Getting Started in Carbon Accounting

Introduction

Carbon accounting is shifting from a voluntary initiative into a core business requirement for many companies across multiple sectors, including manufacturing. Carbon accounting, or greenhouse gas (GHG) emissions accounting, provides a structured framework for an organization to define project boundaries, measure, manage, and report their environmental impact according to internationally recognized standards. The most common is the [GHG Protocol and its Corporate Standard] which is widely adopted by governments, industry associations, and companies, and involves quantifying emissions across three scopes.

General Carbon Accounting Process

Emissions Scopes:

Emissions sources are outlined by whether they come from direct or indirect sources. Quantifying emissions allows for more effective management and achievement of business and climate policy goals.

- **Scope 1**: Direct GHG Emissions
  From sources "owned or controlled by the company". Examples include emissions from combustion in boilers, furnaces, vehicles, etc. as well as emissions from manufacturing processes that take place in equipment owned or controlled by the company. Unintentional or "fugitive" emission releases from equipment leaks or other processes are also included.
- **Scope 2:** Indirect GHG emissions
  Generated in the production of purchased electricity and other utilities including gas for steam, heating, and cooling. They are 'indirect' emissions because the emissions are physically generated at the facility where the electricity, natural gas, etc. is produced. They are then purchased and brought into your own organization.

• **Scope 3:** Other indirect GHG emissions

'Value chain emissions' from business activities, including all emissions from your firm's supply chain, products, and services both upstream and downstream; examples include the extraction and production of purchased materials and feedstocks, transportation of purchased fuels, use of purchased products and services, and end of life disposal.

Key Drivers: Regulations and Customers

The regulatory landscape for emissions reporting is rapidly evolving. Currently, more than 40 countries, including the United States, European Union, United Kingdom, Canada, Australia, Singapore, and Japan, require public carbon reporting for Scope 1 and Scope 2 emissions. Recent regulations in the European Union and California may require Scope 3 reporting for some companies with exports to or sales in these markets. Organizations should collaborate with their legal and regulatory colleagues to determine if they are subject to policies governing Scope 3 emissions.

GHG Protocol Corporate Standard. "*Scope 1: Direct GHG emissions" page 25*. https://ghgprotocol.org/sites/default/files/standards/ghg-protocol-revised.pdf

Corporations may impose requirements on their supply chain partners as part of their own emissions accounting and reduction process. Third-party verification is increasingly required to ensure accuracy and completeness of disclosed emissions. Companies may be required to adhere to specific reporting frameworks such as:

- Task Force on Climate-related Financial Disclosures (TCFD), which are now incorporated into IFRS Sustainability Disclosure Standards.

- The Global Reporting Initiative or "GRI", and disclosure-focused organizations.

- The CDP (formerly Carbon Disclosure Project) will also grade and monitor companies' emissions, reduction targets, and progress.

Understanding which requirements your organization must meet demands strong customer relationships to understand and respond to their reporting drivers. A careful analysis of your own facility locations, production volumes, revenue, sites under operational control, and supply chain relationships are important in the preparation and data collection critical to the carbon accounting process for your organization.

Business Value:

You can't manage what you don't measure. Organizations with a solid understanding of their emissions inventory are positioned to capitalize on this information:

- Operationally – Leverage new operational efficiencies to reduce energy consumption, optimize processes, reduce waste/increase material efficiencies, which all serve to reduce costs and enhance profit margins.

- Strategically – Demonstrate to customers how they help them to achieve their own carbon emissions reduction goals may be more competitive, better stand out in RFP processes, or in positioning as a partner of choice.

Automotive Sector Example:

Toyota's Green Supplier Requirement

Toyota expects direct parts, materials, and accessory suppliers to commit to an annual 3% reduction in CO_2 emissions.

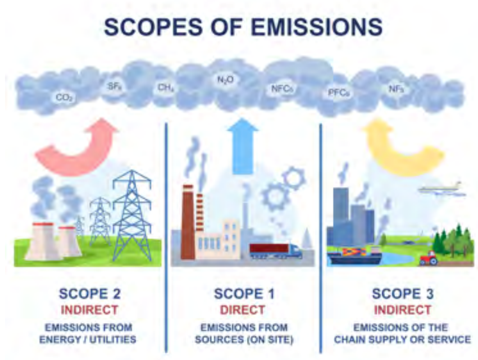
- Stakeholder Management – Knowing and understanding your emissions footprint enables your firm not only to meet customer demands but also satisfy Corporate and/or investor ESG requirements and effectively engage community stakeholders.

Resources and Support

Numerous technical and implementation resources and supports are available to assist with GHG emissions/carbon accounting, including the following:

1. GHG Protocol – The GHG Protocol offers multiple, free calculation tools and guidance (including cross sector, sector-specific, country-specific), as well as in-depth information, and training webinars.

2. US EPA Center for Corporate Climate Leadership – EPA maintains a resource center to help firms measure and manage their GHG emissions inventory. These include:



   a. Simplified guides to GHG management
   b. Scopes 1 and 2, and Scope 3 inventory guides
   c. EPA GHG emissions factors hub (updated regularly)
   d. Global Warming Potential (GWP) values – GWP values provide the common unit of measure among different greenhouse gases, converting them to CO_2 equivalents for accounting and reporting purposes. Per EPA, "the GWP is a measure of how much energy the emission of 1 ton of a gas will absorb over a given period of time, relative to the emission of 1 ton of carbon dioxide (CO_2)."

      The GWP values used in this guidance are calculated by the Intergovernmental Panel on Climate Change.

      Methane (CH_4) and nitrous oxide (N_2O) are commonly included in GHG accounting and are converted into a CO_2 equivalent. Examples of emissions with high GWP include hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), and Nitrogen trifluoride (NF_3).

   e. EPA Simplified GHG Emissions calculator covers Scope 1 and 2 emissions, and some Scope 3 emissions.

3. ISO standard 14064-1:2018, Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removal. Excellent resource for companies that prefer to use the ISO framework: https://www.iso.org/standard/66453.html

4. Waste Reduction Partners, administered by the Land of Sky Regional Council, can help North Carolina businesses meet their environmental, energy and carbon management goals through waste reduction; services include no cost on-site assessments, technical assistance with carbon accounting, and specific improvement recommendations from a team of experienced engineers and scientists.

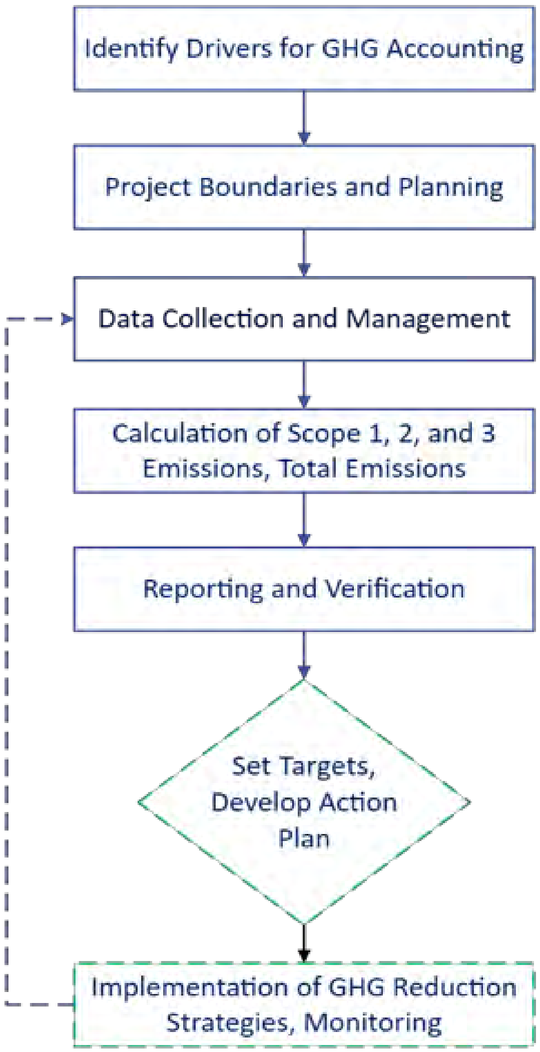
About This Resource: This document is produced by Waste Reduction Partners, a program of Land of Sky Regional Council under contract by the U.S. Department of Environmental Protection Agency. Any opinion, findings, or recommendations expressed herein are those of the author(s), and do not necessarily reflect the views of the U.S. EPA. Online version: wastereductionpartners.org — June 2025

Waste Reduction Partners

LAND OF SKY REGIONAL COUNCIL

Process Flow Diagrams for GHG Reporting

Key Processes for Greenhouse Gas Reporting



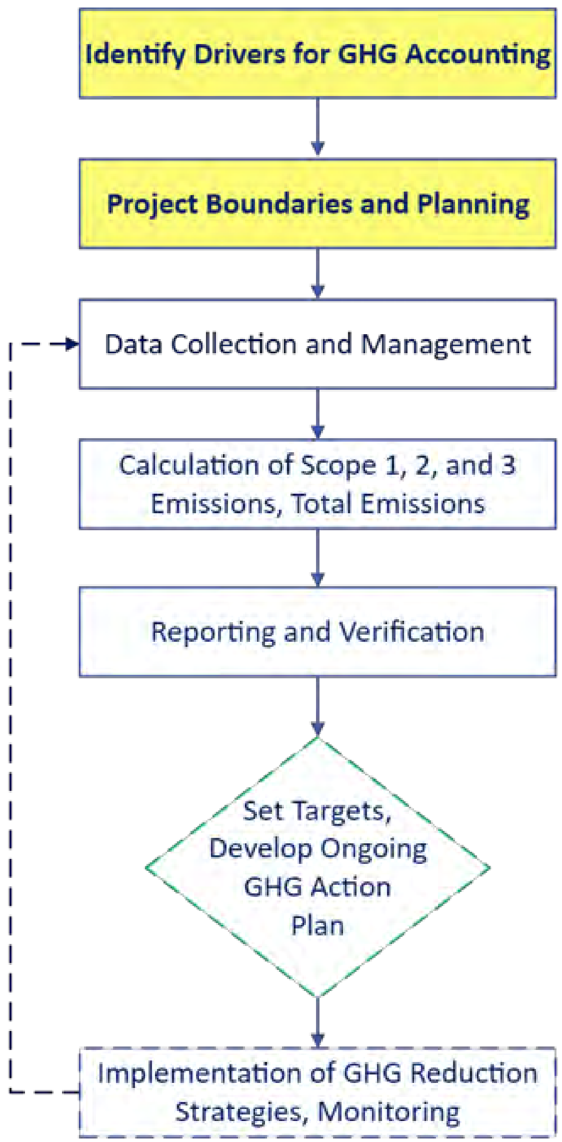
This resource provides an overview of the key steps in greenhouse gas (GHG) reporting.
The results of the GHG accounting process can be used for internal reporting, external reporting, and to guide the ongoing development of your greenhouse gas action plan.

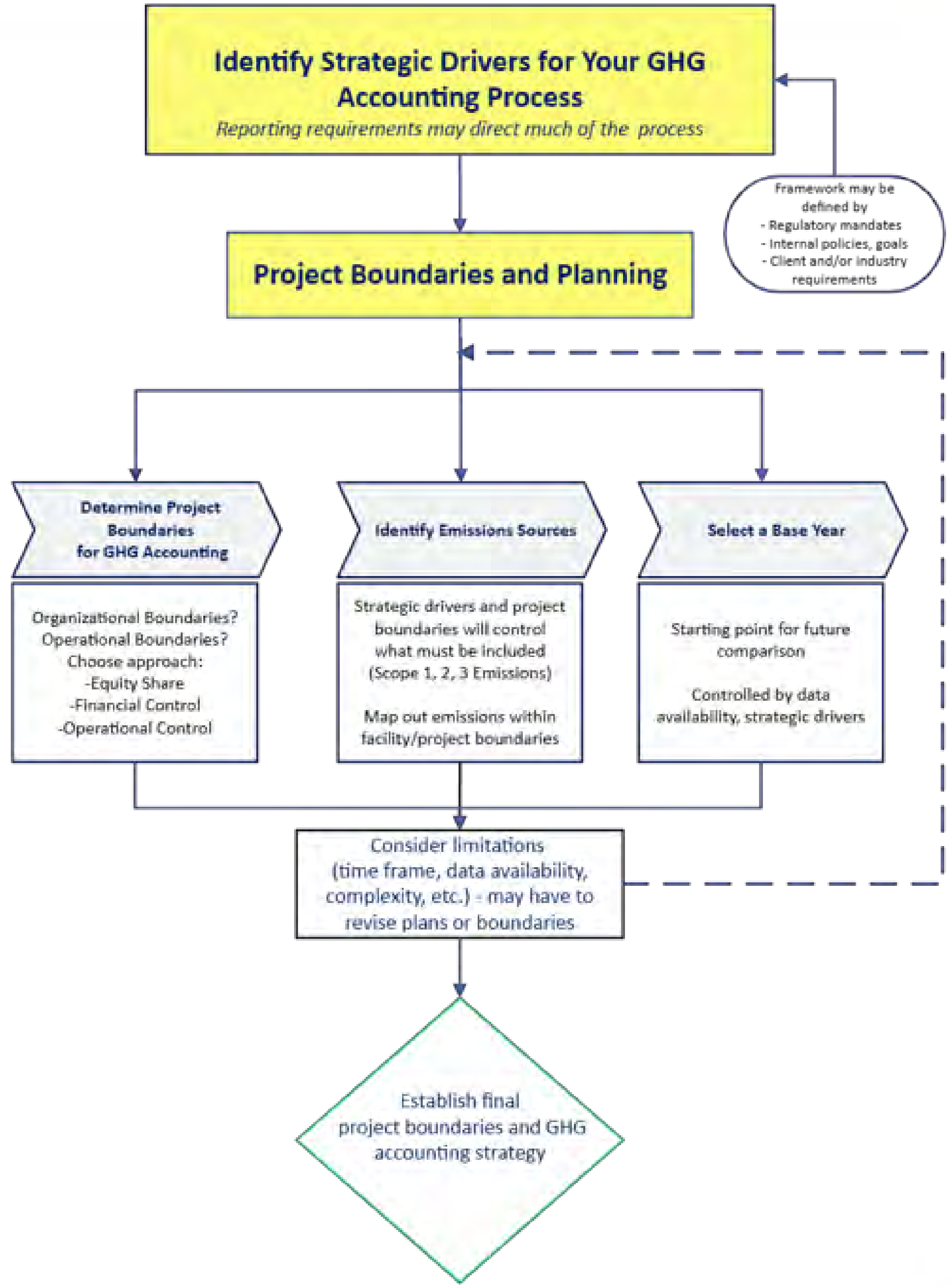
Waste Reduction Partners has developed multiple resources to support the path to net-zero emissions, addressing several critical steps through to the reporting phase.

About This Resource: This document is produced by Waste Reduction Partners, a program of Land of Sky Regional Council under contract by the U.S. Department of Environmental Protection Agency. Any opinion, findings, or recommendations expressed herein are those of the author(s), and do not necessarily reflect the views of the U.S. EPA. Online version: wastereductionpartners.org — June 2025

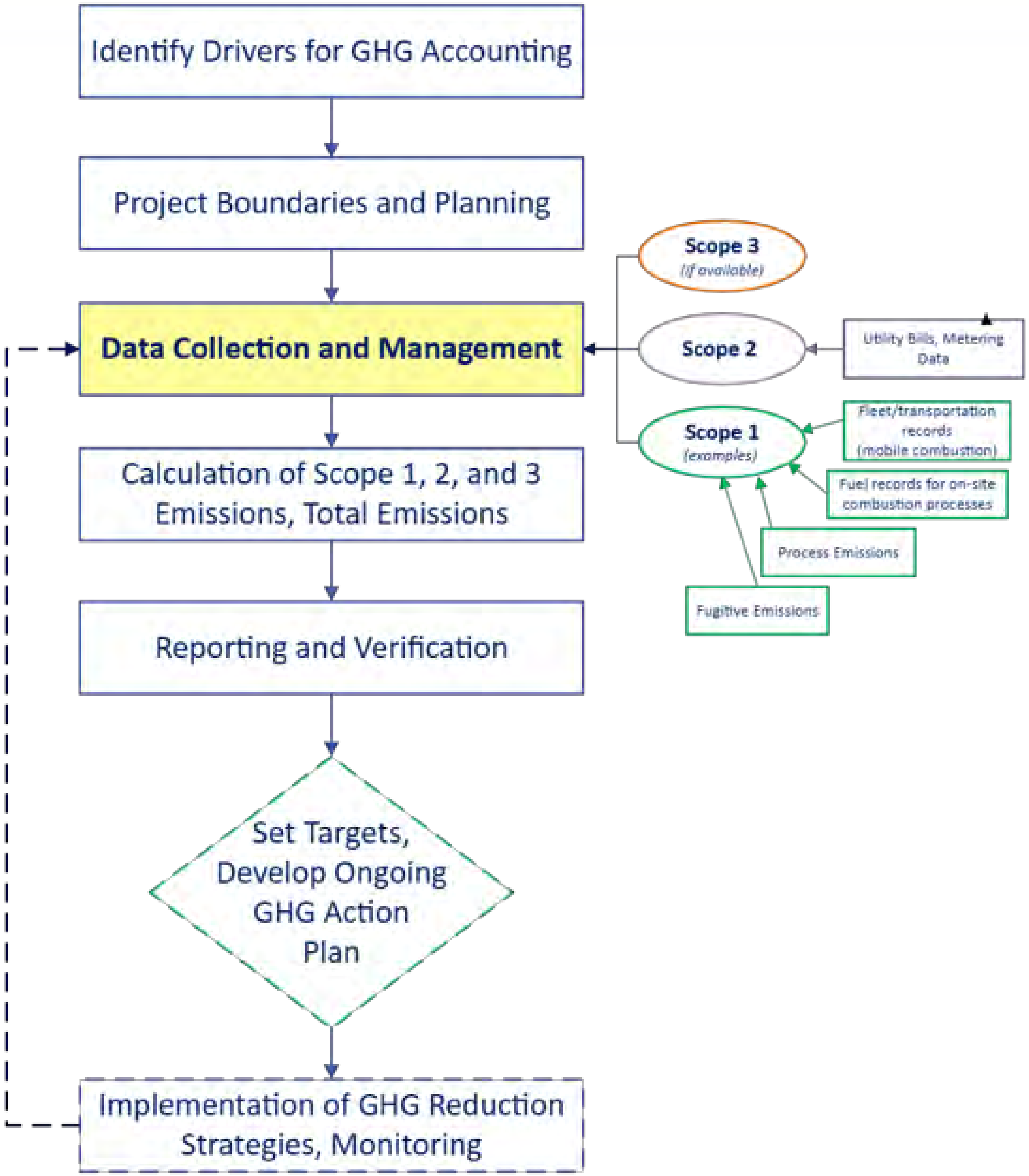
WRP Waste Reduction Partners
LAND OF SKY REGIONAL COUNCIL

