Managing the Inventory's Quality

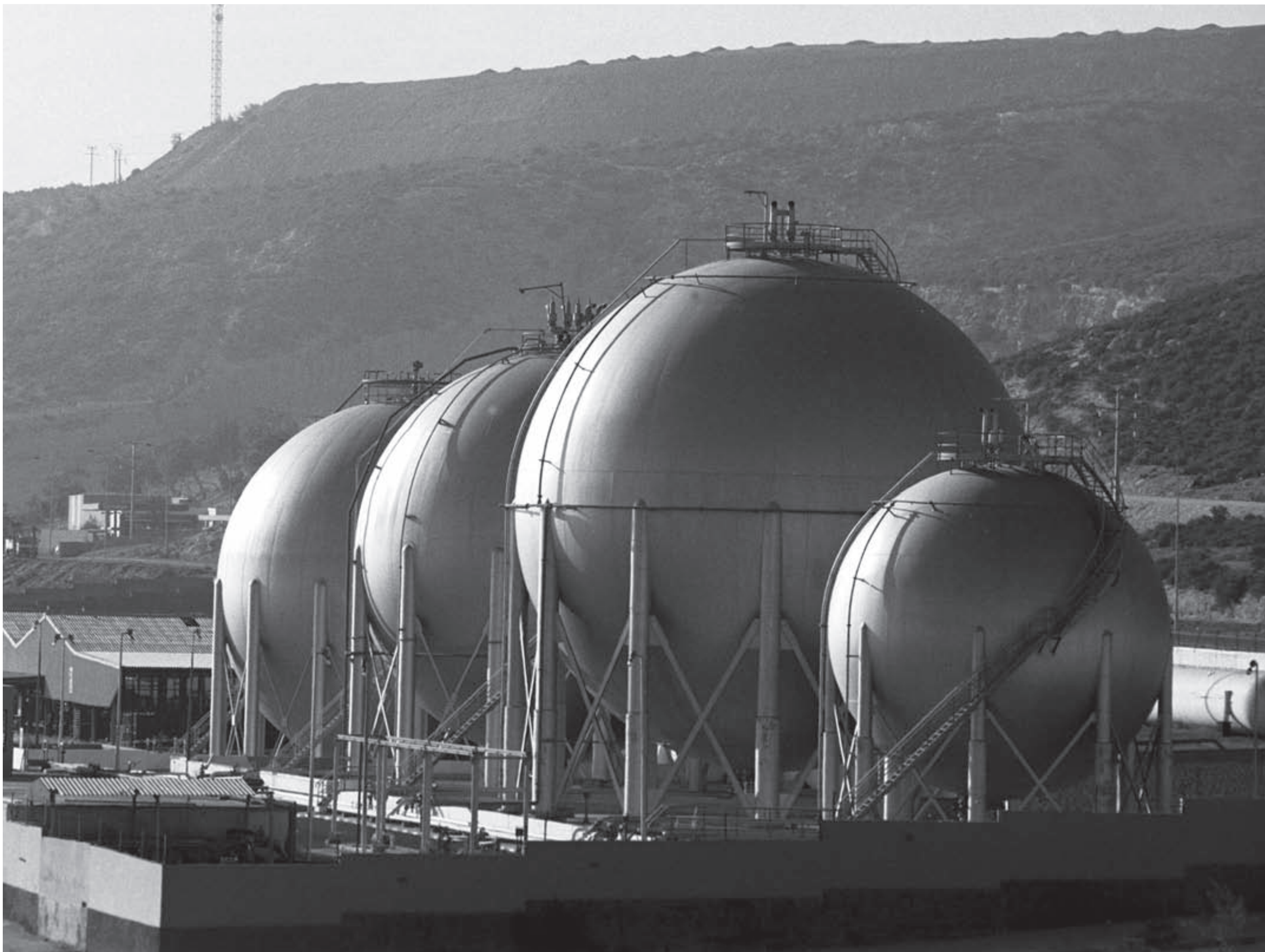
Most sector-specific tools do not directly address managing an inventory's quality, except perhaps in reference to data collection and uncertainty. Unless stakeholders have had experience with different data management systems, the general guidance in a document like the Corporate Standard may be sufficient. An exception is when the GHG program provides specific reporting software to help companies collect data. In this case, users of the calculation tool may appreciate a description of how the software works. Annex A in this Tool Guidebook also lists resources offering guidance on quality assurance and quality control measures.

Reporting Emissions

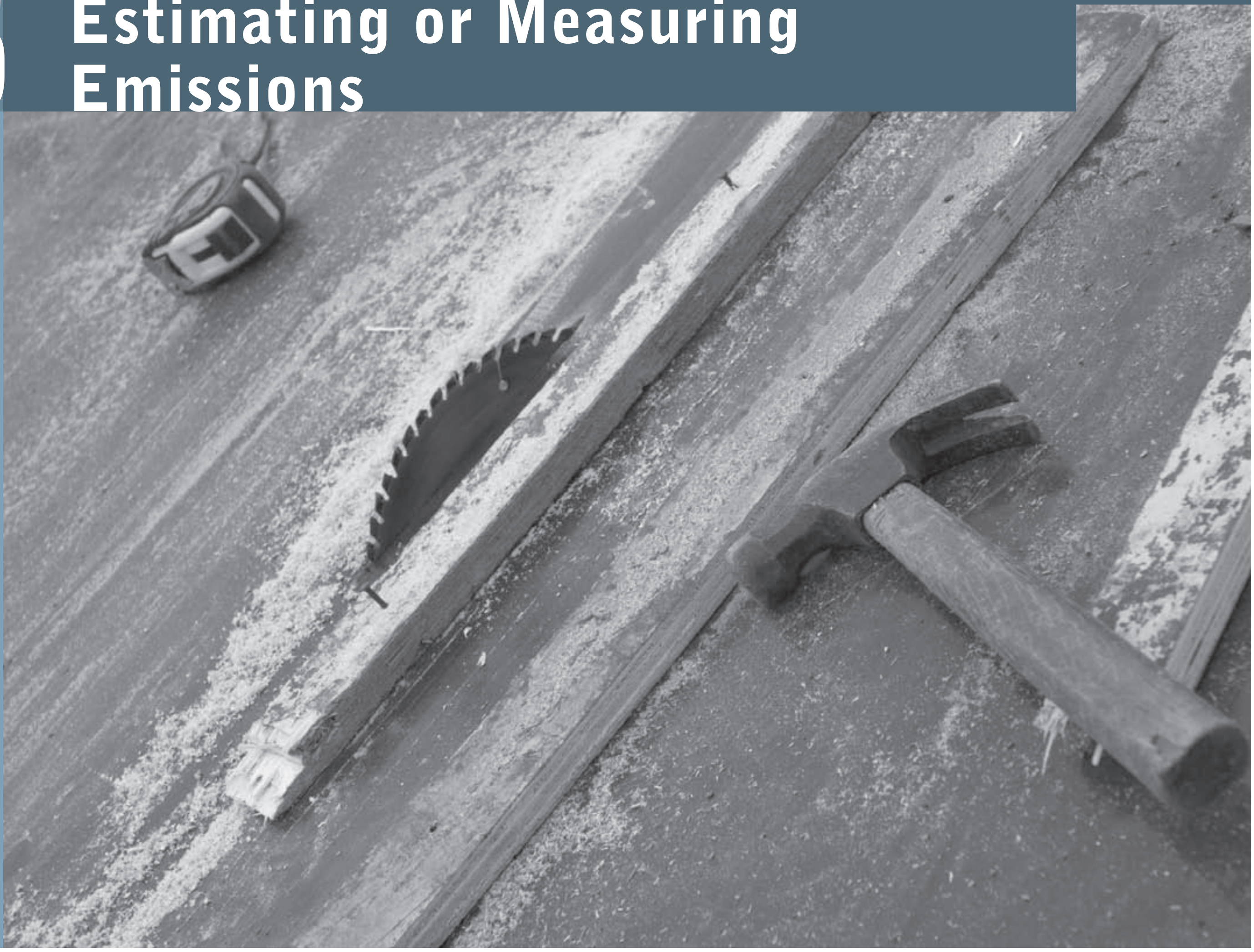
Many sector-specific tools provide guidance on presenting the results of the inventory. If the GHG program is using a particular reporting template or software platform, that information should appear in this section.

Notes

[1] See www.ghgprotocol.org.
[2] See, for example, the pulp and paper tool at www.ghgprotocol.org.
[3] See, for example, the ammonia tool at www.ghgprotocol.org.
[4] For a complete description of these two approaches, see chapter 3 of the Corporate Standard.



