Identifying and Calculating GHG Emissions

Once the inventory boundary has been established, companies generally calculate GHG emissions via the following steps:

1. Identify GHG emissions sources
2. Select an emissions calculation approach
3. Collect activity data and choose emissions factors
4. Apply quantification methodology to estimate GHG emissions
5. Roll-up emissions data to the corporate level (covered in Chapter 9)

These steps are described in the following sections. *A short description of the Core Module guidance developed by and available from the Climate Leaders program is also provided. Core Modules are available on the Climate Leaders website at http://www.epa.gov/climateleaders.*

Identify GHG Emissions Sources

The process of identifying emissions sources is typically completed with the following three steps:

1. Identify *core direct* emissions sources
2. Identify *core indirect* emissions sources
3. Identify *optional* emissions sources to the extent desired

Refer to Chapter 4 for a refresher on common sources of emissions and how they should be categorized (direct or indirect core emissions, or as optional emissions). Every business has some processes, products, or services that generate direct and/or indirect emissions from one or more broad source categories. Almost all businesses generate indirect emissions due to the purchase of electricity for use in their processes or services. Appendix 1 provides an overview of GHG emissions sources organized by emission category and industry sector. The appendix may be used as an initial guide to identify your major GHG sources.

The emissions identification step should look for emissions sources that result from both routine and non-routine operations. Non-routine operations might include maintenance activities (including turnarounds) and upset conditions. In some cases, non-routine operations may be a significant source of emissions.

Select an Emissions Calculation Approach

Direct measurement of GHG emissions by monitoring concentration and flow rate is not common. More often, emissions are calculated based on a mass balance or stoichiometric basis specific to a facility or process. The most common approach for calculating GHG emissions is through the application of documented emission factors. These factors are calculated ratios relating GHG emissions to a proxy measure of activity at an emissions source. The

revised IPCC Guidelines for National GHG Inventories refer to a hierarchy of calculation approaches and techniques ranging from the application of generic emission factors to direct monitoring.

In many cases, particularly when direct monitoring is either unavailable or prohibitively expensive, accurate emission data can be calculated from fuel use data. Even small users usually know both the amount of fuel consumed and have access to data on the carbon content of the fuel through default carbon content coefficients or through more accurate periodic fuel sampling. Companies should use the most accurate calculation approach that is available to them and that is appropriate for their reporting context.

Collect Activity Data and Choose Emissions Factors

The third step in identifying and calculating emissions is to collect the data necessary to complete the quantification method selected in the previous step. To facilitate completion of this step, the reporting entity should list the quantification method and relevant data required to quantify each emission source. Table 6-1 presents an example. *Documentation of these data elements is part of the Inventory*

Table 6-1: Example Data Collection Roadmap

Emission Source	*Quantification Method*	*Data Required*	*Data Sources**
Onsite stationary combustion sources	*Insert selected method here, e.g., fuel use times fuel – specific emission factor (EF)*	*Fuel use measured in mass, volume, or energy units* *Fuel-specific emission factor.*	*Insert specific data source here*
Imported electricity use	*Electricity use times source specific EF*	*Electricity use* *Source-specific (or regional grid) emission factor*	*Insert specific data source here*
Process specific: Ex. Production of adipic acid	*Calculate N_2O emissions by multiplying the amount of adipic acid produced by the N_2O emissions factor; deduct fraction abated*	*Adipic acid production (tonnes)* *Emission factor (tonnes of N_2O/tonnes of adipic acid produced)* *Fraction abated (%) – percent of emissions abated by reduction technologies and practices* *Utilization factor (%) – percent of time abatement technology was in use*	*Insert specific data source here*
Continue list of reporter-specific emission sources or groups of emission sources	*Continue list of relevant quantification methodology*	*Continue list of data needs unique to the selected quantification methodology*	*Continue list of data needs unique to the selected quantification methodology*

**For ease of data collection and to facilitate the verification exercise, the data sources should include specification of where the required data can be derived, e.g., AP 42 emission factor, fuel use data from plant site-specific data collection system, etc.*

Management Plan submittal required under the Climate Leaders program. Documentation of these data elements helps to facilitate the data collection activity, enhance data verifiability, and identify opportunities for further improvement in inventory accuracy and efficiency.