PROCESS FLOW DIAGRAMS FOR GHG REPORTING

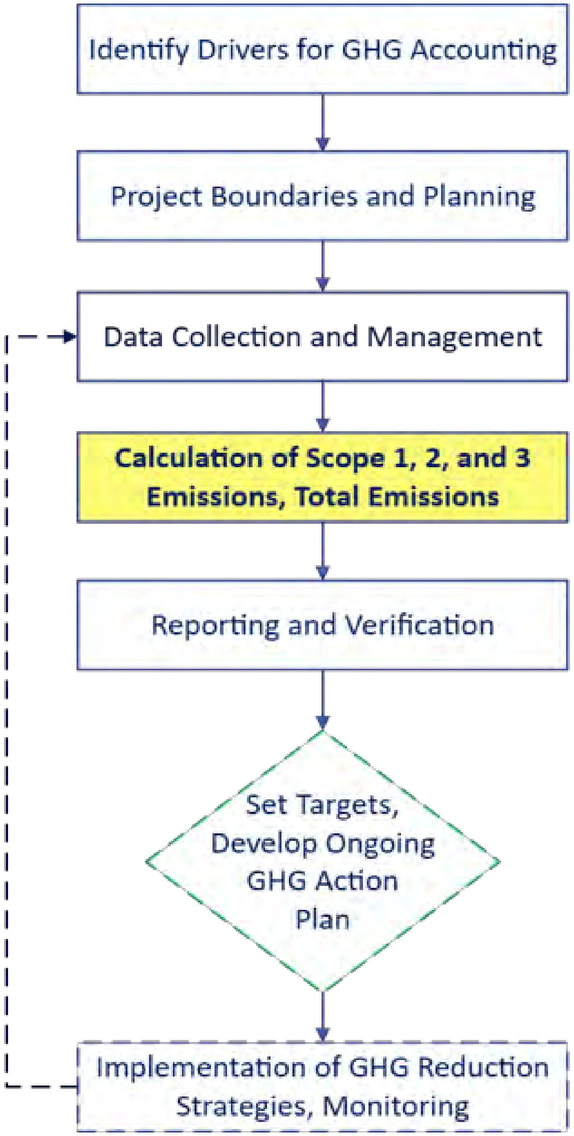


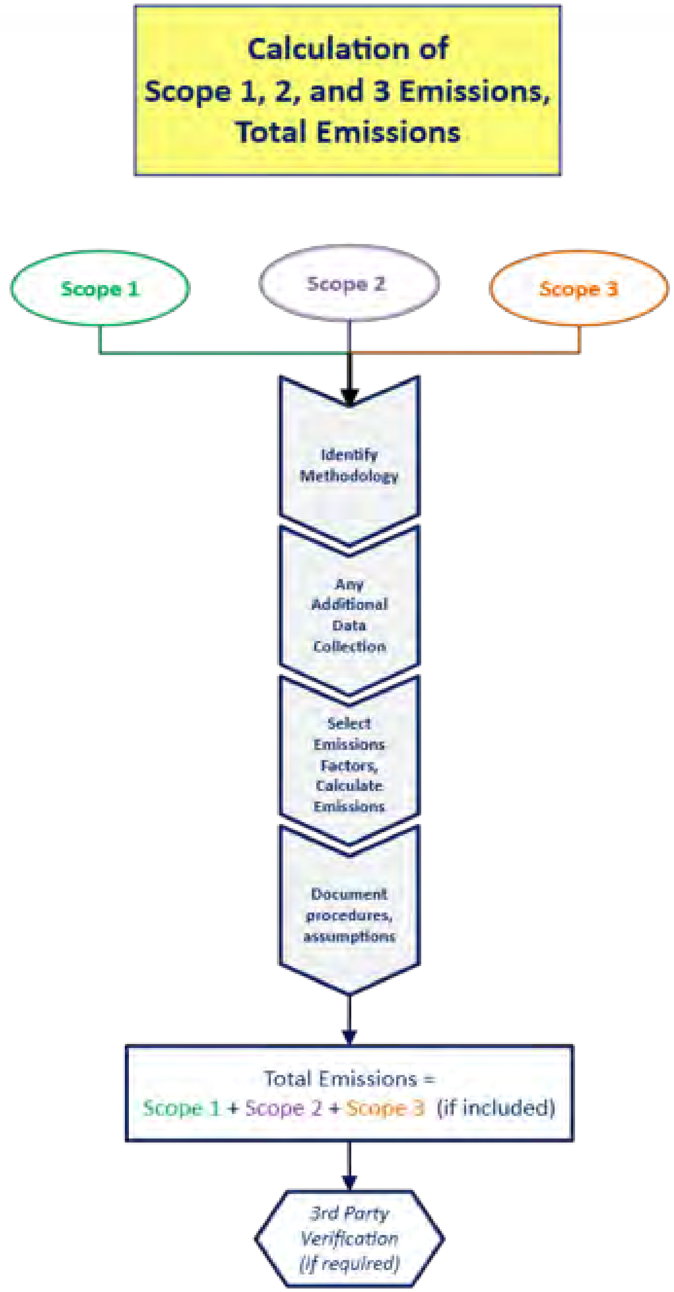


PROCESS FLOW DIAGRAMS FOR GHG REPORTING

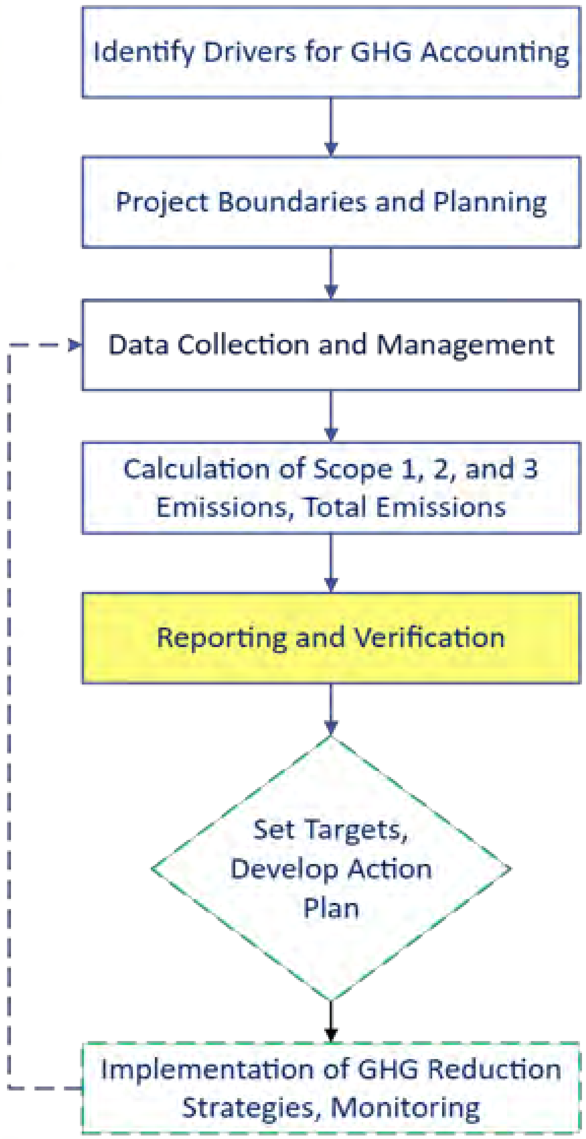


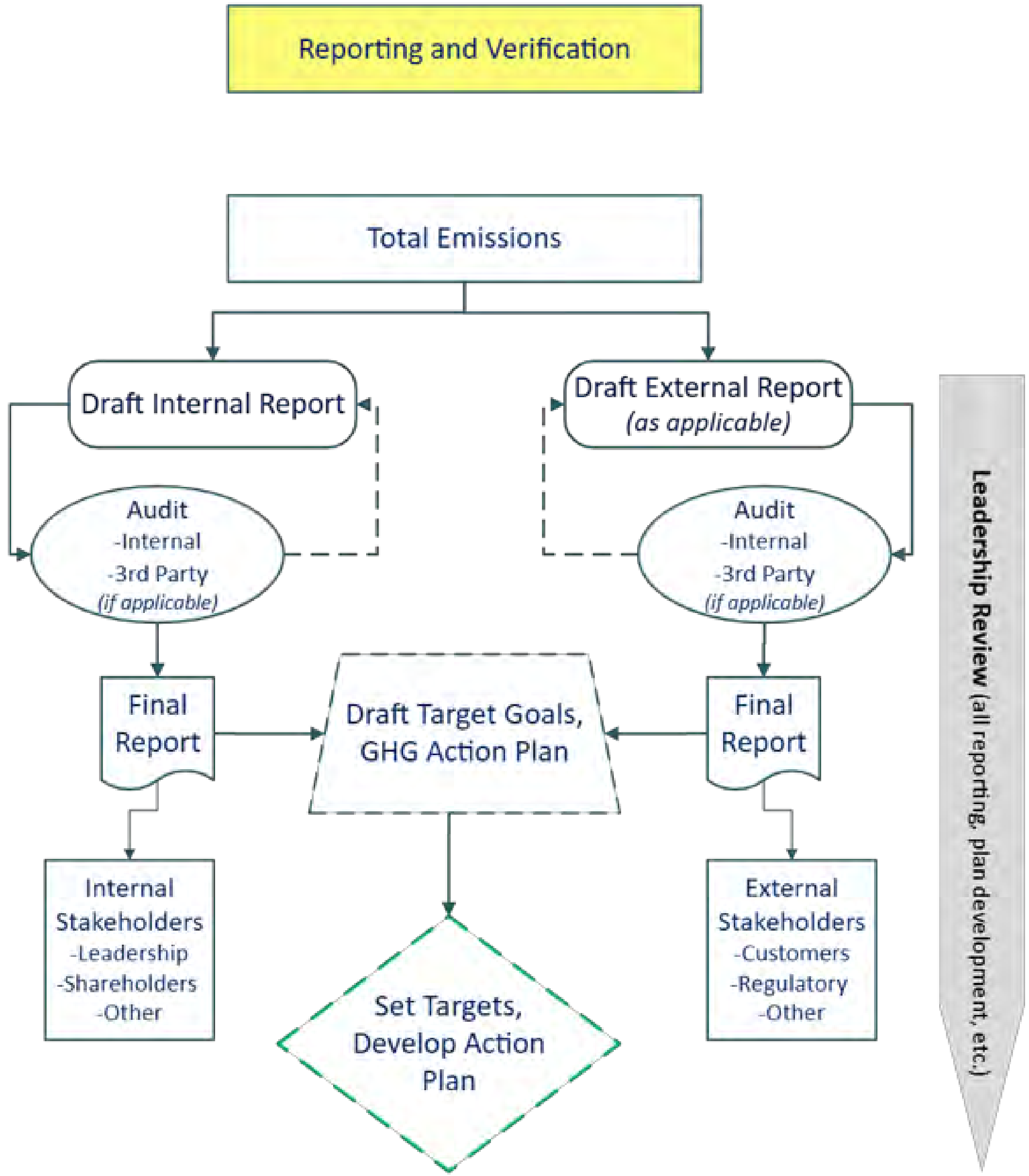
PROCESS FLOW DIAGRAMS FOR GHG REPORTING



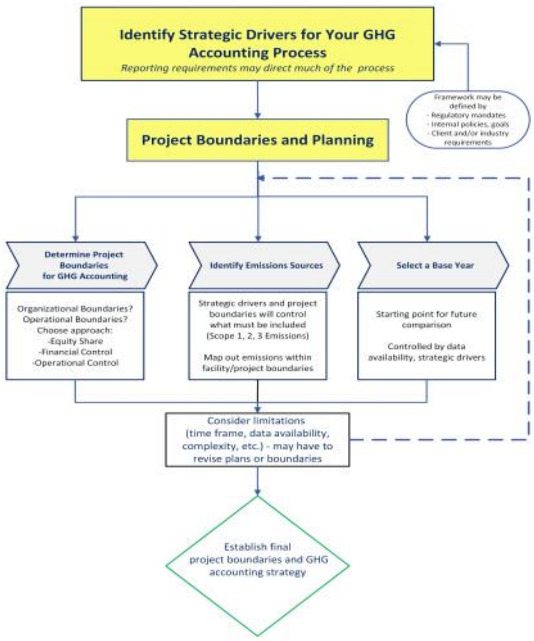


PROCESS FLOW DIAGRAMS FOR GHG REPORTING





Establishing Project Boundaries and Planning



Introduction

You need to establish a basic framework for your facility's carbon accounting program, including defining project boundaries, identifying emission sources, selecting a base year, handling common data limitations, and understanding the gaps in your approach. It is important to identify the strategic imperatives driving the GHG emissions inventory accounting effort, as this will dictate what information you need to collect and the required format for reporting.

Examples of questions you should consider at the start

1. *Has the firm's leadership or parent company made commitments to account for and reduce Scope 1 and Scope 2 GHG emissions?* To meet these goals, you will need to tailor your data collection efforts and influence operations at facilities controlled by your organization.

2. *Do you need to include Scope 3, indirect 'value chain' emissions, in your accounting effort?* If so, obtaining insight into supplier and customer emissions and use data is a major effort and will take more time.

3. *Is your organization being asked to respond to a customer emissions survey, to help quantify their own Scope 3 emissions?* You may need to collect specific data to help your customers evaluate progress toward their own reduction goals or other sustainability targets. Successful efforts to align with customer requirements could promote a competitive advantage.

Responses to questions like these will change the boundaries, scope, and requirements of your emissions accounting effort.

Overview of GHG Protocol scopes and emissions across the value chain

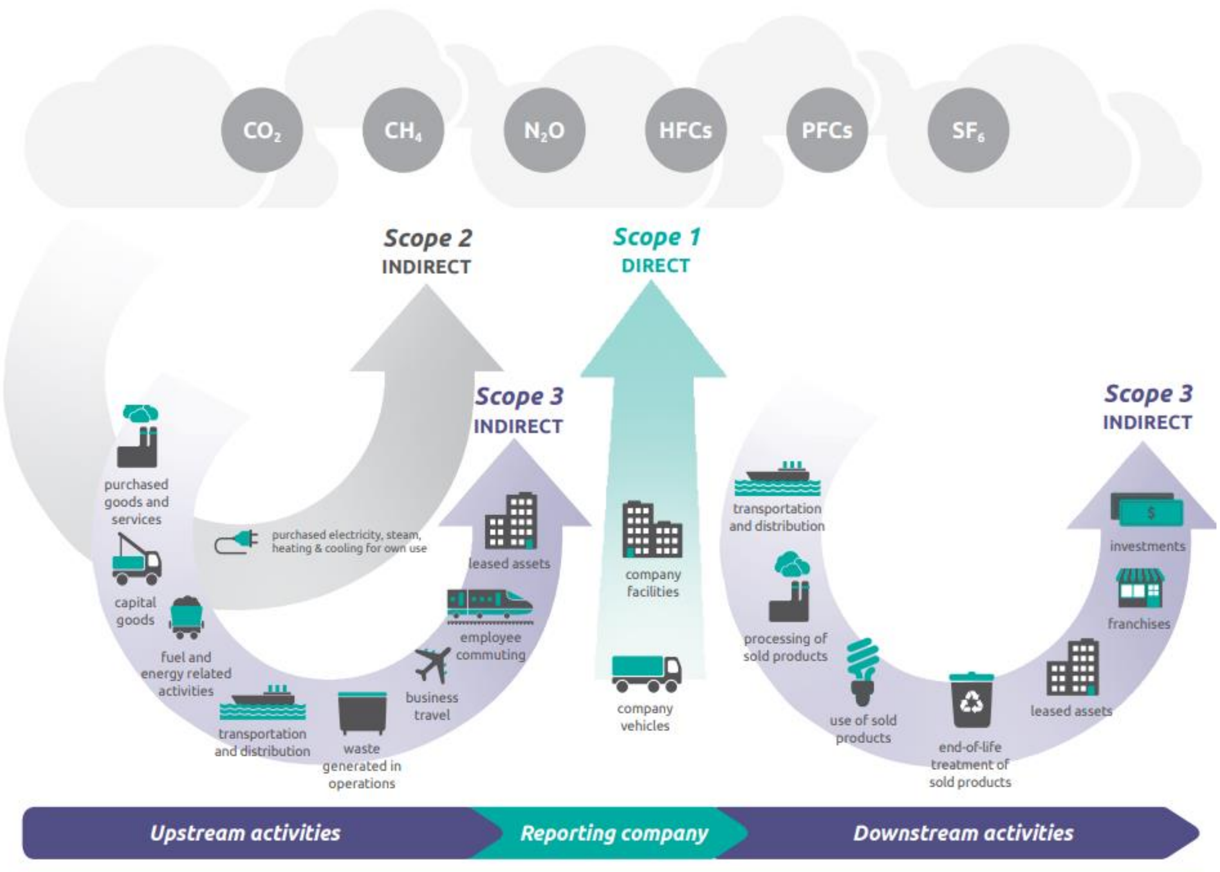


Image Credit: [WRI/WBCSD Corporate Value Chain (Scope 3) Accounting and Reporting Standard]

Scope 1 Direct Emissions Sources

These typically fall under four categories:

⇒ Stationary Combustion: Emissions from equipment including, but not limited to, boilers, furnaces, heaters and incinerators.