5 Estimating or Measuring Emissions



Central to a customized calculation tool is the guidance on calculating emissions from the multiple business units and GHG sources included in the reporting entity's organizational and operational boundaries. This chapter discusses the four methods for estimating or measuring GHGs, SO_2, and NO_x emissions; summarizes their advantages and disadvantages; and explains how to select or incorporate an emissions measurement approach into a customized tool, including guidance on implementing a "tier" structure.

Much of the information in this chapter is based on guidance documents from both the IPCC 2006 Guidelines and national government agencies, which tool developers are encouraged to read. A reference list at the end of this Tool Guidebook provides other sources of information for both GHGs and other air emission inventory purposes (see annex A).

Major Categories of Emission Measurement and Estimation Techniques

The four main methods for quantifying GHG emissions are: (1) emission factors–based approaches, (2) mass (material) balance measures, (3) predicative emission–monitoring systems (PEMS), and (4) continuous emission–monitoring systems (CEMS).

Each category provides the following general information: an overview of the approach, its possible uses for various sources and/or gases, its limitations, and, when applicable, customization options.

EMISSION FACTOR–BASED CALCULATION APPROACH

An *emission factor* is a coefficient that quantifies the emissions or removals of a gas per unit activity, and it often is based on a sample of measurement data, derived as a representative rate of emissions for a given activity level under a particular set of operating conditions.[1] This factor allows users to calculate emissions without needing to gather site-specific data on the quantity of emissions released.

The general equation for emissions estimates is

$$E = A \times EF$$

Where

E = emissions

A = activity data (e.g., fuel consumed, material input, throughput, or production output)

EF = emission factor (usually the weight of the pollutant or the unit weight, or the volume or duration of the activity, e.g., tons CO_2 or tons of coal)

Although often developed to estimate emissions for larger inventories (e.g., by the IPCC for national inventories),[2] quantification approaches based on emission factors are used in several contexts, including all types of both voluntary and mandatory programs (entity-level, unit-level, etc.) and for all types of air emissions. Emission factors have been developed for specific emission-generating activities or processes for all five different source types (stationary combustion, mobile combustion, process emissions, fugitive emissions, and waste emissions), as well as for carbon sinks. In addition, different emission factors have been developed for the different activity data available for the estimations. For example, mobile combustion emissions can be calculated using (1) an emission factor representing the carbon content of the fuel multiplied by the amount of fuel used, or (2) an emission factor based on a distance-based metric (e.g., miles) multiplied by the distance traveled by the vehicle being measured. Most entity-level calculation tools offer an emission factor calculation option for most of the sources covered, even when other estimation or measurement approaches are provided. But if a customized tool is to be used to support programs like a cap-and-trade program or to quantify emission reduction projects for programs like the Kyoto Protocol's Clean Development Mechanism, some emission factor–based approaches may not be sufficient to meet the program's required level of certainty. These programs, however, generally state clearly which methods are acceptable.

Emission factors may be developed using data from periodic sample testing or stack testing, mass balances, control-equipment specifications, and/or emission models. (See IPCC 2006 Guidelines, Volume 1, Chapter 2.) Most factors are averages of all available data of acceptable quality, and they generally are assumed to represent long-term averages for all facilities in the source category. For this reason, emission factors developed with credibly collected[3] data from facilities in a specific region or from the facility itself are more likely to be representative of and preferable to emission factors developed in other countries or using international-level data.

Familiarity with the data from which an emission factor has been created allows users to better understand the range of uncertainty that may result from using that emission factor for their specific facility or unit. Even when sources with similar processes, control systems, and pollutants are used to derive an emission factor, the data from the sources being used still might differ by a factor of five or more.[4]

One way, therefore, to improve the accuracy of the emission factors for all gases and sources is to encourage the development of site-specific factors. This requires testing at the source[5] in a representative variety of operating conditions and then using the test data to develop an emission factor for the source itself. Although not all sources can use this process, companies with large stationary combustion units or other large sources that represent a significant percentage of their emissions may find that it greatly improves the accuracy of their inventory. Because such procedures may be expensive, reporters and GHG program administrators may need to work together to decide whether such procedures should be a priority and whether financial or technical help may be available.

In general, emission factors tend to more accurately estimate CO_2 emissions and less accurately estimate CH_4, N_2O, SO_2, NO_x, and other criteria air emissions, whose estimates are affected by the specific characteristics of the fuel and the reporter's operating conditions and equipment. Emission factors also are generally more accurate for stationary and mobile combustion sources, and less for process, fugitive emission, and waste sources, in which differences in the entity's practices and equipment may significantly change the resulting emissions. Moreover, for any one source, more than one emission factor approach may be available, with some being more accurate than others. For example, different emission factors can be used to calculate the GHG emissions from cement production, depending on the available activity data (see box 10).

BOX 10 Alternative Ways of Quantifying GHG Emissions from Producing Cement

Both the IPCC 2006 Guidelines and entity-level tools use the following methods for calculating the GHG emissions from cement production. The methods are listed in order of increasing certainty in the resulting estimations, which are represented by the different tiers. The tier 1 methodology produces the least certain estimation, and a quantification of carbon using tier 3 results in the most certain estimation. In this example, the different types of activity data produce the different certainty of the tier 1 and tier 2 estimations.

- Tier 1 emissions are based on clinker production estimates inferred from cement production data, correcting for imports and exports of clinker (an input required for cement production). The estimation of emissions is directly linked to cement production.
- Tier 2 emissions are estimated directly from clinker production data (rather than clinker production inferred from cement production) and a national or default emission factor.
- Tier 3 emissions are calculated based on the weights and compositions of all carbonate inputs from all raw material and fuel sources, the emission factor(s) for the carbonate(s), and the fraction of calcination achieved. The tier 3 approach relies on plant-specific data.

The WRI/WBCSD Cement Tool (vol. 2.0), one of the more advanced tools for entity-level accounting in this sector, uses tiers 2 and 3 approaches and emphasizes the advantages of using plant-level data whenever possible.

ACTIVITY DATA

Besides emission factors, improving the activity data component of the equation can also raise the quality of the inventory. This can be done in one of three ways:

1. Activity data may be collected in several different, more or less accurate, ways. For example, records of fuel purchases may be less accurate than a fuel flow meter or fuel flow measurements, depending on how well the meters are calibrated, how well they are maintained, and so forth. Reducing the uncertainty of the activity data can greatly improve the quality of the inventory data.
2. Other methods can be used to verify the quality of the primary activity data. For example, monthly fuel purchase records can verify that fuel flow meter readings are within a reasonable tolerance.
3. Changing the method of collecting data enables a more accurate emission factor approach to be used. Certain activity data require assumptions that make the estimation method inherently less certain. For an example of different types of activity data that may be collected for calculating emissions from cement production (see box 10).

The tool's guidance should help users improve the collection of activity data, verify the quality, and include emission factor-based methods that use activity data easily gathered by the entity. During the tool customization process, it is helpful to determine which elements of the inventory can be significantly improved by using better emission factors or activity data and how much they can reduce uncertainty.

MASS BALANCE METHOD

To estimate emissions, a *mass* (or *material*) *balance* approach follows the mass flow of an element through a process.[6] Because chemical elements (e.g., carbon and oxygen) cannot be destroyed or created, this approach can be used when an element's input and output streams and the chemical reactions that it undergoes can be accurately identified.

The general equation is

Input = Output + Emissions

Where

Input = Input of the chemical element being tracked, for example, C (carbon).

Output = Output of the chemical element not emitted into the atmosphere, for example, C in fly ash.

Using a mass balance approach for CO_2 emissions from stationary combustion sources is considered a relatively accurate method of quantification, especially when the actual carbon content of the fuel is known. An equation for GHG emissions from burning fuel in stationary combustion units may look like the following:

$$E = A \times CC \times GHV \times OF$$

Where

E = emissions

A = activity data

CC = carbon content of the fuel

GHV = heating value of the fuel

OF = percent of the fuel oxidized

Users may obtain information about a fuel's carbon content from the seller of the fuel or from a fuel analysis collected for operational purposes, which, with a default heating value and oxidation factor, can lead to a more accurate calculation.

In its Stationary Source Emissions Measurement Program: International Good Practice Document (here called the SSEMP Draft Good Practice Guidance),[7] the US EPA warns that while a mass balance approach may be used successfully in a number of situations, it is

> applicable only when accurate input, output and uncertainty quantities can be determined. Inaccuracies associated with individual material tracking, or other activities inherent in each material handling stage can result in large deviations for total facility emissions. Small errors in data or calculation parameters including those used to calculate the mass elements for the mass balance equation (e.g., pressure, temperature, stream concentration, flow and control efficiency) can result in potentially large errors in the final estimates.[8]

Generally, the mass balance approach should be applied over a sufficiently long period of time so that errors and uncertainties in determining inputs and outputs are averaged out (i.e., weekly samples of coal carbon content averaged to an annual value). This means that this approach is better for determining annual emissions than daily or hourly emissions required for certain types of emissions with seasonal variations (e.g., NO_x and SO_2).