For most small- to medium-sized companies and for many larger companies, *core direct* emissions should be calculated based on the purchased quantities of commercial fuels (such as natural gas and heating oil) multiplied by relevant published emissions factors. *Core indirect* emissions should typically be calculated from metered electricity consumption and supplier-specific, local grid, or other published emission factors. *Optional* emissions should be calculated from activity factors such as passenger miles and published or third-party emissions factors. In all of these cases, if source/facility-specific emissions factors are available, it is preferable that they be used. *Climate Leaders provides source-specific guidelines to help facilitate the emissions estimation approach.*

Industrial companies, such as those involved in fuels extraction and processing, chemicals, minerals, pulp and paper, waste management, and primary metals, will be faced with a wider range of alternative approaches/methodologies. *These companies should seek guidance from the Climate Leaders sector-specific guidelines* (where available) or from their industry associations, e.g., International Aluminum Institute, American Petroleum Institute, WBCSD project: Toward a Sustainable Cement Industry, etc.

In some cases, unit conversions will be required to adjust activity data to the same units used in emission factors. Selected unit conversions are presented in Appendix 2.

Apply Quantification Methodology to Estimate GHG Emissions

This section provides an overview of the *Climate Leaders GHG Inventory Protocol Core Module guidance documents.* Companies may use their own GHG calculation tools, provided they are consistent with the approaches described in the respective sector guidelines.

There are two main categories of guidance documents:

- **Cross-sector guidance** that can be applied to many different sectors: stationary combustion, indirect electricity, mobile combustion, and HFC use in refrigeration and air-conditioning
- **Sector-specific guidance,** e.g., aluminum, iron and steel, cement, etc.

Most companies will need to refer to more than one guidance document to cover all of their GHG sources. For example, to calculate GHG emissions from an aluminum smelter, the company would use the calculations for aluminum production, stationary combustion (for any generation of energy on-site), and mobile combustion (for owned transportation of materials and products, and vehicles employed on-site).

Structure of Guidance Documents

All cross-sector and sector-specific *core module* guidance documents are based on a similar structure and offer step-by-step guidance on measuring and calculating emissions data.

The general structure of the guidance section is as follows:

- **Overview:** provides a description of purpose and scope, the calculation method recommended, and a process description
- **Calculation methods:** describes different calculation methods depending on the availability of site-specific activity data and emissions factors
- **Choosing activity data and emissions factors:** provides good practice guidance and references for default emissions factors
- **Quality control:** provides good practice guidance
- **Internal reporting and documentation:** provides guidance on internal documentation to support emissions calculations

Default emissions factors are provided, but it is also possible to use customized emissions factors if more accurate emissions factors are available. The emissions of different GHGs are calculated separately and then converted to CO_2-equivalents on the basis of their global warming potential.

Some of the guidance takes a tiered approach, offering a choice between a simple and a more advanced calculation approach. The more advanced approach results in more accurate emissions data, but usually requires a higher level of data detail and a more thorough understanding of the technologies used in the business operations.

Table 6-2 provides an overview of the calculation guidance documents available from the *Climate Leaders program,* and their main features.

*Table 6-2: Overview of GHG Guidance Documents Currently Available Through Climate Leaders**

Guidance Documents	*Main Features*
Stationary Combustion	■ *Calculates direct GHG emissions from combustion of fuels in stationary equipment* ■ *Default emission factors provided for different fuels*
Indirect Electricity	■ *Calculates indirect GHG emissions from purchased electricity* ■ *Default emission factors provided for grid electricity* ■ *Provides guidance for allocating emissions from a cogeneration facility to the separate steam and electricity outputs*
Mobile Combustion	■ *Calculates direct GHG emissions from mobile sources, including road, air, water, and rail transport* ■ *Default emission factors provided*
Refrigeration and Air Conditioning (AC) Unit Use	■ *Calculates emissions resulting from leaks of HFCs and PFCs from refrigeration and AC units* ■ *Found in industrial and commercial facilities as well as mobile sources*
Municipal Solid Waste Landfilling	■ *Calculates direct GHG emissions from landfill gas emissions at owned/operated municipal solid waste landfill sites*
Iron and Steel (DRAFT)	■ *CO_2 and other GHG emissions (direct and indirect) associated with the manufacturing of iron and steel*
Cement Manufacturing (DRAFT)	■ *Process CO_2 and other GHG emissions associated with the manufacturing of cement*
Refrigeration and AC Unit Mfg. (DRAFT)	■ *Calculates emissions resulting from leaks of HFCs and PFCs from refrigeration and AC unit manufacturing*