⇒ Mobile Combustion: Emissions from any vehicles or equipment owned by your facility, such as company cars, shunt trucks, and forklifts.

⇒ Process Emissions: GHGs released during manufacturing processes, such as CO2 released during chemical processing or aluminum smelting.

⇒ Fugitive Emissions: Unintentional releases from equipment leaks, seals, cooling towers, or wastewater treatment.

Scope 2: Indirect GHG emissions – Generated in the production of purchased electricity and other utilities including gas for steam, heating, and cooling. They are 'indirect' emissions because the emissions are physically generated at the facility where the electricity, natural gas, etc. is produced.

Scope 3: Other indirect GHG emissions – 'Value chain emissions' from business activities, including the emissions from your supply chain as well as upstream and downstream products and services.

Setting Project Boundaries

For organizations doing GHG emission accounting, you will need to consider both *Organizational Boundaries* and *Operational Boundaries*. Per the US EPA:

- **Organizational Boundaries** — determine which entities (e.g., subsidiaries, joint ventures, partnerships) and assets (e.g., facilities, vehicles) will be included in Scope 1 and Scope 2 GHG emissions inventory.
  Scope 3 emissions do not fall within your organizational boundary; these are indirect emissions that occur throughout the entire supply chain and product lifecycle, and are outside of your direct control.

- **Operational Boundary** — Operational boundaries define the specific emission sources — such as purchased electricity, gas boilers, etc. that are included in an organization's Scope 1 and 2 inventory.

Organizational and operational boundaries of a company

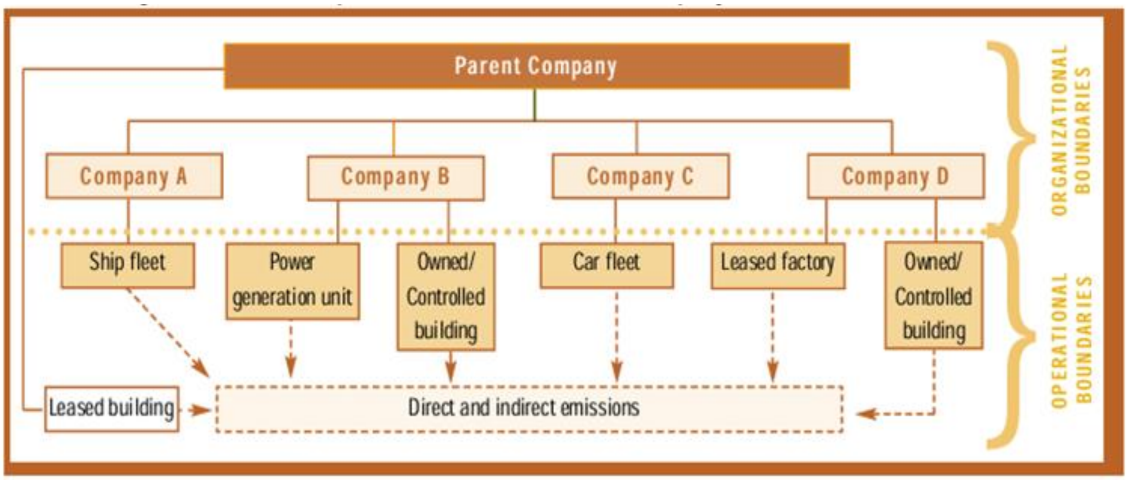


Image Credit: GHG Protocol Corporate Standard , pg. 25

Boundary Setting Approaches:

There are three main approaches used for setting organizational boundaries – equity share, financial control, and operational control. The firm should choose an approach and apply it consistently across its entities and assets for inclusion in its emissions inventory. Please refer to EPA's Center for Corporate Climate Leadership: Emissions Inventorying and Guidance page or the GHG Protocol Corporate Standard for more detailed explanation and examples.

1) **Equity Share** – GHG emissions from operations and assets are attributed according to the share of equity, or economic interest, in the operation.
2) **Financial Control** – Financial control is determined by the ability to "direct the operation's financial and operating policies," and a majority ownership (>50% equity) is not required. An organization accounts for 100% of the GHG emissions from operations over which it has financial control. Operations in which there is an equity stake but **no** financial control are not included.

3) **Operational Control** – An organization incurs 100% of the GHG over which it has operational control. Operational control is signified by the authority to introduce and implement operating policies. If equity in a facility exists but there is no operational control, the facility's emissions are not counted by the organization.

Several types of entities and assets and how they are included in the Scope 1 and Scope 2 inventory under the three different boundary approaches are shown below. Each box represents the percent of emissions included in the boundary. In practice, these three approaches differ most for leased facilities or vehicles.

Percent of Scope 1 and 2 emissions for entities or assets included under each consolidation approach

Entity or Asset	Equity Share	Financial Control	Operational Control
Wholly owned asset	100%	100%	100%
Group company/subsidiary/ franchise	Equity share	100% if controlled; 0% if not	100% if controlled; 0% if not
Joint venture/partnership	Equity share	Equity share	100% if controlled; 0% if not
Associated/affiliated company	Equity share	100% if controlled; 0% if not	0%
Leased asset—finance/capital lease	100%	100%	100%
Leased asset—operating lease	0%	0%	100% if controlled; 0% if not

Image Credit: US EPA Center for Corporate Climate Leadership: Determining Organizational Boundaries and Consolidation Approaches.

Identify Emissions Sources

It is critical to identify where GHG emissions are coming from within your facility boundaries. The data that must be collected is influenced by how the data will be used. For example, a customer supplier survey might only require data about major combustion processes, utilities, and production before automatically calculating and assigning a proportional emission score. If you must conduct more comprehensive accounting, you will likely need to collect a larger, more specific dataset.

Map out the major emission sources within your facility boundaries before moving on to calculation approaches. For most manufacturing facilities, the largest emissions sources (Scope 1 and 2) will fall within stationary equipment operations, core manufacturing processes, and purchased electricity.

Other Considerations

Scope 3 Emissions – How organizational boundaries are defined (e.g., operational control versus financial control) will affect what is included as Scope 3 emissions. For example, under an ***operational control*** approach, emissions from vehicles or an operating lease for a warehouse would be included in Scope 1 and Scope 2 emissions; under an ***equity share*** approach, these would count as Scope 3 emissions.

Other Considerations Cont'd

Double Counting – Double counting emissions is possible if multiple companies have an interest in the same entity but use different approaches in defining project boundaries, for example if one company uses an ***equity share*** method and another uses a ***financial control*** approach. This should be avoided if possible as it could complicate regulatory reporting and affect emissions trading requirements.

Choosing a Base Year

When starting to track GHG emissions, it is important to establish a reference point called a "**base year"** for future comparisons. Sometimes customer or industry surveys will request data back to a particular year, which effectively sets the base year for you.

If an organization is driving the accounting process, they ***can*** choose any year with appropriate data available; a better practice is to pick the earliest year for which high-quality emissions data exist for the facility.

Although most firms utilize a fixed base year to allow for more consistent long-term comparisons, some use an average across several consecutive years as a base year to smooth out unusual spikes or dips in emissions that might not represent typical operations.

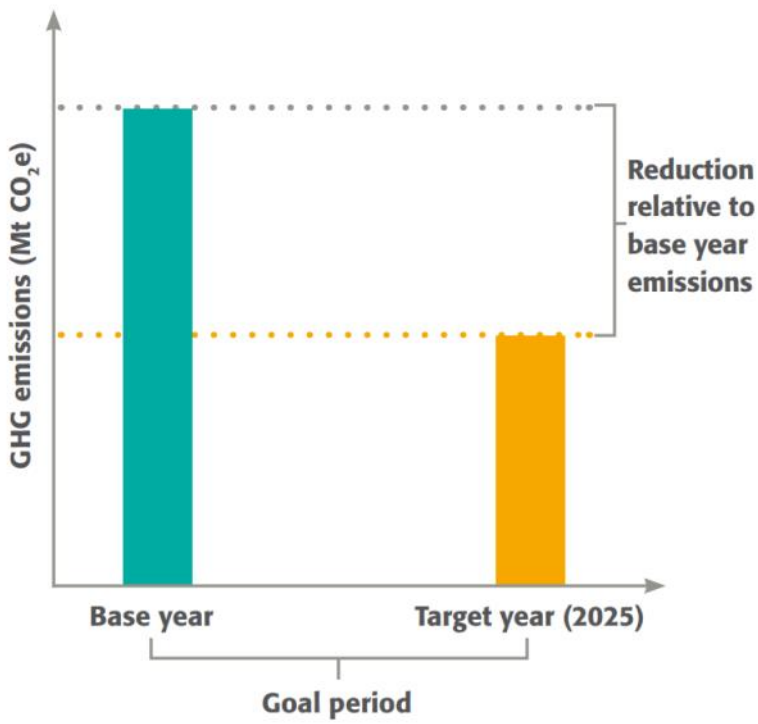


Image credit: https://ghgprotocol.org/sites/default/files/standards/Mitigation_Goal_Standard.pdf p. 42

You should also identify when major changes occur — such as new or divested operations during mergers and acquisitions or a significant market expansion; recalculation of base year emissions or the selection of a completely different base year may be necessary to ensure appropriate comparisons.

Planning and Limitations

Start with what can already be reasonably measured and documented, while building a plan to address data gaps over time. You have to start somewhere, do not worry if it isn't perfect! Begin by mapping out and organizing readily accessible data such as utility bills, process records, and equipment specifications (where available). Take inventory of what monitoring systems may already be in place and identify any obvious gaps for emissions tracking. It is critical to document your assumptions and calculation methods (e.g., GHG Protocol Corporate Standard) clearly from the start - this will be crucial for maintaining consistency.

Common limitations may include:

Historical Data – Firms will often have incomplete records for the desired base year. This could require a more recent base year selection or the need to develop a method for estimation. If so, clearly state and document these assumptions. As data gaps are identified, steps can be taken to implement new monitoring or data collection systems; Staff training opportunities should also be identified and supported.

Examples of Monitoring Gaps

Fuel usage – A firm obtains a bulk propane delivery each month to power its fleet of forklifts, with no tracking of propane consumption by individual vehicles. This monitoring gap can be addressed with process changes such as logging when tanks are changed and/or installing meters on the forklifts to create a more robust fuel tracking system. **Clearly state and document the approach used!**

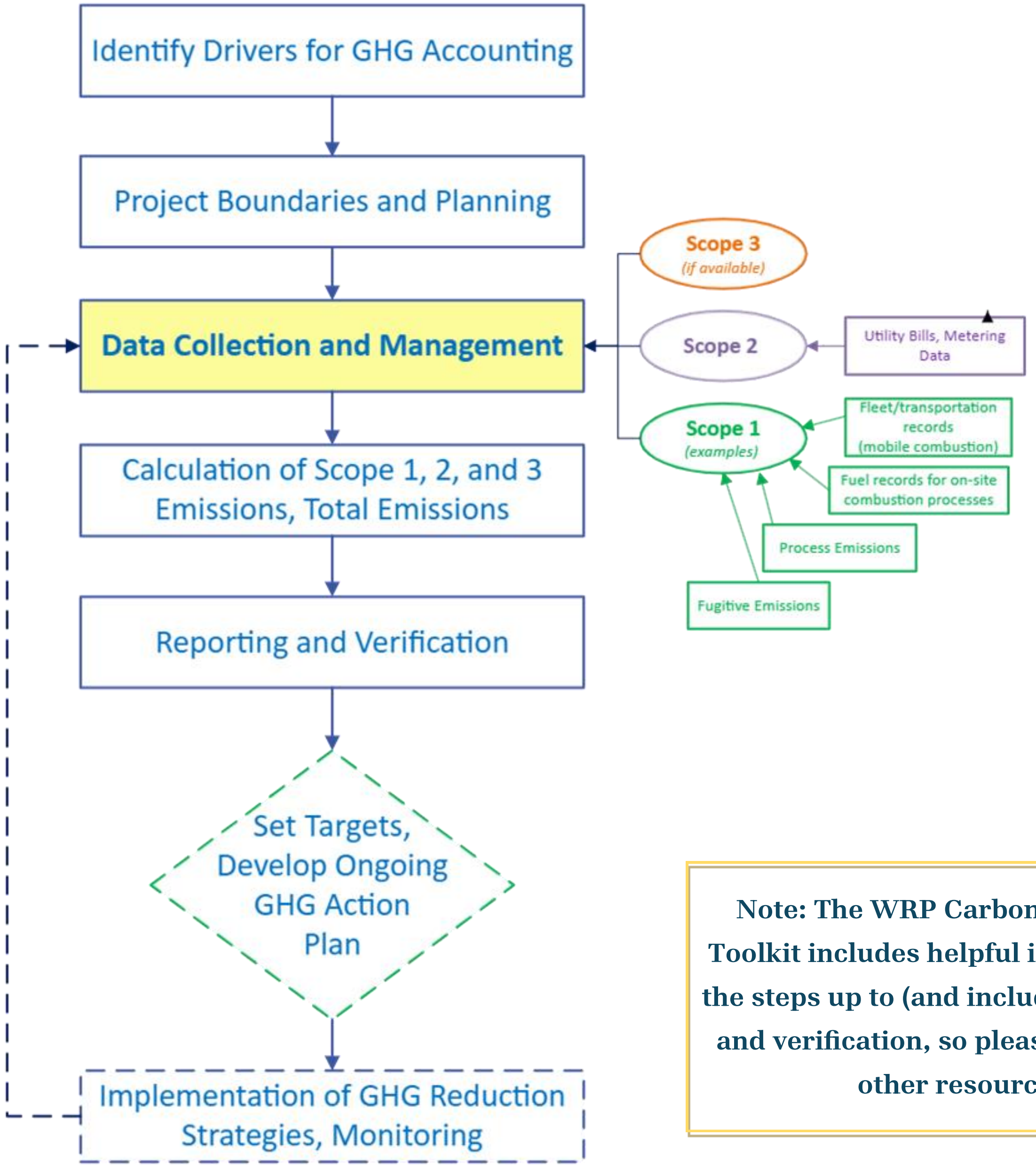
Natural Gas-powered Boilers - A company uses natural gas to power boilers for steam generation. There is no direct metering of gas use by the boilers, but the monthly gas bill with usage data is available. Monthly CO2 equivalent (CO2e) emissions can easily be calculated using information on the bill and a standard emissions factor.

About This Resource: This document is produced by Waste Reduction Partners, a program of Land of Sky Regional Council under contract by the U.S. Department of Environmental Protection Agency. Any opinion, findings, or recommendations expressed herein are those of the author(s), and do not necessarily reflect the views of the U.S. EPA. Online version: wastereductionpartners.org — June 2025

Waste Reduction Partners
LAND OF SKY REGIONAL COUNCIL

Data Collection and Management

While defining the project boundary sets the stage, data collection and management serve as the foundation for your GHG accounting efforts. You will be updating and expanding your data collection and management efforts as your GHG accounting and minimization strategies mature over time.



Note: The WRP Carbon Accounting Toolkit includes helpful information on the steps up to (and including) reporting and verification, so please explore the other resources.

One approach is to begin by "**mapping out**" known Scope 1 and Scope 2 emissions – use your knowledge and understanding of the facility to identify and prioritize the largest likely contributors to your GHG footprint. Over time, you can refine your GHG accounting process to include factors that may be more difficult to quantify, or may have a lower impact. Several examples of this mapping approach are shown for Scope 1 emissions at the end of this document.

Once you've mapped out the priority Scope 1 and 2 emissions, begin by gathering readily available data to start your quantification efforts. You'll need to focus on collecting data on energy consumption, such as electricity and natural gas bills. You will also need to collect fleet and transportation records for mobile combustion sources and determine if you need to quantify fugitive emissions (such as refrigerant leaks from company-owned refrigeration and HVAC systems). Be sure to capture any on-site combustion processes that may not be reflected in major utility bills, such as diesel generators for back-up power. You'll also want to evaluate your process chain, to determine if there are any GHG emissions related to the processes specific to your industry or facility.

Finally, you may also need to compile supply chain data if your GHG accounting process includes Scope 3 emissions.

Example 1: Automotive Parts Manufacturer

Mobile combustion sources from owned or leased delivery trucks, fleet vehicles, forklifts, and other equipment.