The mass balance approach is generally best for determining emission rates for carbon dioxide and uncontrolled sulfur dioxide,[9] except for processes in which a large portion of the sulfur or carbon input is retained in the product or for sources that employ control equipment and the outputs of gas are less easy to track as a result of the inputs. Stationary combustion sources are one area in which this approach is used; other sources include ferroalloy production and certain emissions from aluminum production processes. The IPCC 2006 Guidelines does not use a mass balance approach to calculate CH_4 emissions, even when it was used to calculate CO_2 emissions for the same process. This is because the CH_4 emissions depend on factors other than the quantity of inputs, such as the equipment's operating parameters. This approach also works better with gaseous and liquid fluids, for which fuel flow measurements are more accurate than they are for solid fuels. Like emission factors, a mass balance approach may be developed for either broader use or in a more site-specific context, the latter being more accurate. This approach is generally less applicable to fugitive emissions, process emissions, waste sources, and carbon sinks whose inputs and outputs may be difficult to track.

PREDICTIVE EMISSIONS–MONITORING SYSTEM (PEMS)

A *predictive emissions–monitoring system* (PEMS) is a set of mathematical models that develops a numerical relationship between a unit's operating parameters (e.g., fuel usage, steam production, or furnace temperature) and a pollutant.[10] A PEMS is not a direct measurement approach because the concentrations emitted are not tested continuously in order to determine the quantity emitted. Instead, it is a hybrid of continuous monitoring and a stack test. It allows users to make more site-specific estimations and can be very accurate.

When a PEMS is used, first a correlation test is performed to create a relationship between the GHG emission rate and the process parameters. The emissions then are calculated using the process parameters to predict the emission rates based on the results of the initial source test. The four types of PEMS are first principles, regression, neural network, and hybrid. A PEMS based on first principles uses mass balances, thermodynamics, and reaction kinetics to estimate emissions. A PEMS using regression establishes a statistical relationship between variables and emissions. A PEMS using a neural network constructs an iterative process using weighting factors to estimate emissions. Finally, a hybrid PEMS is a combination of the first principles, regression, and neural network types of PEMS.

Unlike emission factors and certain mass balance equations, the PEMS has been used primarily for stationary combustion emissions or industrial processes in which N_2O is emitted. With the implementation of proper training programs and quality assurance practices, the US EPA has found that this approach can capture high-quality data for CO_2, CO, and NO_x gases. The IPCC also refers to the PEMS as a method for capturing N_2O data.

The SSEMP Draft Good Practice Guidance recommends taking the following steps to ensure that this approach is successfully used for stationary combustion units: certifying the PEMS equipment, recertifying if the calibration fails or the emissions change for any reason, carrying out quality assurance and quality control procedures to make sure that the initial accuracy continues over time, and instituting data availability / missing data substitution protocols.

For more information on ensuring that a PEMS captures high-quality data, see the SSEMP Draft Good Practice Guidance, soon to be available.

CONTINUOUS EMISSIONS–MONITORING SYSTEM (CEMS)

A *continuous emissions–monitoring system* (CEMS) contains all the equipment required to directly measure a gas's concentration or emission rate. A CEMS can capture real-time data for CO_2, SO_2, and NO_x gases from any stationary combustion unit emitting from a smoke stack. It also can be used to calculate the N_2O emissions from processes like the production of nitric acid[11] and adipic acid. With correct operating procedures, CEMS data can be extremely accurate, but without the CEMS's proper installation, performance tests, and ongoing verification, this accuracy can quickly disappear.

Just as for a PEMS, a CEMS requires several steps to ensure that it is successfully applied to stationary units. These steps are certifying the CEMS equipment, recertifying if the calibration fails or the emissions change for any reason, carrying out quality assurance and quality control procedures to make sure that the initial accuracy continues over time, and instituting data availability / missing data substitution protocols.

For more information on ensuring that a CEMS captures high-quality data, see the SSEMP Draft Good Practice Guidance.

Selecting and/or Incorporating an Emissions Measurement Approach

In addition to identifying the types of gases and sources of emissions, the developers of the customized tool must decide which emissions estimation or measurement approach to select, and also (1) the type of program or use, (2) its cost, and (3) its capacity.

TYPE OF PROGRAM OR USE

When considering which quantification approaches may be appropriate, the use of the customized tool must be decided as well. Will it be for internal management, a voluntary program, or a regulatory program? What type of approach (data collection, command/control, or market-based approaches) will it use? Depending on how the customized tool will be used, its developers may need a framework to determine the quantification methodology required to meet the program's data certainty needs. For example for voluntary applications, various methods may be presented as options along with guidance on which one to choose. In most cases, more than one option is offered to the user, the difference being when and how the user may choose among the different options. Creating a "tier" framework is one way to do this, and there is more discussion of this at the end of this chapter.

INTERNAL BUSINESS MANAGEMENT

If the companies/sectors for which the tool is being customized are unlikely to participate in a GHG program, then providing flexible estimation or measurement approaches, along with guidance on their possible applications, allows the users themselves to decide whether more rigorous approaches are needed. Information about the cost of different approaches also may be helpful. Although emission factor quantification methods certainly are included in such a tool, providing a "tier" framework for other approaches as well as an overview or indication of where these approaches are used in other parts of the world may also help promote the use of other quantification approaches that also increase accuracy and consistency.

VOLUNTARY PURPOSES

Selecting the appropriate estimation or measurement approach(s) for voluntary programs often requires creating a balance among ensuring business participation, measuring the program's GHG or emission impacts, and serving the program's long-term objectives. Often the approaches presented to these users of voluntary programs are more flexible, allowing them to decide whether more rigorous estimation or measurement approaches are appropriate. Other important considerations are

1. *Compliance and data quality:* A voluntary program may not enforce participation. But once a participant has joined a program, it may impose verification requirements carried out by third parties. The cost of such procedures for both the program participant and the program itself may differ according to the quantification method used and thus must be taken into account. For example, a verification company will need more time to double-check the procedures used to develop site-specific emission factors than it would if a default emission factor is used. Another consideration is whether the verifiers have the capacity to ensure that systems like PEMS and CEMS have been installed and function properly, even though companies may be willing to follow these approaches voluntarily.

2. *Types of sources covered:* Voluntary programs may cover a broader range of sources (stationary, mobile, industrial, fugitive, waste, and LULUCF [Land Use, Land-Use Change, and Forestry]) and gases (CO_2, CH_4, N_2O, etc.) in order to increase the likelihood of participation. In such cases a wider, rather than a deeper, knowledge of emissions is sought, and emission factor and mass balance approaches may be more suitable for the various sources.

MANDATORY PURPOSES

Regulatory programs are generally less flexible than voluntary programs and define more narrowly the methods that the participants need to use to quantify emissions. This section provides guidance on choosing an approach for a regulatory program.

1. *Accuracy:* When collecting the data for an inventory, any of the approaches may be suitable—assuming that the appropriate approach is applied to the correct sources—especially for longer time periods (e.g., at least one year). The EU ETS is a good example of a program for various types of sources that requires its reporters to meet a specific level of certainty (which sometimes differs, depending on the source) when developing their GHG emissions inventory. It does, however, provide some flexibility regarding which quantification methods are applied.[12] Depending on the type of regulatory program (cap-and-trade versus data collection programs), the program administrator may also take into account the cost of the different methods. The EU ETS, for example, does allow reporters to use a less stringent quantification approach if they can show that the cost of accepted methodology is too high.

2. *Compliance:* When collecting data to ensure compliance with a certain program, the appropriate estimation or measurement method depends on the standard being tracked, the specific pollutants involved, and how compliance is achieved. For example, the ability to compare the emissions from the same type of unit in different entities or facilities may be necessary to ensure compliance in a regulatory program. This often means that quantifying GHG emissions from units using similar, if not identical, quantification approaches and with the same level of rigor may be more important than insisting on the methodology that has the greatest certainty. Knowing exactly what is being emitted at a specific time may also be important to determine compliance (often the case for other air emissions, such as NO_x and SO_2, whose impacts on the environment depend on the time of year they are released). Therefore, the ability to track emissions accurately in shorter time periods (e.g., less than a year) makes the PEMS or CEMS a more suitable method for certain gases, since regulations focus on certain time periods.