**Additional calculation guidance modules are in development.*

CO_2-equivalent and Global Warming Potential

EPA has adopted the convention forwarded by the United Nations Framework Convention on Climate Change (UNFCCC) and the IPCC of comparing the radiative forcing ability of individual gases by using a relative measure for each GHG, termed its global warming potential (GWP). GWP is the ability of each greenhouse gas to trap heat in the atmosphere relative to carbon dioxide, which serves as the reference gas. Table 6-3 lists GWPs for the primary recognized GHGs.

Partners can report emissions of other GHGs (i.e., those listed in the IPCC Third Assessment Report) as optional emissions.

Table 6-3: Gas Atmospheric Lifetime GWP[a]

Greenhouse Gas	Formula	Atmospheric Lifetime (years)	Global Warming Potential
Carbon dioxide	CO_2	50 — 200	1
Methane[b]	CH_4	12 +/- 3	21
Nitrous oxide	N_2O	120	310
Sulfur hexafloride	SF_6	3,200	23,900
HFCs:			
HFC-23	CHF_3	264	11,700
HFC-32	CH_2F_2	5.6	650
HFC-41	CH_3F	3.7	150
HFC-125	C_2HF_5	32.6	2,800
HFC-134	$C_2H_2F_4$	10.6	1,000
HFC-134a	$C_2H_2F_4$	14.6	1,300
HFC-143	$C_2H_3F_3$	3.8	300
HFC-143a	$C_2H_3F_3$	48.3	3,800
HFC-152a	$C_2H_4F_2$	1.5	140
HFC-227ea	C_3HF_7	36.5	2,900
HFC-236fa	$C_3H_2F_6$	209	6,300
HFC-245ca	$C_3H_3F_5$	6.6	560
HFC-4310mee	$C_5H_2F_{10}$	17.1	1,300
PFCs:			
PFC-14	CF_4	50,000	6,500
PFC-116	C_2F_6	10,000	9,200
PFC-218	C_3F_8	2,600	7,000
PFC-3-1-10	C_4F_{10}	2,600	7,000
PFC-c318	$c\text{-}C_4F_8$	3,200	8,700
PFC-4-1-12	C_5F_{12}	4,100	7,500
PFC-5-1-14	C_6F_{14}	3,200	7,400

Source: IPCC Second Assessment Report (SAR)

a 100-year time horizon

b The methane GWP includes the direct effects and those indirect effects due to the production of tropospheric ozone and stratospheric water vapor. The indirect effect due to the production of CO_2 is not included

To provide consistency within the inventory, the Partner's GHG inventory should be based on metric tonnes of CO_2-equivalents (CO_2-eq). CO_2-equivalents are calculated by multiplying tonnes of any particular GHG times its relevant GWP. The following example illustrates this approach.

Example: Calculating CO_2-equivalents

A Partner's GHG inventory contains 7,000,000 tonnes/yr of CO_2 emissions, 400,000 tonnes/yr of CH_4 emissions, and 700 tonnes/yr of N_2O emissions.

Total CO_2-eq = tonnes CO_2(GWP[CO_2]) + tonnes CH_4(GWP[CH_4]) + tonnes N_2O(GWP[N_2O])=

7,000,000 (1) + 400,000 (21) + 700 (310) = 15,617,000 metric tonnes CO_2-eq

Other useful conversion factors for units of measure and fuel characteristics can be found in Appendix 2.