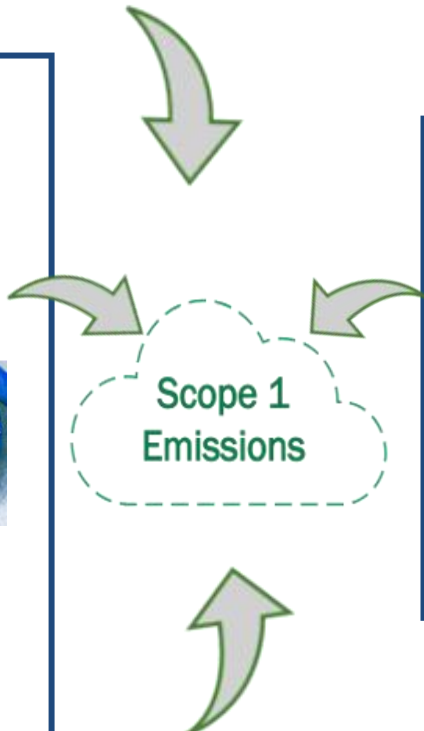
On-site fuel combustion for steam generation and building heat, furnaces, ovens, and equipment for processes such as backup power generation, metal smelting, heat treatment, painting, etc.

Fugitive emissions - unintentional release of refrigerants from cooling systems.

Example 2: Synthetic Fiber Manufacturer (with recycled content)

On-site fuel combustion for steam generation, building heat, and backup power generation, among other applications.

Process emissions from plastics recycling/ fiber production.



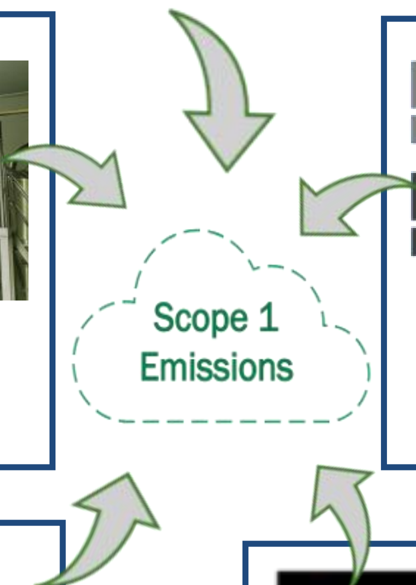
Fugitive emissions - unintentional release of refrigerants from cooling systems.

Mobile combustion sources from owned or leased delivery trucks, fleet vehicles, forklifts, and other equipment.

Example 3: Craft Brewery

The fermentation process generates excess CO_2, which may be emitted to the atmosphere (options available for capture & beneficial use).

On-site combustion of natural gas used for building heat, brew kettles, etc.



Mobile combustion sources from owned/ leased delivery trucks, fleet vehicles, forklifts, and other equipment.

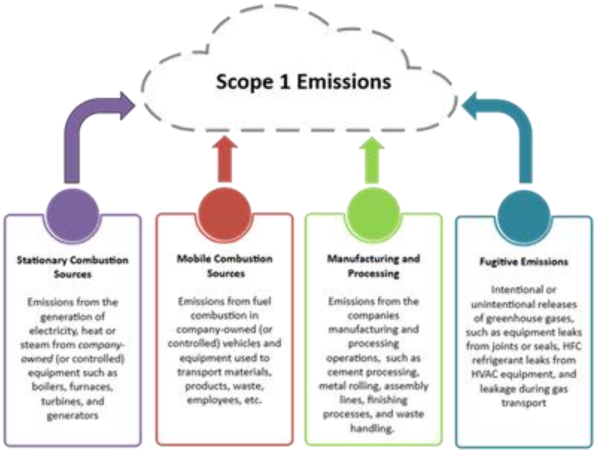
Fugitive emissions - unintentional release of refrigerants from cooling systems.

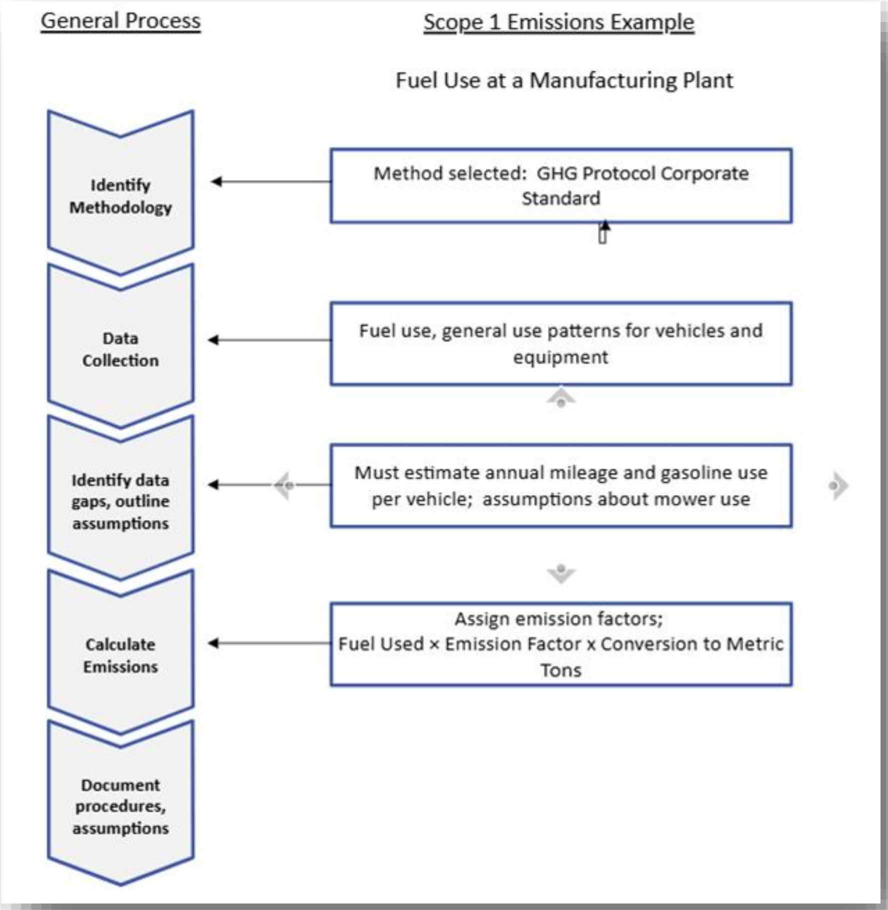
On–site Waste Management practices can produce emissions from processes such as incineration, short or long term storage of organic material, or on-site composting.

About This Resource: This document is produced by Waste Reduction Partners, a program of Land of Sky Regional Council under contract by the U.S. Department of Environmental Protection Agency. Any opinion, findings, or recommendations expressed herein are those of the author(s), and do not necessarily reflect the views of the U.S. EPA. Online version: wastereductionpartners.org — June 2025

Scope 1 Emissions Example: Calculating Gasoline Use at a Small Manufacturing Facility

In this example, staff at a manufacturing facility have been instructed by corporate leadership to initiate the process of accounting for greenhouse gas emissions. The team will begin by calculating emissions from gasoline use on-site and in their operations.





1.Identify Methodology

a. In this example, company leadership has made the decision to follow the GHG Protocol Corporate Standard .

A company may be required to report its emissions as a supply chain partner via a customer survey or industry-level survey which may require a different methodology. In the automotive sector, for example, many supply chain manufacturers and suppliers are required to follow the OEM-led M2030, which is underpinned by the GHG Protocol's Corporate Standard.

Responding to the survey may be simpler than performing calculations, but the same data and information are required. The amount of information requested by the survey can vary, and questions may change from one year to the next.

b. The monitoring period is for the calendar year 2024 (Jan 1-Dec 31)

2. Data Collection, Assumptions, and Initial Calculations to Determine Annual Fuel Use

a. Map out the fuel uses. In this plant, gasoline is used for fleet vehicles (including company owned cars used by employees), and landscaping equipment (mowers).

b. Next-contact the EHS Manager or Facilities Department to obtain monthly consumption logs (or meter information) from the onsite gasoline tanks, along with invoices for bulk fuel purchases.

c. Contact the purchasing department to obtain monthly totals for offsite fuel purchases for fleet vehicles, including company-owned cars driven by employees.

d. Compile data for 2024:

	Gasoline Use (Gallons)
	All
January-24	197
February-24	161
March-24	419
April-24	243
May-24	433
June-24	346
July-24	337
August-24	227
September-24	270
October-24	441
November-24	197
December-24	283
Annual total:	**3554**

3. Identify data gaps, estimate what you can, and document assumptions.

In this example there was no detailed information available for the gasoline use. Different vehicles will generate different emission profiles when a gallon of gasoline is combusted; in this case, we must make assumptions about how much fuel is used by each vehicle category (cars, light trucks, lawn mowers, other equipment, etc.) to calculate emissions. It is **perfectly valid** to make assumptions as long as they are clearly stated, reasonable, and documented.

The EHS manager is able to gather information on the age, make, model and annual mileage of each vehicle and they have also interviewed employees to understand general usage patterns.

To estimate annual fuel usage, the average fuel economy (miles per gallon) for each vehicle was obtained from the joint EPA/DOE website, where you can search for information on specific vehicle makes and models (https://www.fueleconomy.gov/feg/findacar.shtml). If more detailed fuel usage and mileage information had been available, the actual mpg per vehicle could have been directly calculated.

Example calculation, fuel use for a fleet vehicle:

The 2009 Toyota Tundra was driven 14,500 miles in 2024. From the joint EPA/DOE website (https://www.fueleconomy.gov/feg/findacar.shtml) average fuel economy for this vehicle is 15 miles per gallon (mpg).

$$Estimated\ gas\ use = \frac{miles\ per\ year}{avg\ mpg} = \frac{14,500\ miles\ per\ yr}{15\ miles\ per\ gallon} = 967\ gallons$$

Example calculation, fuel use for landscaping equipment (mower):

The maintenance staff were interviewed to obtain information on how much gasoline is used for mowing. Based on this information, the following assumptions were made:

- Mowing occurs 21 times between April 1 – October 15th
- Each mowing event takes ~2.5 hours to complete
- Mower consumes 2 gallons/hr of gasoline when running

Calculate gasoline used for mowing in 2024:

$$Gas\ used = \frac{gal}{hr} = \frac{hrs.of\ mowing}{event} = x\ of\ events;\ \frac{2\ gal}{hr}\ x\ \frac{2.5\ hrs.of\ mowing}{event}\ x\ 21\ events = 105\ gallons$$

With the estimates on gasoline consumption in hand, the EHS manager can compile more complete information about fuel use, taking care to note the assumptions:

Year	Make	Model	Fuel Economy (mpg)	Miles driven 2024	Annual gas use (gallons)
2019	Honda	Passport	22	————	————
2020	Toyota	Camry	34	19020	559
2009	Toyota	Tundra	15	14500	967
2012	Toyota	Tundra	15	16140	1076
2015	JD	Z97OA Mower	——	——	105

Notes:

1. Actual fuel use for specific vehicles was not tracked, average EPA fuel economy for make and model used to estimate for vehicles: https://www.fueleconomy.gov/feg/findacar.shtml
2. Mower use estimated to be 21 events between April 1 - October 15
    - Estimated average fuel consumption **(2 gal/hr, and 2.5 hr per mowing event)**

4. Assign Emissions Factors and Calculate CO2 Emissions

Calculating greenhouse gas releases generally involves the use of ***emission factors*** which relate the amounts of CO_2, CH_4, and N_2O emitted to a set amount of activity, such as gallons of fuel consumed or million standard cubic (scf) of natural gas that are burned. Default emission factors are tabulated by the EPA and other organizations and can be used when more specific or custom values are not available. In many cases companies need only activity data, such as the amount of distance traveled or the gallons of fuel used to calculate their emissions.

Always check the EPA Emission Factors Hub website for the most recent Emissions Factors document and/or Excel spreadsheet. CO_2 emission factors are organized into categories including Stationary Combustion, Mobile Combustion CO_2, Electricity, Steam and Heat, and several Scope 3 categories.

Example: Find the 2024 CO2 emissions factor for the 2009 Toyota Tundra fleet vehicle

From 2025 EPA Emissions Factors (Table 2) (Mobile Combustion CO2), the CO2 Emissions factor for the gasoline used in a 2009 Tundra would be 8.78 kg CO2 per gallon.

Table 2 — **Mobile Combustion CO_2**

Fuel Type	kg CO_2 per unit	Unit
Aviation Gasoline	8.31	gallon
Biodiesel (100%)	9.45	gallon
Compressed Natural Gas (CNG)	0.05444	scf
Diesel Fuel	10.21	gallon
Ethanol (100%)	5.75	gallon
Kerosene-Type Jet Fuel	9.75	gallon
Liquefied Natural Gas (LNG)	4.50	gallon
Liquefied Petroleum Gases (LPG)	5.68	gallon
Motor Gasoline	8.78	gallon
Residual Fuel Oil	11.27	gallon

For CO2, the calculation is straightforward: *Emissions = fuel use (gallons) x CO2 emissions*

For the 2009 Tundra: *Emissions = 967 gallons x 8.78 kg CO2 per gallon = 8487 kg CO2 or 8.49 metric tons (mt)* **(conversion: 1000 kg = 1 metric ton)**

Example: Find the 2024 CO2 emissions for a JD Z790A mower

The CO2 emissions factor will be the same for the lawnmower, 8.78 kg CO2/gal

Emissions = 105 gallons x 8.78 kg CO2 per gallon = 922 kg CO2 or 0.92 mt

5. Calculation of CH4 and N20 Emissions from fuel use, and Conversion to CO2e

You may need to include CH4 and N2O emissions in your GHG accounting as they are also greenhouse gases. Emissions factors for CH4 and N2O are tabulated in the 2025 EPA Emissions Factors for mobile combustion sources from diesel and alternate fuels, for both on and off-road use; values are tabulated based upon general vehicle type and (in some cases) general engine type. The off-road category includes equipment used in agriculture, lawn and garden, construction, railroad, mining, and other industries. The specific CH4 and N20 emissions factors will vary by vehicle year, make, model, and type.

The default CH4 and N2O emission factors for a 2009 pickup truck (our Toyota Tundra) can be found from 2025 EPA Emissions Factors (Table 3) **: 0.0095 g CH4** per vehicle mile, and **0.0036 g N2O** per vehicle mile.

Note the difference in units (grams per vehicle mile) compared with the CO2 emission factor, which is presented in kg CO2 per gallon of fuel used.

Example: Determine 2024 CH4 and N2O emissions for the 2009 Toyota Tundra

Emissions = emission factor x # of miles

2009 Tundra, CH4 emitted in 2024 = 0.0095 g CH4/mile x 14,500 miles = 137.8 grams CH4

2009 Tundra, N2O emitted in 2024 = 0.0036 g N2O/mile x 14,500 miles = 52.2 grams N2O

For greenhouse gas accounting, the amount of CH4 and N2O must be converted to the "equivalent" amount of CO2 that would result in the same amount of heat retention, or CO2e. The conversion requires use of the Global Warming Potential (GWP) of these two gases, which are listed at the top of the 2025 EPA Emissions Factors document as well as in Table 11:

Gas	100-Year-GWP
CH_4	28
N_2O	265

Source: Intergovernmental Panel on Climate Change (IPCC), Fifth Assessment Report (AR5), 2013. See the source note to Table 11 for further explanation.

Example: Determine the 2024 CO2e for CH4 emissions for the 2009 Tundra

CH4 emissions x GWP = Equivalent amount of CO2 (CO2e) emissions

Mass of CH4 emitted in 2024 = 137.8 g (or 0.1378 kg) from previous example

GWP for CH4 (100 year) = 28 (from table above)

0.1378 kg CH4 x 28 = 3.9 kg CO2e (or 3.9 x 10-3 metric tons (mt) of CO2e)

The standard practice for most approaches (including the GHG Protocol) is to use the GWP values from the IPCC's 5th Assessment Report (AR5); these are the values listed in Table 11 of the 2025 EPA Emissions Factors document. The IPCC periodically updates the GWP numbers, which can complicate comparisons; the AR5 values are typically used to ensure a consistent baseline. You should verify which GWP timeframe your company wants you to use (100-year vs. 20-year); the 100-year GWP value is most common in corporate carbon accounting, but the 20-year methane GWPs are sometimes used. If you need to use IPCC GWP values from a different Assessment Report you can find them here https://www.ipcc.ch/assessment-report/. Be sure to document which GWP values you are using to ensure internal alignment and consistency.

Example: Find the 2024 N2O emissions from the lawnmower, expressed as CO2e

The lawnmower is a 27 Horsepower (20.1kW) machine with a 4 stroke engine
Gasoline use in 2024 (estimated): 105 gallons

Steps:

- Find the N2O emissions factor, 2025 EPA Emissions Factors (Table 5): 1.50 g N2O/ gal of gas
  Calculate N2O emissions:
  1.50 g N2O/gal of gas x 105 gal of gas = 157.5 g N2O, or 0.1575 kg N20 for 2024
- Find GWP for N2O: From 2025 EPA Emissions Factors document, 100 yr GWP (AR5) = 265
  Calculate CO2e: 0.1575 kg N2O* 265 = 41.7 kg CO2e, or **0.0417 mt CO2e**

The total CO2e from gasoline use at the plant is calculated to be 31.3 mt, as shown in the table below. The contribution from CH4 and N2O are very small for this particular case study, compared with the CO2 emissions.