3. *Type of sources covered:* Some regulatory programs may not want to combine types of sources with calculations of vastly different uncertainty levels. For this reason, the EU ETS started its cap-and-trade program looking at CO_2 from large emitters only, whose measurement techniques were already quite advanced. When deciding which sources to include, a program might want to know whether they can be covered using a similar measurement or estimation method. If not all methods lead to the same level of accuracy, this could affect the program's integrity because of the very different uncertainty levels of the various estimations. For example, the environmental integrity of a cap-and-trade program may be questioned if the allowances sold by companies come from sources whose estimation of GHG emissions is still highly uncertain compared with the quantification of the GHG emissions that the buying company must offset. In such a case, the programs should stipulate whether some approaches can minimize the damage. An example is using conservative emission factors to offset the loss of

accuracy for less rigorous approaches or limiting trades between sources with very different uncertainty levels.

4. *Data quality:* Is it possible and easy to double-check inventory data? If so, who will be carrying out the quality control, and how will the procedure be implemented? If it is clear that the GHG program has limited internal resources to devote to the document's quality control, then methods with less intensive quality control procedures should be used, such as the emission factors and mass balance approaches.

COST CONSIDERATIONS

The cost of the four estimation or measurement approaches differs widely. The CEMS is clearly the most expensive, not only to implement, but also to maintain. If maintained correctly, however, it provides the most accurate data available for stationary sources for a number of different gases. If market mechanisms are in place to trade allowances and the like, the CEMS may be worth the higher cost. The PEMS, also used mainly for stationary sources, usually is less than half as expensive as the CEMS.[13] Although with capital costs starting at $112,000 and annual maintenance costs starting at around $42,800,[14] the PEMS is still a relatively expensive option compared with even the most stringent mass balance approach. Once developed, emission factors are the least expensive option. But developing site-specific emission factors may require some capital costs (e.g., fuel flow monitors, fuel sampling, and analysis).

CAPACITY CONSIDERATIONS

When considering which estimation or measurement approach to recommend for a particular tool, the capacity to implement the approach must be considered as well. For companies deciding whether to develop an inventory, capacity is as much a deterrent as cost. Furthermore, a regulatory program may need large resources for building capacity if more complex quantification approaches are required.

When default factors are provided, using calculation approaches with emission factors requires the least amount of capacity from users and programs. These straightforward calculations can be easily integrated into Excel spreadsheets and an entity's management systems. Many tools already exist, and knowledge is constantly expanding through various programs and international processes. But if programs require entities themselves to collect site-specific data or carbon content measurements, then more expertise will be necessary, although environmental management companies often are capable of performing these measurement tasks.

The mass balance approach may require greater technical expertise from the user because collecting input and output data is often more complicated than collecting activity data. Mass balance approaches, however, are often better for industries that already monitor their inputs and outputs even if not for calculating their air emissions. For example, to calculate emissions from aluminum production, the quantity of net anode consumption per tonne of aluminum and total metal production must be known, which is information that most companies will already have.

In most countries, the CEMS is not widely used by regulatory agencies, plant operators, third-party contractors, and vendors, although it is currently the most prevalent method in the United States. For most countries, using a CEMS for stationary sources requires training experts in different user segments to ensure the proper installation, use, and maintenance of the CEMS system, as well as full and accurate compliance. Implementing a PEMS may also take significant resources and time to educate and train its users and to establish systems and practices. Nonetheless, the PEMS is being used, sometimes frequently, outside the United States to quantify air emissions.

Creating a Tier Framework

In order to give inventory developers some flexibility in quantifying their emissions, several different tools, protocols, and GHG programs use "tiers" or "preferred approaches" to help decide which methods to use to quantify emissions and also to indicate their relative complexity and potential accuracy or level of certainty. These tiers are not meant to represent equal accuracy for each different source. For example, a tier 3 method for quantifying stationary combustion may be much more accurate than a tier 3 method for quantifying fugitive emissions. Instead, the tiers are meant to show greater accuracy or certainty of the estimation of GHG emissions for the entity in question.

Some GHG programs may insist on using a particular tier unless the reporter can show why it should not be used. For example, the EU's ETS allows reporters to choose a lower tier only if they can prove that using a higher, more accurate tier is too expensive. Other programs use tiers to enable users to choose where they will invest their resources in using a higher tier. For example, the IPCC recommends that countries use the higher tiers when calculating GHG emissions from key sources. Table 3 gives some examples of programs and the tiers that they offer as well as their general guidance on which tiers are required.

As seen in the EU ETS guidance, different "tiers" may be created for activity data (e.g., fuel flow and net calorific values), emission factors, composition data, oxidation factors, and/or conversion factors[15] or as seen in the IPCC structure, it can be the level at which data is collected that counts.

The difficulty of using a "tiers" approach is that it often is not easy to distinguish among the different methods. That is, the accuracy of two different methods may be interchangeable, depending on various factors, and it is not always possible to distinguish between them. An example is

TABLE 3 Current Programs Using Different Tiers

PROGRAM AND PROGRAM TYPE	TYPE OF TIER
IPCC (national-level reporting)[16]	• In the IPCC 2006 Guidelines, a *tier* (usually there are three) is a level of methodological complexity. Tier 1 is the basic method; tier 2 is intermediate; and tier 3 is the most demanding in regard to complexity and data requirements. Tiers 2 and 3 are sometimes referred to as *higher-tier* methods and are generally considered to be more accurate. • Tiers 2 and 3 are recommended for a country's key sources.
California Registry (corporate-level voluntary reporting)[17]	• The California Registry's General Reporting Protocol and its sector-specific protocols list two approaches for users, the preferred approach and a slightly less rigorous approach. The California Registry restricts the methods that program participants may use, so as to enhance the consistency and comparability of the reporters' inventories. • No criteria are provided for obtaining permission to use the non-preferred approach provided.
EU Emissions Trading Scheme (facility-level mandatory reporting)[18]	• The activity-specific guidelines contain specific methods for determining the following variables: activity data (consisting of the two variables, fuel/material flow and net calorific value), emission factors, composition data, and oxidation and conversion factors. These different approaches are referred to as *tiers*. The tiers' numbers, from 1 upward, represent increasing levels of accuracy, with the highest numbered tier the preferred one. • The operator may use different approved tier levels for the variables—fuel/material flow, net calorific value, emission factors, composition data, and oxidation and conversion factors—used in a single calculation. • All operators must use the highest tier to determine all variables for all source streams for all category B (between 50 and 500 Ktonnes CO_2) or category C (greater than 500 Ktonnes CO_2) installations. Only if it can be demonstrated to the satisfaction of the competent authority that the highest-tier approach is technically not feasible or will lead to unreasonably high costs, may the next lower tier be used for that variable in a monitoring methodology. • This tier approach focuses on creating a consistent level of certainty for the results from similar sources.
INGAA Natural Gas Methodology Compendium[19]	• Tier 1 is a general estimate with minimal inputs required (e.g., an emission factor based on miles of pipeline used to estimate the GHG inventory). • Tier 2 refers to the data requirements and emission factors based on facility-level data or the largest emission sources at a site. • Tier 3 refers to the data requirements and emissions based on a site's process operation or equipment-level information. • Additional tiers (e.g., tier 3+, tier 4, and beyond) pertain to emission determinations requiring additional data—and higher costs for inventory development. These approaches are typically beyond the current practices for inventory development. They also require thorough documentation to ensure that an external reviewer or auditor can understand and validate the estimation. • There is no specific guidance on which tier should be used. • Tiers are used more to describe the complexity of the approach and the resulting payoffs in the calculation's certainty.

calculating the GHG emissions from stationary combustion, for which a number of methods might produce similar results in terms of certainty depending on the situation. Table 4 shows a sample "tier" structure in which this difficulty is encountered. In such cases, it sometimes is better to use a "preferred" approach or approaches, without attempting to specify the accuracy of similar methods.

Notes

1 IPCC 2006 Guidelines.

2 IPCC default emission factors (tier 1) tend to be general and so should be used only when no other emission factors are available to develop the corporate-level GHG inventory.

3 This means the data have undergone proper quality assurance and quality control procedures.

4 See USEPA, Stationary Source Emissions Measurement Program: International Good Practice Document, draft, May 2006.

5 For example, using stack tests.

6 This could be an industrial or a combustion process. For an example of a mass balance method of calculating CO_2 emissions from petrochemical and carbon black production, see http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_3_Ch3_Chemical_Industry.pdf, p. 66.

7 USEPA, Stationary Source Emissions Measurement Program.

8 Ibid.

9 Ibid.

10 Ontario Ministry of Environment, Step by Step Guideline for Emission Calculation, Record Keeping and Reporting for Airborne Contaminant Discharge (Toronto: Ontario Ministry of Environment, revised May 2004).