Year	Make	Model	Miles Driven	2024 gas use	CO2 Emissions Factor	Annual CO2 Emissions	Annual CO2 Emissions	CH4 Emissions Factor	CH4 GWP	Annual CH4 Emissions	Annual CH4 Emissions	N2O Emissions Factor	N2O GWP	Annual N2O Emissions	Annual N2O Emissions
				(gallons)	kg CO2 per gal of gas	(kg)	(mt)	g CH4 / mile driven	100 yr, AR5	(mt)	(mt CO2e)	g N2O/mile driven	100 yr, AR5	(mt)	(mt CO2e)
2019	Honda	Passport	18630	847	8.78	7435	7.44	0.0079	28	0.000147	0.0041	0.0012	265	0.000022	0.0059
2020	Toyota	Camry	19020	559	8.78	4912	4.91	0.005	28	0.000095	0.0027	0.0014	265	0.000027	0.0071
2009	Toyota	Tundra	14500	967	8.78	8487	8.49	0.0095	28	0.000138	0.0039	0.0036	265	0.000052	0.0138
2012	Toyota	Tundra	16140	1076	8.78	9447	9.45	0.0096	28	0.000155	0.0043	0.0033	265	0.000053	0.0141
2015	JD	Z970A Mower	--	105	8.78	922	0.92	2.99*	28	0.000314	0.0088	1.50*	265	0.000158	0.0417
					Totals:		31.20				0.0238				0.0827
												Overall total CO2e (mt) =			31.3

Notes:

Actual fuel use not tracked for vehicles, estimated based upon annual mileage and avg mpg.

Mower assumptions: **21 Mowing events per year; 2.0 gallons gas used/ hr; 2.5 hrs per event.**

* Emissions factors for CH4 and N2O for lawn and garden equipment are expressed in grams/gallon of gasoline.

1000 g = 1kg 1000kg = 1 metric ton (mt)

2025 EPA GHG emission factors, IPCC GWP values (AR5, 100 yr) EPA2025GHGEmissionsFactors

Be sure to check for the most recent EPA GHG emissions factors: EPAGHGEmissionsFactor Hub

Additional references for GWP values for other IPCC assessment years: http://www.ipcc.ch/assessment-report/

6. Document Assumptions and Methodology

It is good practice to generate a basic document or Appendix that includes

- Data sources (e.g., Monthly fuel purchase logs, mileage information, etc.)
- Emission factors and GWP sources (e.g., EPA, IPCC documentation)
- Assumptions
- Calculation Methodology (e.g., Direct multiplication of activity data by emission factor; Source of Calculation – GHG Corporate Protocol; EPA Emissions Factors)
- Anything atypical or unusual
- Data gaps that you would like to address for the next reporting period, and any strategies that may help streamline the effort

Resources

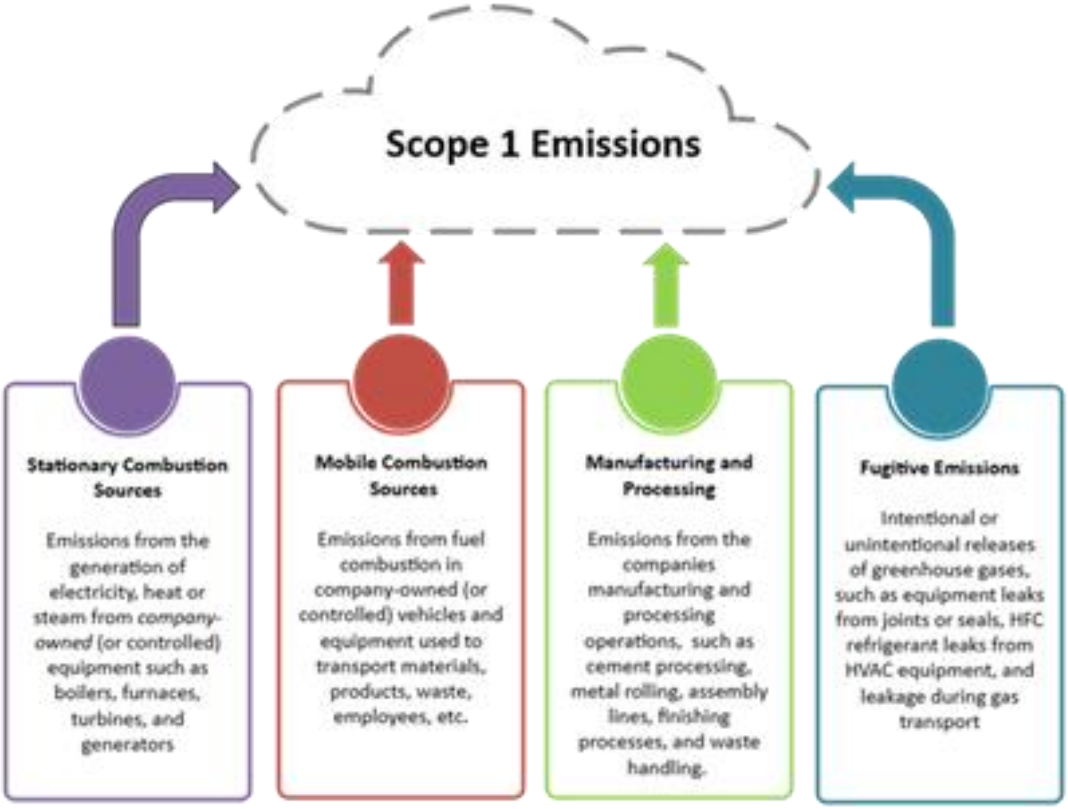
1. https://www.epa.gov/climateleadership/scope-1-and-scope-2-inventory-guidance
2. GHG Corporate Protocol
3. EPA Emission Factors Hub
4. 2025 EPA Emissions Factors
5. EPA/DOE website https://www.fueleconomy.gov/
6. Fuel economy for specific vehicles: https://www.fueleconomy.gov/feg/findacar.shtml
7. IPCC assessment reports https://www.ipcc.ch/assessment-report/

About This Resource: This document is produced by Waste Reduction Partners, a program of Land of Sky Regional Council under contract by the U.S. Department of Environmental Protection Agency. Any opinion, findings, or recommendations expressed herein are those of the author(s), and do not necessarily reflect the views of the U.S. EPA. Online version: wastereductionpartners.org — June 2025

Scope 1 Example: Fugitive Emissions from Refrigerant Losses

In this example a small commercial facility has been tasked by corporate leadership to quantify their greenhouse gas emissions, and they've specifically been instructed to include fugitive emissions based on a client request. **Fugitive emissions** are unintentional releases of GHGs that occur from equipment leaks, process venting, fire extinguishers, the use of refrigerants in cooling systems, etc.

This example will focus on calculating fugitive refrigerant emissions, which are classified as Scope 1 because most facilities own their air conditioning equipment. In this example, we will demonstrate the use of two calculation approaches included under the GHG Protocol Corporate Standard – the *Screening Method* and the *Material Balance Method*. These two calculation approaches are clearly documented in the 2014 EPA Guidance document Direct Fugitive Emissions from Refrigeration, Air Conditioning, Fire Suppression, and Industrial Gases .



Overview

In the business world the **GHG Protocol's Corporate Standard** is the most widely used methodology for calculating a carbon inventory. Alternatively, a company may need to report emissions as a supply chain partner to a customer or industry survey. The GHG Protocol's Corporate Standard is used in this example, but the methodology used will also be influenced by customer requirements. If a manufacturing or commercial operation fully leases and outsources all AC equipment, operation, and service to an external provider, the fugitive refrigerant emissions become a Scope 3 (indirect) value chain emission to the commercial facility and would be classified as a Scope 1 (direct) emission to the external provider.

Even small refrigerant leaks can have a significant climate impact because many refrigerants– particularly hydrofluorocarbons (HFCs) - have a very high global warming potential (GWP). The GWP is a measure of how much heat is trapped by a molecule of the gas relative to carbon dioxide (CO_2) over a specific time period; CO_2 has a baseline GWP of 1. For example the common HFC refrigerant blend R-410A has a GWP of 2088 (IPCC AR4) indicating it is a potent greenhouse gas.

In 2020, the US Congress enacted the American Innovation and Manufacturing (AIM) Act. This act required HVAC manufacturers to switch to refrigerants with a GWP of 700 or less by January 1, 2025 for use in new equipment. Refrigerants such as R-410A – while still allowed for use in existing equipment - will eventually be phased out. For the most updated information, visit the US EPA website for HFC Reduction .

For GHG accounting, fugitive refrigerant emissions must be converted to CO_2 equivalents (CO_2e) using GWP values.   Many organizations will use GWP values from the IPCC's 2013 Fifth Assessment Report (AR5) or the most recent AR6 report (2021). Some US organizations will use the 2007 AR4 values for HFC refrigerants and blends, as those values are cited in US EPA resources and are referenced in the AIM act. GWP values for IPCC AR4 (2007), AR5 (2013), and AR6 (2021) have been summarized for many different gases in the GHG Corporate Protocol GWP Summary, GWP values for HFCs, HFC blends, and some substitutes are available in the US EPA Technology Transitions GWP Reference Table, which can be used in addition to the 2014 EPA guidance on fugitive emissions . Note that some refrigerants have different names depending on the reference (e.g. R-32 is also known as HFC-32).

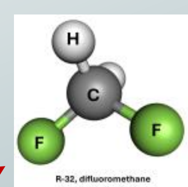
If the GWP of your refrigerant blend is not listed or if you need to use different reference values, you can calculate the Global Warming Potential (GWP) using the mass-weighted average of the GWP for the individual components.

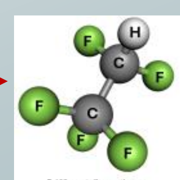
Example:

R-410A is a blend that is 50% R-32 (HFC-32) and 50% R-125 (HFC-125) by mass.

Component	GWP (IPCC AR4)	Fraction in R-410A blend
R-32 (aka HFC-32)	675	0.5
R-125 (aka HFC-125)	3500	0.5

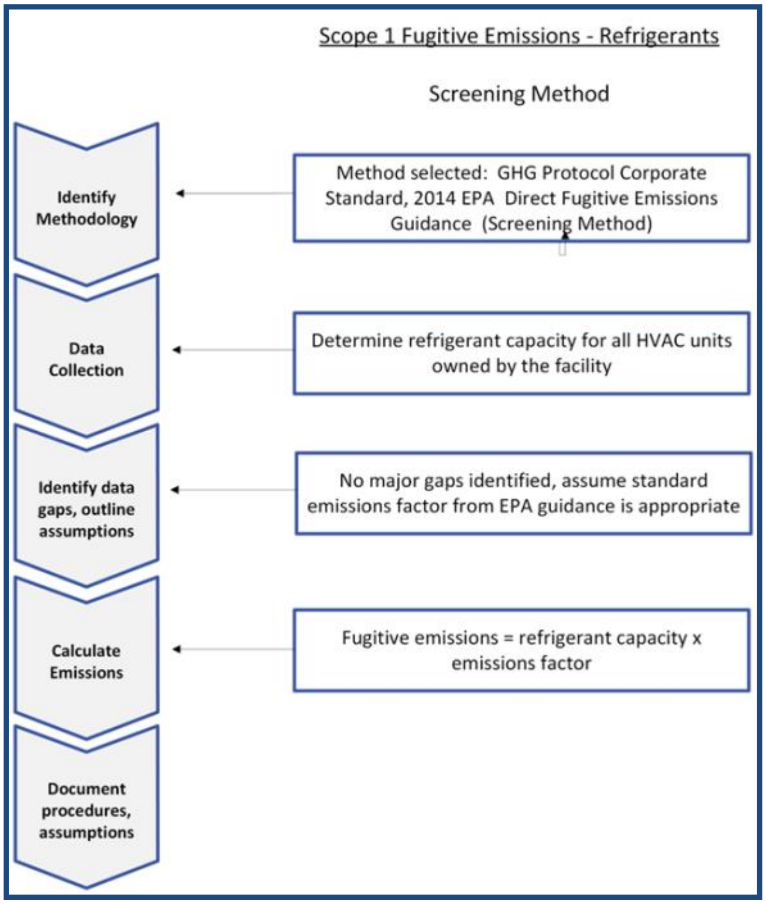
The GWP of R-410A = (0.5 x 675) + (0.5 x 3500) = 2087.5, rounded to **2088**





Case 1

Estimating Fugitive Refrigerant Emissions using the Screening Method



1) **Identify Methodology**

a. Corporate leadership has indicated the GHG Protocol Corporate Standard will be used to determine Scope 1 and 2 emissions for the facility. The facility will also use the 2014 EPA guidance (Direct Fugitive Emissions from Refrigeration, Air Conditioning, Fire Suppression, and Industrial Gases) to calculate fugitive refrigerant emissions.

The Global Warming Potential (GWP) values cited in the 2014 EPA guidance for individual refrigerants and blends are based on the IPCC AR4 report; additional GWP values from a variety of sources are available at the EPA US EPA Technology Transitions GWP Reference Table. The company will use the AR4 values for fugitive refrigerant emission calculations, as these numbers align with the US AIM act and have been used at their other facilities.

b. A preliminary review of maintenance documents indicates the company does not have detailed information on the exact amount of refrigerants recharged into each of the three HVAC units. The team will estimate emissions using the Screening Method, which does not require as much data as the Materials Balance approach.

c. The monitoring period is for calendar year 2024 (Jan 1-Dec 31)

2) Data Collection – Screening Method

a. Obtain refrigerant capacity for the three HVAC units from the Facilities department.

Commercial HVAC Unit 1 = 18 lbs
Commercial HVAC Unit 2 = 15 lbs
Commercial HVAC Unit 3 = 15 lbs

Total Capacity = 48 lbs

b. The team verified the HVAC equipment uses the refrigerant blend R-410A (sometimes referred to as HFC-410A)

c. Determine the standardized emissions factor for Commercial A/C units. No new HVAC equipment was installed in 2024 and none was decommissioned, so only Operating Emissions will need to be considered for 2024. From the table below, the Emissions Factor for these units would be 10%.

Default Emission Factors for Refrigeration/Air Conditioning Equipment

(From 2014 EPA Guidance, based on 2006 IPCC Guidelines)

Type of Equipment	Capacity (kg)	Installation Emission Factor k (% of capacity)	Operating Emissions x (% of capacity/yr.)	Refrigerant Remaining at Disposal y (% of capacity)	Recovery Efficiency z (% of remaining)
Domestic Refrigeration	0.05–0.5	1	0.5	80	70
Stand-alone Commercial Applications	0.2–6	3	15	80	70
Medium & Large Commercial Refrigeration	50–2,000	3	35	100	70
Transport Refrigeration	3–8	1	50	50	70
Industrial Refrigeration including Food Processing and Cold Storage	10–10,000	3	25	100	90
Chillers	10–2,000	1	15	100	95
Residential and Commercial A/C including Heat Pumps	0.5–100	1	10	80	80
Mobile Air Conditioning	0.5–1.5	0.5	20	50	50

Source: 2006 IPCC Guidelines for National Greenhouse Gas Inventories

3. Calculate Fugitive R-410A Emissions using the Screening Approach

(a) The estimated fugitive emissions from the three commercial HVAC units would be calculated as follows:

Fugitive R-410A Emissions from Operation = $C \times (E_F / 100) \times T$

*Where **C** = refrigerant capacity, E_F = emissions factor, and **T** = time (in years)*

<u>For this example:</u>

Fugitive R-410A Emissions from Operation = 48 lbs × (10 /100) x 1 = 4.8 lbs

For more detail on estimating fugitive emissions for newly installed equipment, or equipment that is removed from service, please refer to the 2014 EPA guidance document.

(b) Convert R410A emissions to CO2e

For greenhouse gas accounting, the fugitive refrigerant emissions must be converted to the "equivalent" amount of CO2 that would result in the same amount of heat retention, or CO2e. The conversion requires use of the GWP value for R-410A. As described previously, the GWP values will be obtained from the 2014 EPA guidance (Table 2) and are based on the IPCC AR4.

Fugitive Emissions in CO2e = Fugitive R-410A Emissions × GWP for R-410A

GWP of R-410A = 2088

<u>For this example:</u>

Fugitive Emissions in CO2e = 4.8 lbs × 2088 = 10,022 lbs CO2e

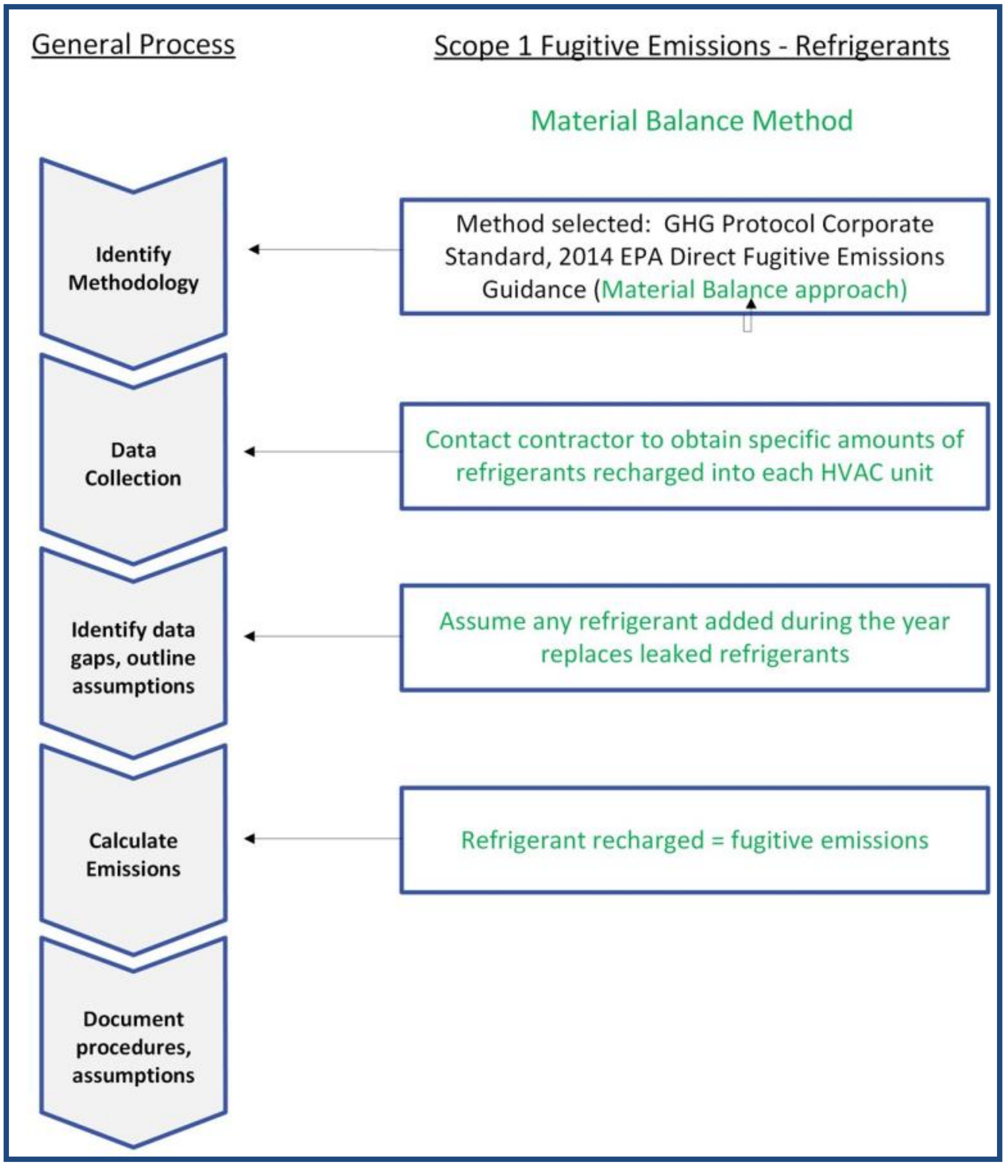
10,022 lbs CO2e = 4.5 metric tons CO2e

(Conversion: 2204.6 lbs per metric ton)

Case 2

Fugitive Refrigerant Emissions using a Materials Balance Approach

During a meeting with an important client to discuss sustainability metrics, they indicated they would prefer a materials balance approach to calculate fugitive emissions. The new approach is shown below, with changes highlighted in green:



1. Identify Methodology

The general **methodology is the same as in Case 1 except that the Materials Balance approach**, outlined in the 2014 EPA guidance, will be used instead of the Screening Method.

2. Data Collection – Materials Balance Method

The team contacted the Facilities Department and the Purchasing Department to obtain contact information for the contractor(s) hired in 2024 to service their HVAC equipment. They were able to document how much R-410A was recharged during each of the service visits in 2024:

Service Date	R-410A Recharged (lbs)
3/31/2024	0.9
6/60/2024	1
9/30/2024	1.4
12/31/2024	1.0
Annual total:	**4.3**

Although the aggregate data were sufficient for calculating the fugitive refrigerant emissions, a team member suggested they also request service data for each individual unit:

Service Date	R-410A Recharged (lbs)		
	Unit 1	Unit 2	Unit 3
3/31/2024	0.2	0.5	0.2
6/60/2024	0.2	0.7	0.1
9/30/2024	0.3	0.7	0.4
12/31/2024	0.2	0.6	0.2
Annual total:	**0.9**	**2.5**	**0.9**

3. Calculate Fugitive R-410A Emissions using a Materials Balance Approach

In this approach, it is assumed that the amount of refrigerant recharged into an HVAC system is equivalent to the amount of refrigerant that is lost to the atmosphere in that same year.

Fugitive R-410A Emissions in 2024 = Amount of R-410A Recharged into HVAC Systems

Fugitive R-410A Emissions in 2024 = 4.3 lbs

Convert R410A emissions to metric tons of CO2e

Fugitive Emissions Refrigerant Emissions as CO2e = Fugitive R-410A Emissions × GWP for R-410A

For this example:

Fugitive Refrigerant Emissions as CO2e = 4.3 lbs × 2088 = 8978 lbs CO2e

8978 lbs CO2e = **4.1 metric tons CO2e**

(Conversion: 2204.6 lbs per metric ton)

Final Step for Both Cases: Document the Assumptions and Methodology.

For both cases, this can be a simple document or Appendix showing:

1. Data source (e.g., Quarterly or periodic service records, HFAC data)
2. Emission factors, sources for GWP values, etc.
3. Document all assumptions, list any critical data gaps that affect data quality
4. Calculation Methodology

Describe anything atypical, or any other findings. It would be worth noting that HVAC Unit 2 (15 lb capacity) seems to be losing more refrigerant than the other two units. The team can determine if it makes sense to evaluate HVAC Unit 2 and address any potential leaks.

References and Resources

Greenhouse Gas Protocol Corporate Standard. 2015

https://ghgprotocol.org/corporate-standard

Greenhouse Gas Protocol. 2024. Global Warming Potential Values.

https://ghgprotocol.org/sites/default/files/2024-08/Global-Warming-Potential-Values%20%28August%202024%29.pdf

IPCC 2007. Climate Change 2007: The Physical Science Basis. Working Group I contribution to the Fourth Assessment Report (AR4).

https://www.ipcc.ch/report/ar4/wg1/

IPCC. 2013. Climate Change 2013: The Physical Science Basis. Working Group I contribution to the Fifth Assessment Report (AR5).

https://www.ipcc.ch/report/ar5/wg1/

IPCC. 2021. Climate Change 2013: The Physical Science Basis. Working Group I contribution to the Sixth Assessment Report (AR5).

https://www.ipcc.ch/report/sixth-assessment-report-working-group-i/

US EPA. 2014. Greenhouse Gas Inventory Guidance Direct Fugitive Emissions from Refrigeration, Air Conditioning, Fire Suppression, and Industrial Gases. https://www.epa.gov/sites/default/files/2015-07/documents/fugitiveemissions.pdf

U.S. EPA. Technology Transitions GWP Reference Table.

https://www.epa.gov/climate-hfcs-reduction/technology-transitions-gwp-reference-table

U.S. EPA. Protecting Our Climate by Reducing Use of HFCs

https://www.epa.gov/climate-hfcs-reduction

About This Resource: This document is produced by Waste Reduction Partners, a program of Land of Sky Regional Council under contract by the U.S. Department of Environmental Protection Agency. Any opinion, findings, or recommendations expressed herein are those of the author(s), and do not necessarily reflect the views of the U.S. EPA. Online version: wastereductionpartners.org — June 2025

Waste Reduction Partners

LAND of SKY REGIONAL COUNCIL

Scope 2 Emissions Overview

Indirect Sources

This module provides information on identifying and determining indirect, purchased Scope 2 emissions, along with practical steps for both location-based and market-based methods. A detailed example of the electricity calculation for purchased electricity is presented as a separate resource.

Companies and organizations engaged in greenhouse gas accounting are required to quantify emissions consumed from purchased electricity, steam, heat, or cooling. These are known as Scope 2 emissions under the GHG Protocol's Corporate Standard.

Scope 2 emissions can be considered as the carbon footprint of the energy you buy and use, but don't produce yourself. These typically include anything listed on an energy or utility bill. Scope 1 emissions come directly from an emissions source you own or control, while a Scope 2 emission physically occurs offsite at the power plant or utility generating the energy purchased for and consumed at the facility. Scope 2 emissions are the responsibility of the end-user and are included in the GHG accounting for a company or firm.

For many industries, Scope 1 (direct) emissions are higher than Scope 2 (indirect) emissions, primarily due to the intensive on-site fuel combustion used for heating processes, as well as process emissions (https://www.epa.gov/ghgemissions/industry-sector-emissions). However, Scope 2 emissions may be a larger source of GHG emissions for some industry sectors - particularly those that include:

- Energy-intensive electrical equipment or processes
- Reliance on electric heating or cooling systems
- Operation over multiple shifts (e.g., 24/7, 24/5 model)
- Minimal on-site fuel combustion

Businesses and consumers can often significantly reduce Scope 2 emissions and lower operating costs by decreasing electricity use through improved energy efficiency.

Types of Scope 2 Emissions

Electricity is the most common source of Scope 2 emissions. This is purchased from either a local or large utility, as well as from the underlying regional electric grid.

- EPA eGRID: The EPA's eGRID database provides grid-specific emissions information and is regularly updated. North Carolina electricity comes from the SRVC sub-region of the SERC Reliability Corporation (SERC) operated grid. You will need this CO_2 equivalent emissions rate for calculating your Scope 2 emissions score. You always want to use the latest value when accounting for your current year. This is because you would lose out on the lower emissions score arising from the greening of the grid if you were to go back and assign the older emission factor to more recent power consumption.

A snapshot of the NC data pulled from the site can be seen in the following image, indicating the most recent update in June 2025:

eGRID with 2023 Data

Released: January 15, 2025
Revision 1 Released: January 17, 2025
Revision 2 Released: June 12, 2025

- eGRID 2023 Summary Tables (xlsx) (962.55 KB)
- eGRID 2023 Summary Tables (pdf) (401.09 KB)

eGRID Subregion Total Output Emission Rates (lb/MWh)

Show entries Search: srvc

eGRID Subregion	CO_2	CH_4	N_2O	CO_2e	Annual NO_X	Ozone Season NO_X	SO_2
SRVC	593.419	0.045	0.006	596.326	0.282	0.316	0.152

from: https://www.epa.gov/egrid/summary-data

- **Utility-provided Emissions Factor:** In North Carolina, your utility may provide you with the precise emissions factor value for the electricity your firm purchased. If the utility provides a letter with the specific emissions factor, this will yield a more accurate emissions value than a location-based EPA eGrid value.

Note: Ideally you would go back and re-report emissions from prior years using the Utility's specific emission factor for each given year, to ensure an 'apples-to-apples' comparison over time. However, it is a relatively recent trend for utilities to provide this data, and they may not be able to provide past data. Best practice is to include the information in your reporting to explain what you did and why. For example, a report may include the following statement:

In 2018-2022 the calculations used EPA eGrid data, and in 2023 we switched to a utility-supplied value.

It is critical to identify the data sources used for GHG accounting, and to document any changes in the process.

- **Combination:** Using both utility-provided and EPA eGrid data might be suitable in situations where a firm has multiple locations across the country. For instance, the utility-provided emissions factor can be applied to the North Carolina site. At the same time, eGrid subregion data can be used for other sites where utility-specific data is not available. Proper documentation is essential.

Other Scope 2 emissions sources include:

•**Steam**: Often purchased from district heating systems or neighboring industrial facilities.

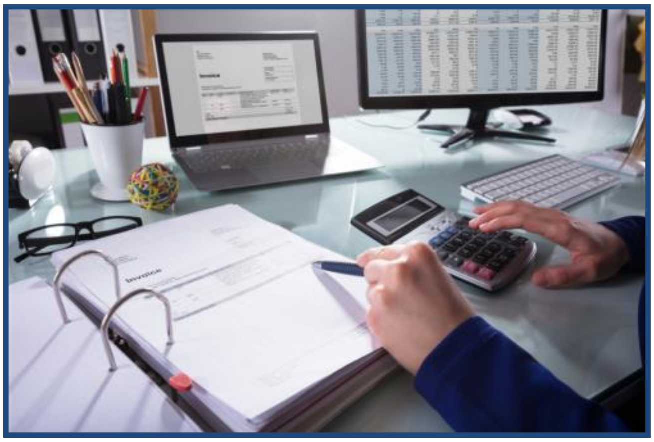
•**Heat**: Purchased hot water or thermal energy for heating, often generated from a central location such as a firm located in an industrial park, for example.

•**Cooling**: Purchased chilled water for air conditioning or process cooling.

•**Compressed Air**: Compressed air may be purchased as a utility in specific industrial settings (e.g., site located within an industrial park with a central generation point).

Other Market-Based Approach Considerations

Renewable Energy Certificates (RECs) - RECs are used to reduce indirect GHG emissions associated with purchased electricity by verifying the use of zero- or low-emissions renewable source of electricity. RECs (MWh of renewable energy) are used in the calculation of gross, market-based Scope 2 emissions, based on the emissions factor assigned to the renewable generation associated with the REC. A buyer of a REC can claim to use 1 MWh of renewable electricity from a low- or zero-emissions resource. Some policies require the REC to be generated in the same market region and sub-region. For NC businesses, this would be in the SERC grid region and SRVC sub-region (EPA link).



It is essential to document all renewable energy purchases, including the documentation of the energy source. In the case of an REC purchase, the power generation must have occurred during the reporting year. Suppose the reporting year and the REC purchasing contract cover different periods. In that case, the emissions factors for the REC should only be applied to the portion of the reporting year covered by the REC purchase agreement.

Once your firm claims a REC, it cannot be resold or claimed by any other entity to avoid double-counting. The REC is "retired" upon counting/assigning it toward your firm's emissions.

For more information on how to incorporate RECs into your GHG accounting effort, please see the following references:

GHG Protocol Scope 2 Guidance

US EPA Greenhouse Gas Inventory Guidance: Indirect Emissions from Purchased Electricity

Internal Alignment – Some companies may handle Scope 2 emissions differently as a site-level subsidiary versus an individual facility. It is typical for a parent company to require your site-level data to integrate into their corporate reporting. Making sure your data collection and approaches align with corporate guidance is important, especially regarding REC and Power-Purchase Agreements.

Resources

GHG Protocol Scope 2 Guidance: https://ghgprotocol.org/scope_2_guidance

GHG Protocol Scope 2 Training and Slides Part 1, Part 2, and Recorded Webinar
Note: Free to access however registration/purchase is required if interested to receive a formal certificate of completion

US EPA eGRID Emission Factors: https://www.epa.gov/egrid

US EPA GHG Inventory Guidance: https://www.epa.gov/climateleadership/scope-1-and-scope-2-inventory-guidance

US EPA Greenhouse Gas Inventory Guidance Indirect Emissions from Purchased Electricity https://www.epa.gov/sites/default/files/2020-12/documents/electricityemissions.pdf

US EPA Offsets and RECs: What's the Difference? https://www.epa.gov/sites/default/files/2018-03/documents/gpp_guide_recs_offsets.pdf

US EPA Power Profiler https://www.epa.gov/egrid/power-profiler#/ Includes maps of the power regions and subregions, as well as average usage data; driven by the 2023 eGRID data.

Green-E Residual Mix Emissions Rate Tables: **https://www.green-e.org/residual-mix**

About This Resource: This document is produced by Waste Reduction Partners, a program of Land of Sky Regional Council under contract by the U.S. Department of Environmental Protection Agency. Any opinion, findings, or recommendations expressed herein are those of the author(s), and do not necessarily reflect the views of the U.S. EPA. Online version: wastereductionpartners.org — June 2025

Waste Reduction Partners

LAND OF SKY REGIONAL COUNCIL

Scope 2 Emissions Calculations & Examples

Companies and organizations engaged in greenhouse gas accounting must quantify Scope 2 emissions resulting from the consumption of purchased electricity, steam, heat, or cooling. An excellent resource is the GHG Protocol's Corporate Standard. This document presents an example of calculating Scope 2 emissions from purchased electricity using both location-based and market-based approaches.

Identify Methodology and Calculation Approaches

In the business world, the GHG Protocol's Corporate Standard is the most widely used methodology for calculating a firm's carbon inventory. Alternatively, your firm may choose (or be required) to report its emissions as a supply chain partner to a customer or industry-led survey. In the automotive sector, for example, many supply chain manufacturers and firms are required to follow the OEM-led M2030, which is also underpinned by the GHG Protocol's Corporate Standard.

Responding to an industry-level supplier survey can be simpler than performing calculations yourself but the same data sources and values are still required. However, different base years may be required, and the survey itself will likely change over time with respect to data needed.

The GHG Protocol's Corporate Standard outlines two methods for calculating Scope 2 emissions, **the *Location-based* method** and **the *Market-based* method.** It is considered a best practice to calculate and report Scope 2 emissions totals using ***both*** the Location-based and Market-based methods, and may be required in some cases.

1. Location-based Method – This method calculates Scope 2 GHG emissions "based on average energy generation emission factors for defined geographic locations, including local, subnational, or national boundaries" for a defined period. It excludes emissions from electricity purchases made to include renewable sources.

2. Market-based Method – The market-based method is a way for companies to take credit for the renewable energy they've procured directly or indirectly, **provided the company owns and can take credit for the low or zero-carbon environmental attribute** associated with the renewable electricity purchased or generated elsewhere in the grid. The concept is that purchasing these zero-carbon attributes will help drive decarbonization of the grid. Procuring these zero-carbon attributes for electricity can be done in several ways, including:

- Renewable Energy Certificates (RECs) – A REC represents the environmental attribute of 1 MWh of renewable electricity generation. Firms can purchase the "green" attributes of renewable energy and include them in their Scope 2 Emissions accounting.

- Utility Green Power Product – Special tariffs or program that your utility company may offer providing certified renewable-based energy.

- Power Purchase Agreements – Your firm directly contracts with a commercial-scale, solar or wind farm renewable project.

- Supplier-specific emissions rates – Custom emission factor for a utility's specific energy mix, or energy consumed in producing a product purchased (e.g., compressed air or steam).

Documentation for low or zero-emission energy sources is critical and is required if you are going to include them in your Scope 2 emissions accounting. Once used, the REC or other source **must** be retired. If your firm utilizes on-site solar or other renewable energy sources, review the contract language to ensure the environmental attributes belong to the company. Developers and utility companies often tie financial incentives for renewables to retaining ownership of the environmental attributes.

Residual Emissions Factor Data – The market-based calculation method acknowledges that other entities will claim ownership of renewable assets on the sub-regional grid. The zero-carbon claims for environmental attributes that can be tracked are removed from the grid's emission factor, so they aren't "counted" more than once. What remains is known as the residual emissions factor or residual mix, which reflects a higher value of CO_2e per MWh than the default eGRID value, as the renewable sources with low or zero emissions have been excluded.