11 See http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_3_Ch3_Chemical_Industry.pdf, p. 21.

12 See Commission of the European Communities, Commission Decision of xx/xx/2006, Establishing Guidelines for the Monitoring and Reporting of Greenhouse Gas Emissions Pursuant to Directive 2003/87/EC of the European Parliament and of the Council (Brussels: 2006), at http://ec.europa.eu/environment/climat/emission/pdf/mrg_2006.pdf.

13 USEPA, Stationary Source Emissions Measurement Program.

14 Ibid.

15 See http://www.defra.gov.uk/environment/climatechange/trading/eu/permits/pdf/comm-decision06.pdf, p. 23.

16 IPCC 2006 Guidelines.

17 See California Climate Action Registry, General Reporting Protocol Version 2.2. www. climateregistry.org/Protocols.

18 See Commission Decision of xx/xx/2006.

19 See www.ingaa.org.

TABLE 4 Estimation Certainty Not Clearly Defined in Approaches for Stationary Combustion GHG Quantification

TYPES OF APPROACHES	HIERARCHY
Published emission factors	
Equipment manufacturer's emission factors	Interchangeable Accuracy
Engineering calculations	
Monitoring over a range of conditions and deriving emission factors (stack testing)	Improved accuracy
Periodic monitoring of emissions (PEMS) or parameters for calculating emissions	Additional data requirements
Continuous emissions or parameters monitoring (CEMS)	Possibly higher cost

6 Designing a Comprehensive Stakeholder Process

Whether a tool will be used in a GHG program or initiative or as part of an educational outreach program led by an NGO or an industry association with no specific program or initiative in mind, engaging stakeholders is one of the most important aspects of a tool customization project. Including stakeholders in the customization of a calculation tool ensures that the final version is valuable to those entities using it to develop a GHG inventory or receiving the GHG inventories for review and also helps build capacity and momentum for the tool's use. Stakeholders can help refine the objectives of the customization process and advise on the functions of various accounting and quantification components (see box 11). Accordingly, while developing the tool, the stakeholders' needs must be taken into account, and once the sectors and programs that the tool will serve have been decided, the main stakeholders participating in the tool customization should be convened.

The Stakeholder Process

The *stakeholder process* is the organization of an open, transparent, and inclusive approach that engages multiple stakeholders in the development and eventual adoption of the customized tool. The positive outcomes of a successful stakeholder process are

1. *More dialogue among different types of stakeholders:* Through the "road test" (in which a company uses the draft customized tool to develop a GHG inventory) and/or peer review, the tool's developers have an opportunity to talk about their work and objectives with businesses and other stakeholders that may be interested in the tool. Companies sometimes offer additional technical information that may be helpful when considering different estimation or measurement approaches, especially during the "road test." In addition, their understanding how the sector and businesses operate may produce more specific sector guidance on operational and organizational boundaries, as well as on various quantification and inventory quality approaches. At the same time, the tool developers have a chance to offer information and education regarding emissions accounting and quantification issues.

2. *A greater sense of ownership of the final product:* By participating in the customization process, stakeholders may get a sense of ownership of the tool and its purposes and applications. Their identification with the final product often encourages the adoption and utilization of the tool by businesses and relevant programs.

3. *A more tailored final product:* The stakeholder process allows members from diverse communities, including businesses and environment NGOs, to discuss their expectations of and interests in a particular calculation tool.

BOX 11 Listening to Stakeholders

While drawing up a work plan for a customized power-sector tool in Mexico, FUMEC, the conveners and main technical developers of the tool, set up a meeting with Mexico's Federal Electricity Commission (CFE) to clarify its interests in and concerns about the project. Early in the meeting it became apparent that in addition to GHG emissions, CFE was concerned that its inventory of other gases—namely, NO_x and SO_2, using default emission factors developed in the United States—was inaccurate. This led to expanding the work plan to include these two gases in addition to the GHG gases. This addition was crucial to attracting these stakeholders' interest in the project.

Who Are the Stakeholders?

The three main groups of stakeholders when customizing a tool are

1. *The eventual users of the tool,* including businesses, companies, or other organizations, as well as consultants, that will use the customized calculation tool to develop a GHG inventory. This stakeholder group's principal needs are a tool that is easy to use, provides cost-effective quantification methods, and develops a quality inventory that can be used in several applications.
2. *The GHG program's administrators* also are users of the tool, but of a different type. They provide the calculation tools to support the participants in their programs or initiatives, engage different sectors and companies, monitor and track the effects of the GHG or other emissions as well as compliance with their programs or initiatives, and/or collect data for future programs. This group of stakeholders may also include industry associations providing technical assistance to or developing the capacity of their member companies to track GHG emissions.
3. *Outside observers and other interested parties* may not use the customized calculation tool, but they still are interested in ensuring that it is consistent with the best practices and broader environmental, social, or policy goals and needs in regard to climate change or air pollution. These stakeholders may include environmental groups, investors, consumers, and government agencies.

Although not all stakeholders may agree to participate or may be needed at every stage of the customization process, their ideas and contributions still should be sought. In any case, all types of stakeholders should be part of the final tool customization processes.

What Is a Stakeholder Process?

Stakeholders may join at many points in the tools customization process. The following is a model of a tool development process and the opportunities for engaging stakeholders.

ESTABLISHING THE CORE ADVISORY TEAM OR TECHNICAL WORKING GROUP

The first opportunity to engage key stakeholders in the tool customization process is when forming the core set of advisors or partners that will help decide on the tool's basic design. This team should be made up of experts who can provide valuable information about different aspects of the tool customization, such as local needs and objectives, common operational issues, current practices, and available data. For example, four of the initial participants could be (1) an expert in the sector being examined, (2) an expert in emissions accounting, (3) a representative from some or all the programs that this tool might support, and (4) an expert who understands what the outside observers and interested parties want. A group of people with these qualifications (one person may have expertise in more than one area) should be able to help create a strong foundation for the tool customization process. If it is not possible to have representatives from all four categories in the core team, this gap should be noted, so it can be remedied later in the stakeholder process. The core team should not, however, have more than six to eight people, as a group larger than this may be unmanageable and slow the tool customization process.

IDENTIFYING THE ROAD TESTER AND ROAD TESTING THE CUSTOMIZED CALCULATION TOOL

A *road tester* is a representative company or several companies willing to test a draft of the calculation tool (guidance and spreadsheets) to develop a GHG emissions inventory (road testing). During the road testing, the company (or companies) can address such issues as difficulties collecting data or understanding the quantification methods. The road tester also can catch any bugs in the Excel spreadsheets when the actual data are entered in the worksheets and point out where shortcuts, simplifications, and the like could make the spreadsheets more user-friendly. If more than one participant is willing to road test (even partially) the document, this is even more helpful.

Although the road testing generally takes place after the draft of the customized calculation tool has been completed but before the peer review, it is important to find a road tester early in the process to ensure having at least one leadership company to encourage others in the sector to join the initiative. The road tester also should be enthusiastic, especially when customized calculation tools are being developed for nonregulatory programs and when deciding which calculation tool to customize. If brought in at the beginning of the tool customization process, the road tester can also help design the customized tool or act as the sector expert if one is not available.

The road tester's operations should be a relatively complete and faithful representation of the types of companies and units in the sector, to test the estimation/measurement methods for all possible sources, provide an example of a common organizational boundary for the sector, and generally represent the various companies that might use the tool. Having more than one road tester can help make the tool suitable for more users by identifying different plant-level operational issues, which also increases the tool's acceptability.

As part of the road testing, the core group in the tool customization process should visit at least one of the plants owned by the road tester, provide on-site training in the customized tool and help in developing the GHG inventory. In fact, companies often are willing to become road testers because of this training opportunity. Especially for nonregulatory programs, it is important to make clear to prospective road testers that even though they will receive training and help in developing their emissions inventory, the inventory will not be made available publicly without their consent and initiative (e.g., through a program or in a sustainability report). Many road testers worry that if they agree to develop an inventory, this information will be made public, and so they refuse. This is less relevant to regulatory programs, but some companies may be concerned about the public release of certain types of data.

SELECTING PEER REVIEWERS

The peer review is another opportunity to attract stakeholders relevant to the tool customization process. If possible, the peer review should come after the road test, to make sure that many of the tool's initial glitches have been caught and remedied. This is not always possible, however, because a full road test sometimes takes quite a bit of time.

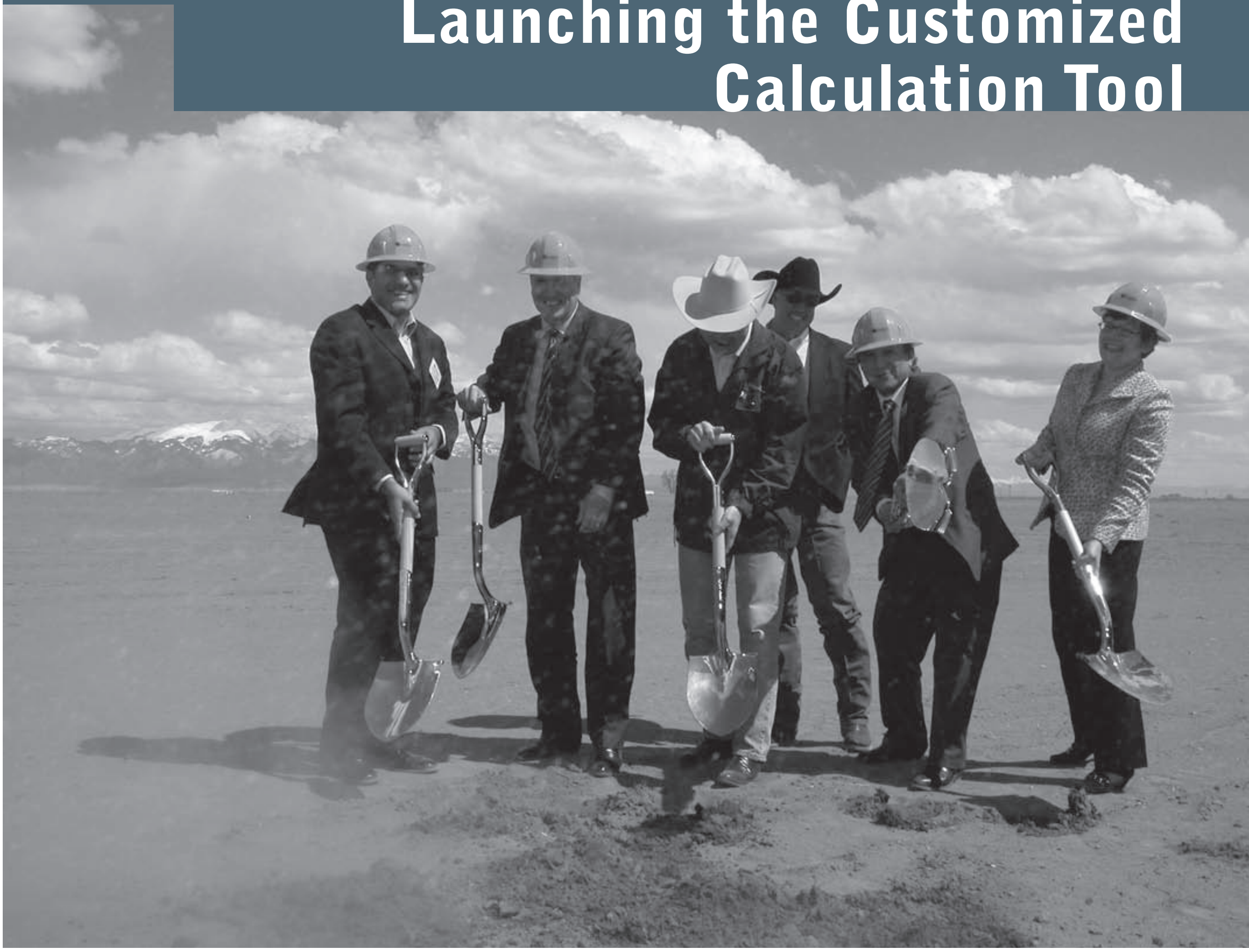
The peer reviewers are generally asked to read the guidance document, test the Excel spreadsheets, and provide feedback after three weeks or a month. If it is possible, a face-to-face meeting with the peer reviewers after they have sent in their comments is helpful. This meeting allows the tool's developers (1) to discuss any disagreements among the reviewers and find a solution and (2) to allow the peer reviewers to talk to one another about their various considerations and limitations. A face-to-face meeting also is a good place to bring unlikely partners together to discuss issues in a relatively neutral setting. If such a meeting is not practical, conference calls or web-based discussion sessions are other options.

Peer reviewers should come from all four main groups of stakeholders cited earlier; ideally several from each group. At this stage, any stakeholders not represented in the core team developing the tool should be present, and thinking broadly about the tool's "users" is important as well. For example, although the tool may be meant for companies in a particular country, an international perspective on the tool helps give it broad acceptability, consistency, and credibility beyond the country's borders. Essentially this means that the tool's quantification methods should be acceptable to international reviewers, so if programs later want to link together, the various partner programs and the GHG emissions can be compared across entities.

An important part of the peer review process is to build connections and a knowledge base to serve as a resource for future tool refinements or implementations. Therefore, it is important to follow up with peer reviewers in various ways, (1) communicating how their comments have been integrated in the tool or if not, why not; (2) giving them a copy of the tool; (3) inviting them to the tool's launch; (4) acknowledging their contribution in the final publication.

Launching the Customized Calculation Tool

7



Once a customized tool has been completed, road tested, and peer reviewed, the final step is to ensure its continued adoption by and relevance to users. This often starts with a briefing for the stakeholders and a launch event to celebrate the tool's creation. Follow-up training permits users with questions about the tool to obtain technical assistance, as well as to continue outreach to those companies not initially part of the customization process. Finally, a process for updating the tools is put into place.

Stakeholders' Briefing and Launch Event

Many stakeholders will already know about the tool long before the briefing and the launch event. This, however, is one of the last opportunities to discuss with a broad stakeholder group the merits of the tool. The briefing and launch event are also a good time to introduce the stakeholders to the core group of tool customizers, including the road tester, and an opportunity for others who participated in the process to convince those who may still not believe that the tool will be useful to them.

Planning a successful meeting requires finding a location, encouraging the stakeholders' attendance, preparing presentations and "lessons-learned" documents, and securing the project's partners, such as the road tester, as speakers.

The following is a checklist of the various components of a successful launch meeting:

Logistics

- *Location:* The location needs to be large and easily accessible to participants, with the equipment (e.g., computers, projector and screen, white boards, microphone, etc.) available for the presenters. If a workshop is to be held at the same time, computers may be needed for training sessions.
- *Invitations:* Invitations should be sent out at least one month in advance to enable the participants to make plans to attend. Stakeholders from all groups (businesses, NGOs, government participants, etc.) who may be interested in the current tool and/or in upcoming tools should be invited. If possible, the invitations should indicate who will be speaking during the event.
- *Food and beverages:* Whether the launch event is to last for only a few hours or for a full day with workshops and training sessions, food is always a good way to keep participants happy.
- *Name tags:* At gatherings where many of the participants may not know one another, name tags always are welcome.

Documents for Distribution

- *Agenda:* A detailed agenda helps make sure the launch runs smoothly.
- *Copies of the tool:* Hard copies and electronic versions (on CDs) of the tool should be available to participants at the meeting.
- *Lessons-learned document:* A document describing what was learned from developing the tool may be interesting to the meeting's participants.
- *Information about relevant programs:* If the tool has been developed for a specific program, information about this program should be available. Indeed, information about any program that could be relevant is helpful.
- *Contact information:* Information about the tool's customizers and others offering technical support for the tool is useful to participants.
- *Future plans:* Information about future plans either regarding the current tool (e.g., training workshops) or other tools should be provided.

Presentations

- *Overview of the process:* An overview of the process should explain the reasons for customizing the tool and how the tool was developed, including the contributions of the core advisers, reviewers, and road tester(s).
- *Overview of the tool:* An overview of the tool should discuss its various components, areas where the tool has been customized, and why. The reasons for various decisions may be explained, for example, if tiers were used for the quantification methods.
- *Road testers' presentation:* The road testers are in the best position to talk about why the customization has been useful, how easy the tool is to use, and why having the tool is important. They might also describe the process and how their contribution made a difference in the final document.
- *Lessons learned:* If not already covered in any previous presentations, the lessons learned may be interesting to the meeting's participants.
- *Other stakeholders' perspectives:* Other stakeholders' perspectives could include information about the tool's broader implications or uses. An NGO or government representative might be the best stakeholder to give this presentation.
- *Next steps:* The next steps should be information about future workshops or training sessions with the tool being launched or work on new tools.

Outreach and Dissemination

Besides a successful launch, there are other ways of disseminating information about the tool. For example, once the customization tool has been completed, it can be

- Included on the websites of the program(s) or initiative(s) that it supports. In addition, the can be included on the websites of the participating stakeholders, such as those of industry associations.
- Included in the broader reporting software of the relevant GHG program.
- Discussed in periodic dissemination and training workshops either related to or independent of the GHG programs that the tool supports.

The media could be invited to cover the launch event, as well as other opportunities, such as conferences, to discuss the tool with interested parties.