The non-profit audit and certification body **Green-e** is the leading provider of US residual emissions factor data. The Green-e residual mix values factor out all Green-e® Energy certified sales of renewable energy, resulting in a higher residual emissions factor for standard electricity obtained from the grid within the specified EPA subregion. Users reporting their GHG data should cite the use of these residual mix rates in their accounting.

The Utility industry also publishes residual mix data through its industry group, the Edison Electric Institute; data is available as a downloadable spreadsheet. Duke Energy Progress and Duke Energy Carolinas in NC both contribute to this resource. Utility account representatives can often help companies understand specific emissions factors assigned.

3. Why Use Both?

In some cases, it may be necessary to use both methods (e.g., client request, regulatory). Showing the calculation for both approaches will make clear the benefits of purchasing electricity with low or zero carbon emissions. When a company buys a REC or enters a PPA, the idea is that it facilitates decarbonization of the grid, and the company should be able to take credit for that improvement. The location-based method does not account for these measures, resulting in a notable difference in the results. However, the information remains helpful in determining the best strategies to achieve the company's sustainability goals.

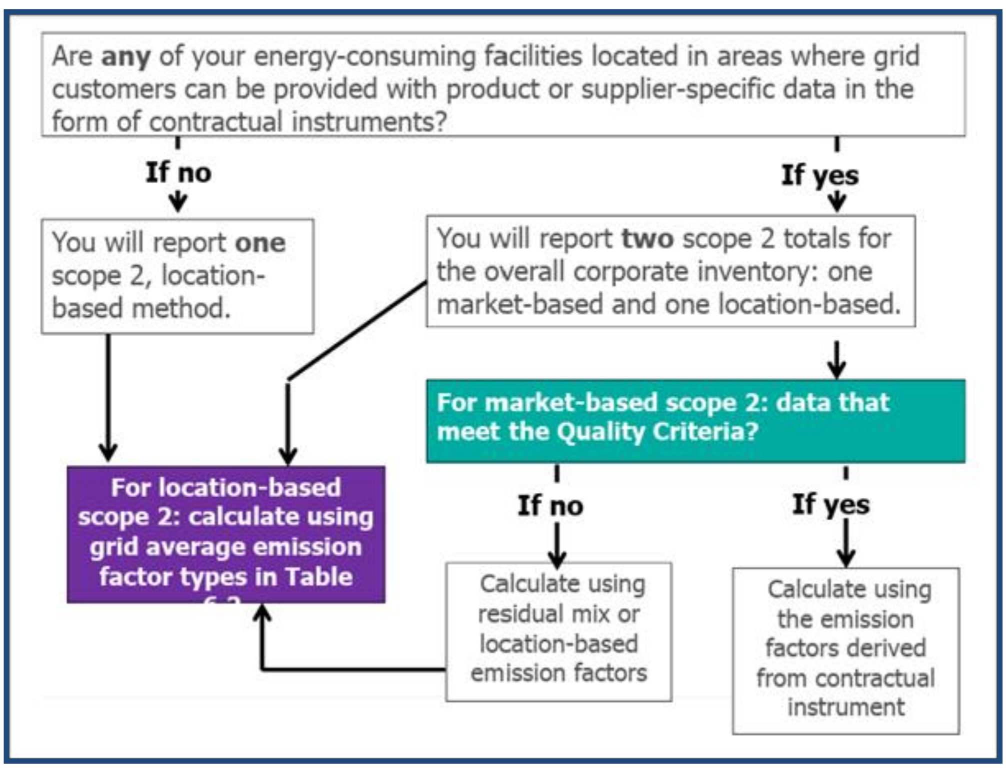


Figure from GHG Protocol: Scope 2 Training

Example: Calculating Scope 2 Emissions for Purchased Electricity

This example walks through the calculations to determine Scope 2 emissions for purchased electricity, for a manufacturing facility in North Carolina in the SERC region, SRVC subregion (see EPA eGRID Subregion Map). Both calculation methods will be shown.

For this example, the monitoring period is for the calendar year 2024 (Jan 1-Dec 31)

Data Collection

a. The plant EHS Manager or Facilities/Maintenance Department obtains total electricity used from utility bills for a given 12-month year period (e.g., 2024). This data is typically in kilowatt hours (kWh).

b. Identify the regional grid emissions factor from EPA eGRID.

The EPA typically updates eGRID data every 1-2 years, and there is a time lag. Always use the most recent eGRID data available for your reporting year and clearly document which version you're using in your GHG inventory. For example, the most recent eGRID2023 (as of this writing) was issued in June, 2025 and uses 2023 data.

Note: Other Scope 2 purchased utilities such as compressed air, heat, or steam should have specific emissions factors for the energy required to produce the product you purchased.

c. Gather all relevant 2024 data. Our simplified example will consider a North Carolina manufacturer that used exactly 1,000,000 kWh of electricity.

Month / Year	Electricity Usage (kWh)
Jan-24	83,333.33
Feb-24	83,333.33
Mar-24	83,333.33
Apr-24	83,333.33
May-24	83,333.33
Jun-24	83,333.33
Jul-24	83,333.33
Aug-24	83,333.33
Sep-24	83,333.33
Oct-24	83,333.33
Nov-24	83,333.33
Dec-24	83,333.33
12-month total	**1,000,000.00**

1. **Location-Based Calculation:**

   a. **Select Relevant Emissions Factor**

   Per EPA's eGRID 2023 data (Rev. 2 June 2025, accessed Aug 2025), North Carolina draws from the SRVC subregion of the SERC grid. This region has a CO2 equivalent emissions factor value of **596.326** lbs CO2e/MWh.
   *Note: Pay close attention to units (**kWh vs MWh, lbs vs kg vs metric tons**).*
   [EPA eGRID Subregion Map]
   [EPA eGRID Summary Data]

eGRID with 2023 Data

Released: January 15, 2025
Revision 1 Released: January 17, 2025
Revision 2 Released: June 12, 2025

- eGRID 2023 Summary Tables (xlsx) (962.55 KB)
- eGRID 2023 Summary Tables (pdf) (401.09 KB)

eGRID Subregion Total Output Emission Rates (lb/MWh)

Show entries Search: srvc

eGRID Subregion	CO_2	CH_4	N_2O	CO_2e	Annual NO_X	Ozone Season NO_X	SO_2
SRVC	593.419	0.045	0.006	596.326	0.282	0.316	0.152

https://www.epa.gov/egrid/summary-data

   b. **Convert electricity used from kWh to MWh:**

   1,000,000 kWh x 0.001 MWh/kWh = 1000 MWh

   c. **Use the emissions factor to calculate the CO2e from the electricity used:**

   1,000 MWh x 596.326 lbs CO2e/MWh = 596,326 lbs CO2e

   d. **Convert from lbs into metric tons of CO2e (or your relevant reporting value):**

   596,326lbs CO2e / (2,204.62 lbs/metric ton) = **270.5 metric tons CO2e**

2. Market-Based Calculation with Renewables -The company will receive credit for the zero or low emission attributes purchased in 2024, and will also need to use supplier-specific or residual mix emission rates from **Green-e** (instead of the eGRID values).

⇒ Timeframe is **Jan 1 – Dec 31, 2024**

⇒ Total 2024 electricity use: **1,000,000 kWh, or 1000 MWh**

⇒ In 2024, the company purchased **20%** (or **200,000 kWh**) of renewable energy through RECs. The contract specifies an emissions factor of **0 lbs CO2e/MWh** for the renewable energy sources.

a. Calculate the market-based CO2e emissions from renewables purchased in 2024:

RECs Purchased: 200,000 kWh x 0.001 MWh/kwh = **200 MWh**

200 MWh x 0 lbs CO2e MWh (emissions factor from the REC contract) = **0 lbs CO2e**

b. Determine the emissions from the remaining electricity purchased:

Calculate the amount of **"standard"** electricity purchased from the grid:

1,000,000 kWh – 200,000 REC kWh = **800,000 kWh**

Convert to MWh: 800,000 kWh x 0.001 MW/kwh = **800 MWh**

c. Find the region-specific (SRVC) Residual Mix Emission Factor from Green-e Table;

(you will want to use the "Adjusted System Mix" value):

eGrid Subregion	CO_2 Emissions (tons)	Net Generation (MWh)	Emission Rate (lb / MWh)	Voluntary RE emissions (lbs)	Voluntary RE (MWh) (12-month vintage)	Adjusted System Mix (lbs / MWh) (12-month vintage)	Difference (lbs / MWh) (12-month vintage)	% Difference (12-month vintage)
SRVC	100,845,600	323,748,776	622.987		3138318	629.084906	6.098	0.98%

The Adjusted System Mix Factor = 629.084906 lbs CO2e / MWh

(Note: this emissions factor is higher than the eGRID value for the subregion. The Green-e certified renewables purchased/used in this region have been removed from the mix, resulting in a higher emissions factor).

d. Calculate the emissions from the 800 MWh of standard electricity purchased:

800 MWh x 629.084906 lbs CO2e/MWh = **503,267.93 lbs CO2e/MWh**

e. Convert into metric tons of CO2e (or your relevant reporting value)

503,267.93 lbs CO2e / (2,204.62 lbs/metric ton) = **228.3 metric tons CO2**

f. Add the emissions from the two sources for the total overall Scope 2 Emissions

Total = Emissions from **renewable sources** + emissions from **adjusted electricity mix**

0 metric tons CO2 + 228.3 metric tons CO2 = 228.3 metric tons CO2

3. Example of a Market-Based Calculation with No Renewables- Below is the market-based calculation if the NC manufacturer did **not** purchase any renewable energy in 2024.

a. RECs Purchased: **0 MWh,** so 0 emissions from renewables

b. Electrical Grid Purchase: 1,000,000 kWh x 0.001 MWh/kWh = **1,000 MWh**

c. Calculation of emissions, using the region-specific (SRVC) Residual Mix Emission Factor for SRVC subregion, from the Green-e Table;

Adjusted System Residual Mix Factor: 629.084906 lbs CO2e/MWh
Emissions: 1,000 MWh x 629.084906 lbs CO2e/MWh = **629,085 lbs CO2e**

d. Convert into metric tons of CO2e (or your relevant reporting value)
629,085 lbs CO2e / (2,204.62 lbs/metric ton = **285.3 metric tons CO2**

Summary

As shown below, the comparison between the Location-Based and Market-Based methods demonstrates how purchasing 20% of electricity from certified renewable sources can significantly lower the Scope 2 emissions calculated for the manufacturing plant.

However, if the company does not purchase any renewable energy attributes, the Market-Based calculation will result in higher Scope 2 emissions. This is because the Market-Based method uses a higher residual mix factor for electricity, which excludes the renewable energy attributes that have been purchased in this region.

Calculation Method	Scope 2 Emissions for 2024 Electricity Use (metric tons of CO2e)
Location-Based	270.5
Market-Based with 200MWh of Renewables	228.3
Market-Based with No Renewables	285.3

*all calculations assume 1000 MWh total electricity use for 2024

Resources

GHG Protocol Scope 2 Guidance: https://ghgprotocol.org/scope_2_guidance

GHG Protocol Scope 2 Training and Slides Part 1, Part 2, and Recorded Webinar

Note: Free to access however registration/purchase is required if interested to receive a formal certificate of completion

US EPA eGRID Emission Factors: https://www.epa.gov/egrid

US EPA eGRID Summary page: https://www.epa.gov/egrid/summary-data

US EPA Power Profiler https://www.epa.gov/egrid/power-profiler#/ Includes maps of the power regions and subregions, as well as average usage data; driven by the 2023 eGRID data.

US EPA GHG Inventory Guidance: https://www.epa.gov/climateleadership/scope-1-and-scope-2-inventory-guidance

US EPA Greenhouse Gas Inventory Guidance Indirect Emissions from Purchased Electricity https://www.epa.gov/sites/default/files/2020-12/documents/electricityemissions.pdf

US EPA Offsets and RECs: What's the Difference? https://www.epa.gov/sites/default/files/2018-03/documents/gpp_guide_recs_offsets.pdf

Green-E Residual Mix Emissions Rate Tables: **https://www.green-e.org/residual-mix**

About This Resource: This document is produced by Waste Reduction Partners, a program of Land of Sky Regional Council under contract by the U.S. Department of Environmental Protection Agency. Any opinion, findings, or recommendations expressed herein are those of the author(s), and do not necessarily reflect the views of the U.S. EPA. Online version: wastereductionpartners.org — June 2025

Scope 3 Emissions: Overview and Considerations

This resource introduces Scope 3 emissions, which are the indirect value chain emissions that occur due to a company's upstream and downstream activities. Several practical considerations are outlined that could be integrated into a current greenhouse gas (GHG) accounting system, focusing on Scope 1 (direct) and Scope 2 (indirect) emissions, in preparation for a future need to include Scope 3 emissions. Establishing good management practices and system design early can facilitate compliance later.

Scope 3 Emissions

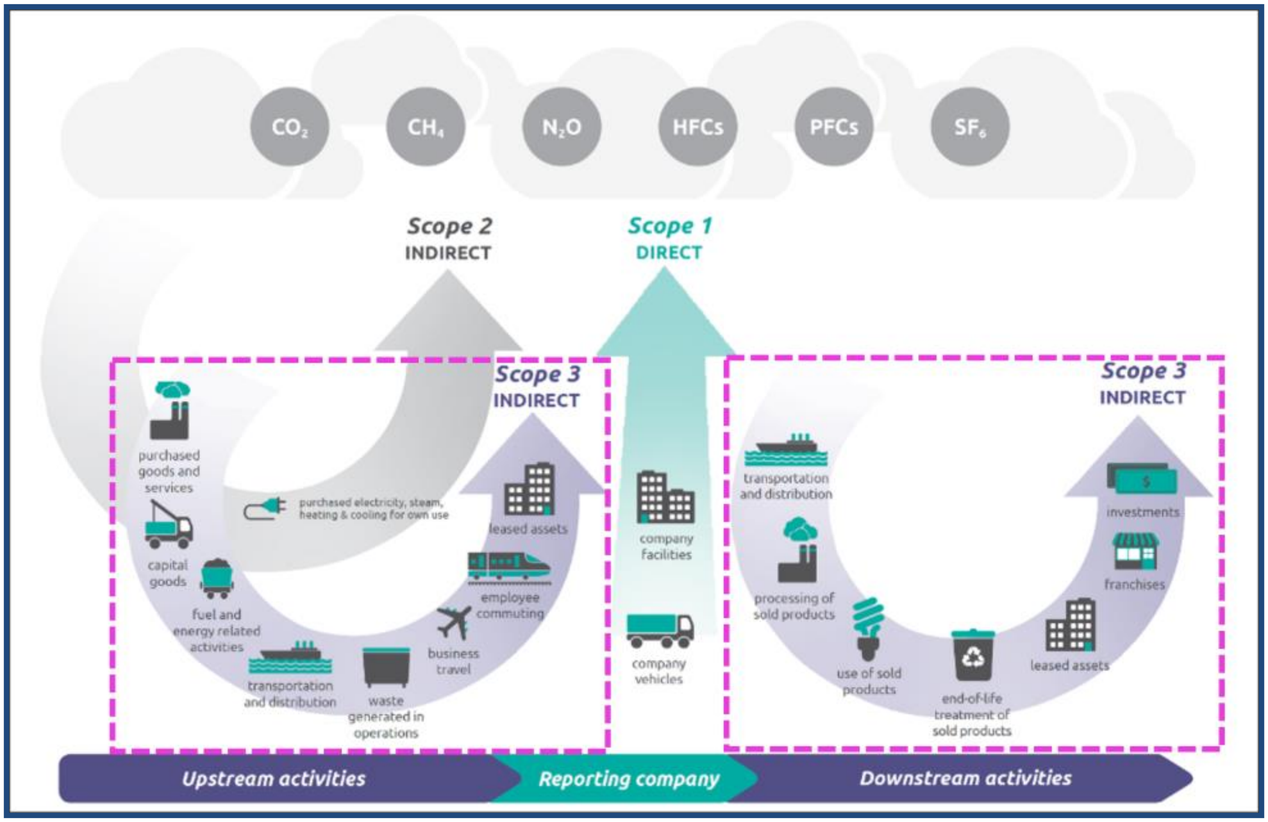


Image modified from GHG Protocol Scope 3 Standard: Overview of GHG Protocol scopes and emissions across the value chain.

Emission sources are classified based on whether they originate from direct or indirect sources. This increases transparency and enables the business to minimize double counting (internally and among companies). This framework organizes emissions in a way that also facilitates better management to attain business and climate policy goals.

Scope 3 or 'value chain' emissions are the indirect GHG emissions that occur because of business activities, from sources a company does not own or control. According to the GHG Protocol Corporate Standard (p. 25), these comprise all other indirect emissions occurring both upstream and downstream including the extraction and production of purchased materials, transportation of purchased fuels, use of sold products and services, and end of life disposal.

Scope 3 Emissions Categories

The GHG Protocol categorizes Scope 3 emissions into 15 distinct categories for both Upstream and Downstream Activities:

Upstream Activities:

1. **Purchased goods and services**
2. **Capital goods**
3. **Fuel and energy-related activ-ties (not included in Scope 1 or 2)**
4. **Upstream transportation and distribution**
5. **Waste generated in operations**
6. **Business travel**
7. **Employee commuting**
8. **Upstream leased assets**

Downstream Activities:

1. **Downstream transportation and distribution**
2. **Processing of sold products**
3. **Use of sold products**
4. **End-of-life treatment of products sold**
5. **Downstream leased assets**
6. **Franchises**
7. **Investments**

Within the GHG Protocol's Corporate Standard, Scope 3 emissions accounting is considered optional, allowing companies flexibility to choose which Scope 3 activities, if any, to include. However, the GHG Protocol also maintains a *separate* Scope 3 Standard; organizations that aspire to meet the Scope 3 Standard must complete accounting across all 15 categories. The Scope 3 Standard is beyond the scope of this guidance document, but interested parties are encouraged to review the GHG Protocol resources.