Technical Assistance and Updates

Depending on the context in which the customized tool was developed, its users may be given support after the tool's development is complete. Even though the users' questions may be relatively minor, the ability to continue interacting with them often increases the tool's usage. Users may also find areas where corrections or additions to the guidance or tool may be needed.

Providing updates is another reason for having a longer-term plan for the tool. Because GHG accounting is a relatively new field, the methods quantifying GHG emissions from different sources continue to be updated and improved as new information, techniques, and technologies are developed and tested. In addition, input data, such as emission factors, may change over time as processes and/or their efficiencies change. In order for a tool to remain relevant over time, the tool customization team should have a plan for revising or updating the tool every two to five years, if possible.

Annex A: Resources and References

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www.ghgprotocol.org.

Additional Resources

IPCC Emission Factor Database
http://www.ipcc-nggip.iges.or.jp/EFDB/main.php

IPCC Global Warming Potentials. 1996 and 2001
http://www.eia.doe.gov/oiaf/1605/gwp.html

IPCC National Inventories
http://unfccc.int/national_reports/items/1408.php

UNDP Capacity Building on GHG Inventories
http://www.rec.org/REC/Programs/UNDP-GHGInventories/Default.html

USEPA: Climate Change and GHG Emissions
http://www.epa.gov/climatechange/emissions.

USEPA: Emission Factor and Policy Applications Centre
http://www.epa.gov/ttn/chief/efpac/index.html

USEPA Emission Inventory Resources: Publications and Reports
http://www.epa.gov/air/aqmportal/management/links/emissions_resources_pub.htm

USEPA: Introduction to Emission Inventories
http://www.epa.gov/air/oaqps/eog/course419a/index.html

Acronyms

CEMS	Continuous Emission Monitoring Systems
CFE	Federal Commission of Electricity (Mexico)
CH_4	Methane
CER	Certified Emission Reduction
CCAR	California Climate Action Registry
CCX	Chicago Climate Exchange
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CO_2-e	Carbon Dioxide Equivalent
US EPA	United States Environmental Protection Agency
EU ETS	European Union Emissions Allowance Trading Scheme
FUMEC	The United States – Mexico Foundation for Science
GHG	Greenhouse Gas
GCV	Gross Calorific Value
HFCs	Hydrofluorocarbons
IPCC	Intergovernmental Panel on Climate Change
NGO	Non-Governmental Organization
NM VOCs	Non-methane Volatile Organic Compounds
NO_x	Nitrogen Oxide
N_2O	Nitrous Oxide
O_2	Oxygen
O_3	Ozone
PEMS	Predicative emission–monitoring systems
PFCs	Perfluorocarbons
PM	Particle Matter
RETC	Registry of Emissions and Pollutant Transfer (Mexico)
SEMARNAT	Secretariat of Environment and Natural Resources (Mexico)
SF_6	Sulfur Hexafluoride
SO_2	Sulfur Dioxide
T&D	Transmission and Distribution
TERI	The Energy and Resources Institute (India)
UK DEFRA	UK Department for Environment, Food and Rural Affairs
WBCSD	World Business Council for Sustainable Development
WRI	World Resources Institute

Glossary

Allowance	A commodity giving its holder the right to emit a certain quantity of GHG.
Annex 1 countries	Defined in the International Climate Change Convention as those countries taking on emissions reduction obligations: Australia; Austria; Belgium; Belarus; Bulgaria; Canada; Croatia; Czech Republic; Denmark; Estonia; Finland; France; Germany; Greece; Hungary; Iceland; Ireland; Italy; Japan; Latvia; Liechtenstein; Lithuania; Luxembourg; Monaco; Netherlands; New Zealand; Norway; Poland; Portugal; Romania; Russian Federation; Slovakia; Slovenia; Spain; Sweden; Switzerland; Ukraine; United Kingdom; USA.
Associated/affiliated company	The parent company has significant influence over the operating and financial policies of the associated/affiliated company, but not financial control.
Base year	A historic datum (a specific year or an average over multiple years) against which a company's emissions are tracked over time.
Base year emissions	GHG emissions in the base year.
Base year emissions recalculation	Recalculation of emissions in the base year to reflect a change in the structure of the company, or to reflect a change in the accounting methodology used. This ensures data consistency over time, i.e., comparisons of like with like over time.
Boundaries	GHG accounting and reporting boundaries can have several dimensions, i.e. organizational, operational, geographic, business unit, and target boundaries. The inventory boundary determines which emissions are accounted and reported by the company.
Cap and trade system	A system that sets an overall emissions limit, allocates emissions allowances to participants, and allows them to trade allowances and emission credits with each other.
Carbon sequestration	The uptake of CO_2 and storage of carbon in biological sinks.
Clean Development Mechanism	A mechanism established by Article 12 of the Kyoto Protocol for project-based emission reduction (CDM) activities in developing countries. The CDM is designed to meet two main objectives: to address the sustainability needs of the host country and to increase the opportunities available to Annex 1 Parties to meet their GHG reduction commitments. The CDM allows for the creation, acquisition and transfer of CERs from climate change mitigation projects undertaken in non-Annex 1 countries.
Certified Emission Reductions	A unit of emission reduction generated by a CDM project. CERs are tradable commodities that can be (CERs) used by Annex 1 countries to meet their commitments under the Kyoto Protocol.
Consolidation	Combination of GHG emissions data from separate operations that form part of one company or group of companies.
Control	The ability of a company to direct the policies of another operation. More specifically, it is defined as either operational control (the organization or one of its subsidiaries has the full authority to introduce and implement its operating policies at the operation) or financial control (the organization has the ability to direct the financial and operating policies of the operation with a view to gaining economic benefits from its activities).
Corporate inventory program	A program to produce annual corporate inventories that are in keeping with the principles, standards, and guidance of the *GHG Protocol Corporate Standard*. This includes all institutional, managerial and technical arrangements made for the collection of data, preparation of a GHG inventory, and implementation of the steps taken to manage the quality of their emission inventory.
CO_2 equivalent (CO_2-e)	The universal unit of measurement to indicate the global warming potential (GWP) of each of the six greenhouse gases, expressed in terms of the GWP of one unit of carbon dioxide. It is used to evaluate releasing (or avoiding releasing) different greenhouse gases against a common basis.

Cross-sector calculation tool	A GHG Protocol calculation tool that addresses GHG sources common to various sectors, e.g. emissions from stationary or mobile combustion.
Direct GHG emissions	Emissions from sources that are owned or controlled by the reporting company.
Direct monitoring	Direct monitoring of exhaust stream contents in the form of continuous emissions monitoring (CEM) or periodic sampling.
Emissions	The release of GHG into the atmosphere.
Emission factor	A factor allowing GHG emissions to be estimated from a unit of available activity data (e.g. tonnes of fuel consumed, tonnes of product produced) and absolute GHG emissions.
Emission Reduction Unit (ERU)	A unit of emission reduction generated by a Joint Implementation (JI) project. ERUs are tradable commodities which can be used by Annex 1 countries to help them meet their commitment under the Kyoto Protocol.
Equity share	The equity share reflects economic interest, which is the extent of rights a company has to the risks and rewards flowing from an operation. Typically, the share of economic risks and rewards in an operation is aligned with the company's percentage ownership of that operation, and equity share will normally be the same as the ownership percentage.
Estimation uncertainty	Uncertainty that arises whenever GHG emissions are quantified, due to uncertainty in data inputs and calculation methodologies used to quantify GHG emissions.
Fugitive emissions	Emissions that are not physically controlled but result from the intentional or unintentional releases of GHGs. They commonly arise from the production, processing transmission storage and use of fuels and other chemicals, often through joints, seals, packing, gaskets, etc.
Greenhouse gases (GHG)	For the purposes of this document, GHGs are the six gases listed in the Kyoto Protocol: carbon dioxide (CO_2); methane (CH4); nitrous oxide (N2O); Hydrofluorocarbons (HFCs); perfluorocarbons (PFCs); and sulphur hexafluoride (SF6).
GHG credit	GHG offsets can be converted into GHG credits when used to meet an externally imposed target. A GHG credit is a convertible and transferable instrument usually bestowed by a GHG program.
GHG offset	Offsets are discrete GHG reductions used to compensate for (i.e., offset) GHG emissions elsewhere, for example to meet a voluntary or mandatory GHG target or cap. Offsets are calculated relative to a baseline that represents a hypothetical scenario for what emissions would have been in the absence of the mitigation project that generates the offsets. To avoid double counting, the reduction giving rise to the offset must occur at sources or sinks not included in the target or cap for which it is used.
GHG program	A generic term used to refer to any voluntary or mandatory international, national, sub-national, government or non-governmental authority that registers, certifies, or regulates GHG emissions or removals outside the company. e.g. CDM, EU ETS, CCX, and CCAR.
GHG project	A specific project or activity designed to achieve GHG emission reductions, storage of carbon, or enhancement of GHG removals from the atmosphere
GHG Protocol calculation tools	A number of cross-sector and sector-specific tools that calculate GHG emissions on the basis of activity data and emission factors.
GHG Protocol Initiative	A multi-stakeholder collaboration convened by the World Resources Institute and World Business Council for Sustainable Development to design, develop and promote the use of accounting and reporting standards for business.
GHG Protocol sector specific calculation tools	A GHG calculation tool that addresses GHG sources that are unique to certain sectors, e.g., process emissions from aluminum production.
GHG registry	A public database of organizational GHG emissions and/or project reductions.

GHG removal	Absorbtion or sequestration of GHGs from the atmosphere.
GHG sink	Any physical unit or process that stores GHGs; usually refers to forests and underground/deep sea reservoirs of CO_2.
GHG source	Any physical unit or process which releases GHG into the atmosphere.
GHG trades	All purchases or sales of GHG emission allowances, offsets, and credits.
Global Warming Potential (GWP)	A factor describing the radiative forcing impact (degree of harm to the atmosphere) of one unit of a given GHG relative to one unit of CO_2.
Group company / subsidiary	The parent company has the ability to direct the financial and operating policies of a group company/subsidiary with a view to gaining economic benefits from its activities.
Heating value	The amount of energy released when a fuel is burned completely. Care must be taken not to confuse higher heating values (HHVs), used in the US and Canada, and lower heating values, used in all other countries.
Indirect GHG emissions	Emissions that are a consequence of the operations of the reporting company, but occur at sources owned or controlled by another company.
Intensity ratios	Ratios that express GHG impact per unit of physical activity or unit of economic value (e.g. tonnes of CO_2 emissions per unit of electricity generated). Intensity ratios are the inverse of productivity/efficiency ratios.
Intergovernmental Panel on Climate Change (IPCC)	International body of climate change scientists. The role of the IPCC is to assess the scientific, technical and socio-economic information relevant to the understanding of the risk of human-induced climate change (www.ipcc.ch).

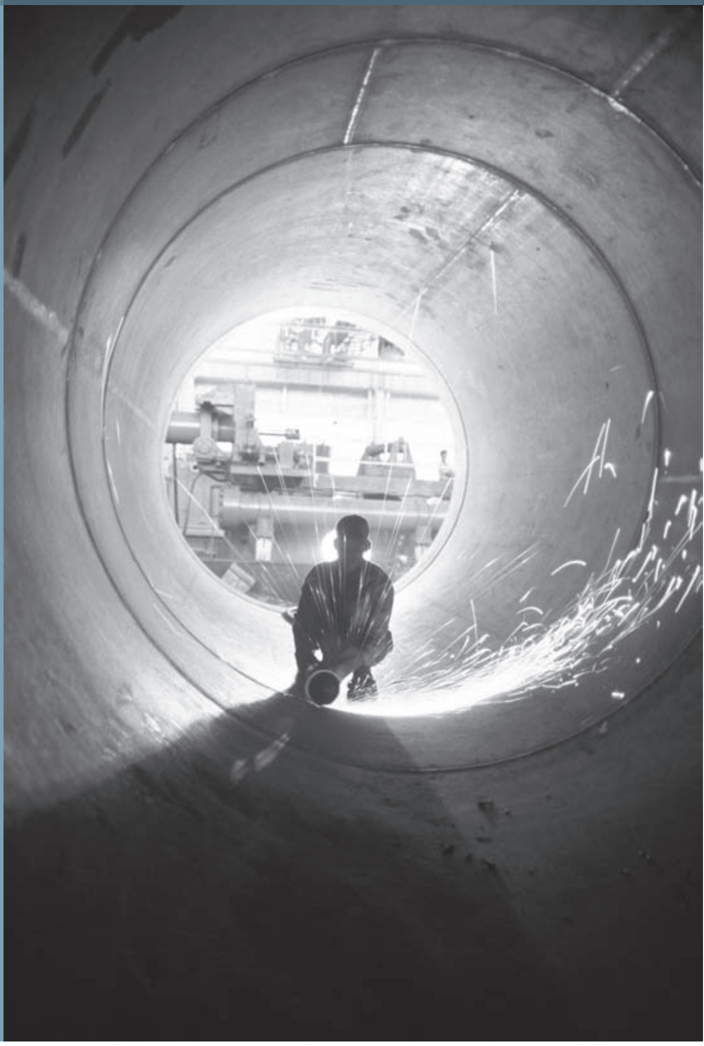
Inventory boundary	An imaginary line that encompasses the direct and indirect emissions that are included in the inventory. It results from the chosen organizational and operational boundaries.
Inventory quality	The extent to which an inventory provides a faithful, true and fair account of an organization's GHG emissions.
Joint Implementation (JI)	The JI mechanism was established in Article 6 of the Kyoto Protocol and refers to climate change mitigation projects implemented between two Annex 1 countries. JI allows for the creation, acquisition and transfer of "emission reduction units" (ERUs).
Kyoto Protocol	A protocol to the United Nations Framework Convention on Climate Change (UNFCCC). It requires countries listed in its Annex B (developed nations) to meet reduction targets of GHG emissions relative to their 1990 levels during the period of 2008–12.
Material discrepancy	An error (for example from an oversight, omission, or miscalculation) that results in the reported quantity being significantly different to the true value to an extent that will influence performance or decisions. Also known as material misstatement.
Materiality threshold	A concept employed in the process of verification. It is often used to determine whether an error or omission is a material discrepancy or not. It should not be viewed as a de minimus for defining a complete inventory.
Mobile combustion	Burning of fuels by transportation devices such as cars, trucks, trains, airplanes, ships etc.
Model uncertainty	GHG quantification uncertainty associated with mathematical equations used to characterize the relationship between various parameters and emission processes.
Non-Annex 1 countries	Countries that have ratified or acceded to the UNFCC but are not listed under Annex 1 and are therefore not under any emission reduction obligation (see also Annex 1 countries).
Operation	A generic term used to denote any kind of business, irrespective of its organizational, governance, or legal structures. An operation can be a facility, subsidiary, affiliated company or other form of joint venture.
Operational boundaries	The boundaries that determine the direct and indirect emissions associated with operations owned or controlled by the reporting company. This assessment allows a company to establish which operations and sources cause direct and indirect emissions, and to decide which indirect emissions to include that are a consequence of its operations.
Organizational boundaries	The boundaries that determine the operations owned or controlled by the reporting company, depending on the consolidation approach taken (equity or control approach).
Process emissions	Emissions generated from manufacturing processes, such as the CO_2 that is arises from the breakdown of calcium carbonate (CaCO3) during cement manufacture. (Chapter 4, Appendix D)
Reporting	Presenting data to internal management and external users such as regulators, shareholders, the general public or specific stakeholder groups. (Chapter 9)
Scope	Defines the operational boundaries in relation to indirect and direct GHG emissions.
Scope 1 inventory	A reporting organization's direct GHG emissions.
Scope 2 inventory	A reporting organization's emissions associated with the generation of electricity, heating/ cooling, or steam purchased for own consumption.
Scope 3 inventory	A reporting organization's indirect emissions other than those covered in scope 2.
Significance threshold	A qualitative or quantitative criteria used to define a significant structural change. It is the responsibility of the company/ verifier to determine the "significance threshold" for considering base year emissions recalculation. In most cases the "significance threshold" depends on the use of the information, the characteristics of the company, and the features of structural changes.

Stationary Combustion Burning of fuels to generate electricity, steam, heat, or power in stationary equipment such as boilers, furnaces etc.

Uncertainty 1. Statistical definition: A parameter associated with the result of a measurement that characterizes the dispersion of the values that could be reasonably attributed to the measured quantity. (e.g., the sample variance or coefficient of variation). 2. Inventory definition: A general and imprecise term which refers to the lack of certainty in emissions related data resulting from any causal factor, such as the application of non-representative factors or methods, incomplete data on sources and sinks, lack of transparency etc. Reported uncertainty information typically specifies a quantitative estimates of the likely or perceived difference between a reported value and a qualitative description of the likely causes of the difference.

United Nations Framework Convention on Climate Change Signed in 1992 at the Rio Earth Summit, the UNFCCC is a milestone Convention on Climate Change treaty that provides an overall framework for international efforts to (UNFCCC) mitigate climate (UNFCCC) change. The Kyoto Protocol is a protocol to the UNFCCC.

Verification An independent assessment of the reliability (considering completeness and accuracy) of a GHG inventory.



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