For organizations currently focused on Scope 1 and Scope 2 emissions, an initial step they can take is to conduct a comprehensive mapping of their value chain to determine the relevance of the 15 Scope 3 categories. Determining relevance is an active conversation with leadership and across the organization, based on factors such as; **Size, Influence, Risk, Stakeholders, Outsourcing, and, Sector guidance.**

The EPA's Scope 3 Inventory Guidance reports supply chain emissions, "are, on average, 11.4 times higher than operational emissions, which equates to approximately 92% of an organization's total GHG emissions," citing CDP (formerly Carbon Disclosure Project) data. Similarly, the private sector consultancy McKinsey estimates that Scope 3 emissions typically account for 90% of total emissions, with the majority coming from the purchase of inputs for production processes. There is clear value in identifying Scope 3 contributions to facilitate future management and reduction of these emissions.

Key Scope 3 Drivers

Even if the current focus may be on Scope 1 and 2 emissions, there are several reasons to incorporate Scope 3 considerations into the design of a GHG accounting system.

Regulatory: Recent regulations, including those in the European Union and California, may require Scope 3 reporting for companies of a certain size or with significant exports to, or sales in, these markets. Firms should work with legal and regulatory colleagues to determine if they are subject to these new policies.

Stakeholder: Investors, customers, end-consumers, and other stakeholders increasingly expect companies to understand and manage their complete carbon footprint, including Scope 3 emissions.

System Efficiency: Building a GHG accounting system with Scope 3 in mind from the beginning is more cost-effective than modifying existing systems later. The exercise of mapping purchased goods and services, for example, can identify potential outliers in terms of distance, freight mode, and cost; or potential single points of failure that can both identify potential savings and risk reductions.

Competitive Advantage: Companies with comprehensive GHG inventories are better positioned to identify emissions reduction opportunities, improve product design, and respond to customer requests for product carbon footprints. They can also illustrate how reduction efforts enable customers to achieve their own public Scope 3 commitments.

Supply Chain Readiness: As larger companies begin tracking their Scope 3 emissions, they will increasingly request emissions data from their suppliers; your Scope 3 emissions may be included.

Green Target-Setting: For a company or organization that is focused on reaching a GHG reduction target, they will likely need to include Scope 3 accounting and strategies to reduce those emissions.

The Science-Based Target Initiative is considered the leading corporate climate action body, developing standards, tools, and guidance that enable companies to set GHG emissions reduction targets across various sectors. SBTI aligns with the global 1.5°C temperature rise and 2050 net-zero ambitions, as outlined in the Paris Climate Accord. SBTI requires a Scope 3 target (and verified accounting) under its 2050 Net-Zero standard. SBTI also requires a Scope 3 reduction target when setting near-term emissions reduction targets "if a company's Scope 3 emissions are 40% or more of total Scope 1, 2, and 3 emissions (i.e., the vast majority of companies)" (SBTI, 2023).

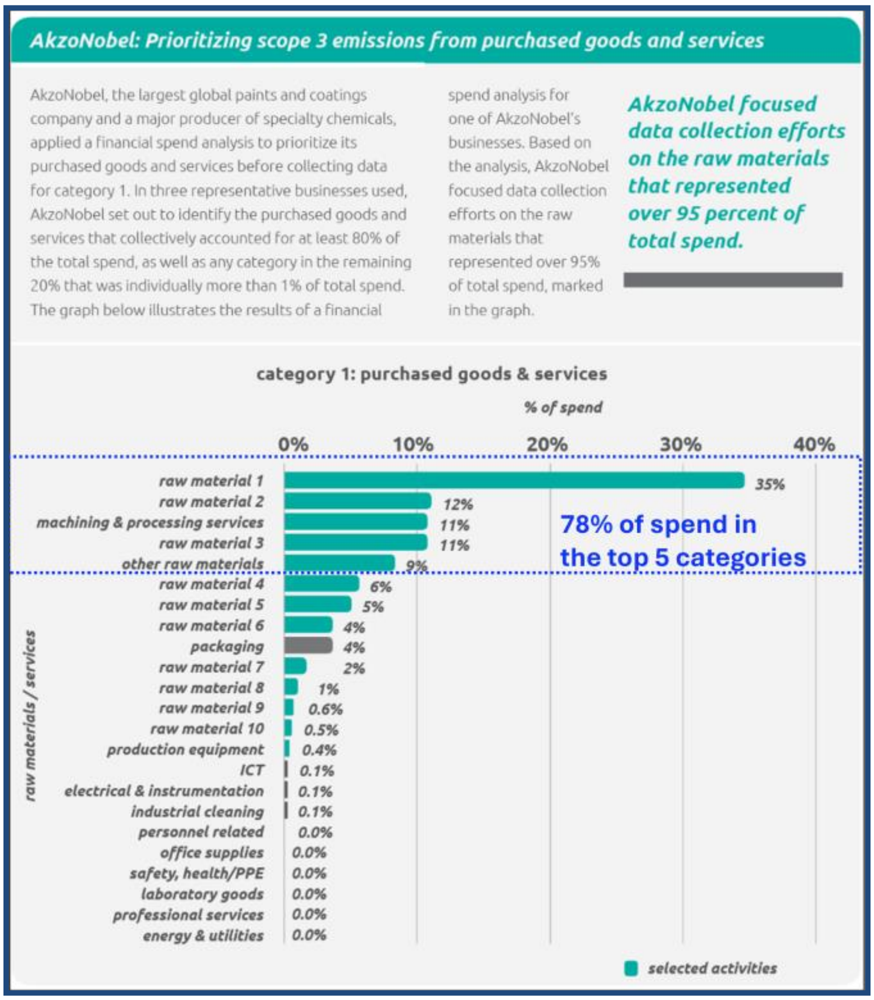
Practical Guidance: Where to Begin

In GHG accounting, the Pareto Principle, commonly referred to as the 80-20 rule, can often be applied. The rule suggests roughly 80% of outcomes or effects come from 20% of causes. With a focus on high-impact areas, businesses can allocate resources to initiatives that will yield the most outstanding results. For example, it may be that 20% of the highest-value customers generate 80% of revenue, or that 20% of suppliers are responsible for 80% of total material costs.

Applying the 80-20 rule to Scope 3 emissions can determine if a few specific sources account for most of a company's value chain emissions; once identified, it may be possible to significantly reduce these emissions with targeted (and less) investment. It may be that a few purchased materials are driving an outsized scope 3 emissions impact.

Example: A company could conduct a spend-based screening assessment to identify the highest-impact suppliers and materials; data collection and calculations can then be refined for these priority areas. More generalized methods could still be used for less significant categories. This approach may be helpful when resources are limited and/or it is challenging to obtain data on supplier and customer usage.

The GHG Protocol's own Scope 3 Standard provides a detailed illustration of a spend analysis conducted by the company AkzoNobel:



Base image from: HG Protocol. Corporate Value Chain (Scope 3) Accounting and Reporting Standard p.69

Other Practical Considerations for Scope 3 Readiness

1. Data Collection and Supplier Engagement – When designing data collection systems for Scope 1 and 2 emissions, include the capability to collect data that can support Scope 3 calculations. There are various methods for calculating Scope 3 emissions, and multiple methods may be used when calculating a Scope 3 category, depending on the availability and accuracy of the activity data. Please see GHG Protocol's Scope 3 Calculation Guidance, which details the various calculation methods and provides examples.

- Near-Term Recommendation – Undertake a relevance assessment to identify the Scope 3 activity categories most relevant to your business. Determine the type of data available for these categories (if any) and create a plan to enhance data tracking over time.

⇒ **Example:** A craft brewery has determined that Scope 3, Category 1 Purchased Goods and Services is a material category. It spends $10 million on barley but just $1 million on yeast. The brewery might engage its largest barley supplier(s) to obtain/pursue a supplier-specific emission factor based on actual activity data and insight, but continue to use secondary (e.g., industry-level) emissions factors for smaller yeast input.

- Near-Term Recommendation – Implement a new policy to document the mass of purchased inputs in (i.e., weight/kg) rather than simply financial and cost terms.

⇒ **Example**: WRP has found among its clients that enterprise resource planning (ERP) software systems are often set up to integrate the data ***only if*** the client has a policy in place to record this information upon receipt of shipment. This data would support some Scope 3 emissions calculations and could guide future emission reduction efforts.

- Future Recommendation – Evaluate how your firm's ERP and other business systems can support Scope 3 data collection and analysis.

- Future Recommendation – If you believe your firm has leverage, identify opportunities to collect emissions data from major suppliers (e.g., your 80/20 pool) and begin a conversation including data disclosure and/or reduction requirements.

2. Organizational Boundaries & Inventory Scope – Your organizational boundary determines where your direct emissions accounting and responsibility end (Scopes 1 & 2) and where value chain emissions accounting and responsibility begin (Scope 3).

- Near-Term Recommendation – When defining organizational boundaries for Scope 1 and 2 emissions, consider how these same boundaries would apply to Scope 3.
- Near-term Recommendation – Conduct value-chain mapping to identify major Scope 3 emissions sources that will need to be quantified in the future.

3. Calculation Methodologies and Emissions Factors – It is important to think about your methodology choices early for converting business activity and operational data into GHG emissions calculations, even if focused only on Scopes 1 and 2 emissions accounting.

- Near-Term Recommendation – When selecting emissions factors and methodologies for Scope 1 and 2 calculations, consider if these sources also provide emissions factors for Scope 3. Maintaining consistency among data across all scopes helps ensure alignment and can save time/increase efficiency when expanding to Scope 3.
- Near-Term Recommendation – Clearly document calculation methodologies to ensure consistency when expanded to include Scope 3. State formulas used, assumptions made, data sources, and include any uncertainties or custom calculations.
- Near-Term Recommendation – Create a management plan to track and update emissions factors that can later be scaled to include Scope 3 factors. The organization can create a database of emissions factors and develop a system for reviewing and updating it.
- Forward Looking – Become certified in the GHG protocol's corporate and scope 3 standards. At a minimum, relevant colleagues should become familiar with Scope 3 calculation methodologies. Depending on your goals, online training platforms exist for specific certificates of completion (e.g., GHG Protocol) or practical competency.

  The GHG Protocol offers webinar training modules and certificates for both its Corporate Standard and Scope 3 Corporate Value Chain Standard. The Corporate Standard online course can be taken at no cost, or for a fee if a certificate of completion is desired. The Corporate Value Chain (Scope 3) online course is paid-only. (Discounts exist for governments, NGOs, non-profits, universities, and student registrants.)

  Numerous free online webinars are available from reputable global organizations.

4. **Data Verification and Quality Control** – Data verification and quality control are critical to sound GHG accounting. Building a robust quality control system early on when implementing Scopes 1 and 2 emissions accounting can create a framework to address the more challenging Scope 3 data collection efforts.

- Near-Term Recommendation – Extend Scope 1 and 2 accounting practices to Scope 3 emissions; examples include

  Range checks - is the parameter within expected values?
  Consistency checks – for example reviewing reported units (kWh, MWh) etc.
  Year-over-year comparisons to identify any marked changes
  Data and calculation audits
  Output validation - benchmarking findings to industry average or intensity metrics

- Future Recommendation – Consider external, third-party verification requirements that may apply to future Scope 3 reporting, and determine what level of data assurance is required.

⇒ **Example:** A manufacturing subsidiary of a large corporate firm may already have policy and procedural guidance and/or requirements that cover the general use of 3rd party auditors in other areas

⇒ **Example:** A small private firm might conduct an external gap analysis to identify areas for improvement or verify readiness in preparation for a formal audit or certification.

Conclusion

While establishing your first GHG inventory for Scope 1 and 2 emissions may seem challenging enough, incorporating Scope 3 considerations from the beginning can yield significant benefit today and in the future. By designing systems and management and data collection processes with your firm's full spectrum of emissions in mind, the firm is better positioned to develop a robust GHG accounting framework.
The 80-20 rule provides a practical framework for approaching the complexity of Scope 3 emissions. By identifying and focusing on the most significant inputs and emissions sources first, your firm can make meaningful progress without the overwhelming scale of a full Scope 3 emissions accounting effort. Similarly, strategically prioritizing key inputs and emissions areas can lead to better resource allocation and management effort to obtain reductions over time.

By taking a proactive approach to Scope 3 emissions now, you can position your organization for success with both your suppliers and customers in an increasingly carbon-constrained business environment.

Numerous technical and implementation resources and supports exist for firms in their GHG emissions/carbon accounting journey.

GHG Protocol – The GHG Protocol offers multiple, free resources including:

The GHG Corporate and Accounting Protocol (revised)
The GHG Protocol Corporate Value Chain (Scope 3) Accounting and Reporting Standard
Calculation tools and guidance

Cross-sector information

Sector specific guidance

Country specific guidance

Training webinars (some with optional certifications)

US EPA

US EPA Scope 3 Inventory Guidance – EPA maintains a resource center focused on Scope 3 including practical calculation and supply chain guidance, as well as emissions factors and other relevant resources

EPA GHG emissions factors hub (updated regularly);

US Environmentally-Extended Input-Output or "USEEIO"

SBTI

Science Based Targets Initiative - Scope 3 Guidance

SBTI sector-specific guidance

New guidance is in development for the automotive sector and apparel industry

About This Resource: This document is produced by Waste Reduction Partners, a program of Land of Sky Regional Council under contract by the U.S. Department of Environmental Protection Agency. Any opinion, findings, or recommendations expressed herein are those of the author(s), and do not necessarily reflect the views of the U.S. EPA. Online version: wastereductionpartners.org — June 2025

GHG Reporting-General & Sector-Specific Resources

CARBON ACCOUNTING TOOLKIT

General Resources

GHG Protocol – The GHG Protocol offers multiple, free resources, including:

The GHG Corporate and Accounting Protocol (revised)
GHG Protocol, Scope 2 Guidance
The GHG Protocol Corporate Value Chain (Scope 3) Accounting and Reporting Standard

Calculation tools and guidance, Cross-sector information, Sector-specific guidance

Training webinars (some with optional certifications)

US EPA -Scopes 1, 2, and 3 Emissions Inventorying and Guidance includes many detailed resources for GHG accounting, as well as a series of past webinars.

U.S. EPA Simplified Guide to Greenhouse Gas Management for Organizations Overview on developing a GHG inventory, intended for small businesses and low emitters.
EPA GHG emissions factors hub (updated regularly)

EPA's Simplified Emissions Calculator

Automotive, Food, Beverage, and Textile Industries

SBTI Science Based Targets Initiative Scope 3 Guidance

SBTI sector-specific guidance

New guidance is in development for the automotive sector and the apparel industry

Other

UNFCC Emissions Calculator

U.S Congressional Budget Office.

2024. Emissions of Greenhouse Gases in the Manufacturing Sector.

https://www.cbo.gov/publication/60030

Automotive, Food, Beverage, and Textile Industries

Sector Specific Resources

Note: some resources may require membership or have associated costs

Automotive

Automotive Industry Action Group (AIAG)

AIAG GHG Reporting Page

Some resources require a membership; includes links to webinars (many are free, recommend searching for "greenhouse" or "carbon"). Also has information on organizations that request automotive industry GHG reporting. Members likely have access to additional resources.

Science Based Targets (SBTi)

New guidance is in development for the automotive sector

Textile (and Garment) Industry

Science Based Targets (SBTi)

WRI Science Based Targets (SBTi) sector guidance, Apparel and Footwear

United Nations Climate Change, Sustainable Apparel Coalition
Guidance for Measuring Greenhouse Gas Emissions for Purchased Goods and Services for the Apparel and Footwear Industry

International Labour Organization Working Paper
Measuring carbon emissions in the garment sector in Asia (freely available)
Detailed publication, examines carbon emissions across the garment sector using the life cycle assessment (LCA) approach as well as methods outlined in the Greenhouse Gas Protocol. The most significant emissions were found to occur during yarn and fabric production. Global, but some findings relevant to many NC industries.

PERSEFONI is a GHG accounting software tool, which includes a free version. Site includes a written case study of an emissions profile for the apparel industry, outlining the key GHG sources.

Sector Specific Resources

Note: some resources may require membership or have associated costs

Food and Beverage

Beverage Industry Environmental Roundtable https://www.bieroundtable.com/work/energy-climate/

Many resources available at no cost, does require sign up to download. Publications include:

Beverage Industry Sector Guidance for Greenhouse Gas Emissions Reporting

In-depth carbon footprint research on various beverage categories including beer, bottled water, carbonated soft drinks, spirits, and wine.

Facility Decarbonization Playbook
Water, Energy, and Greenhouse Gas Emissions Benchmarking studies

Brewers Association

Energy Sustainability Manual. Publication for Small and Independent Craft Brewers. https://www.brewersassociation.org/educational-publications/energy-sustainability-manual/ (membership required)

Renewable Thermal Collaborative and World Wildlife Federation. 2023.

Playbook for Decarbonizing Process Heat in the Food & Beverage Sector. https://www.renewablethermal.org/wp-content/uploads/2018/06/WWF-RTC-Playbook-for-Decarbonizing-Process-Heat_FoodBev_Final.pdf

USDA

Greenhouse Gas Inventory and Assessment Program includes several free resources including methods and tools for farmers and ranchers to assess the GHG footprint of their operations.

PERSEFONI is a GHG accounting software tool, which includes a free version. Site includes a written case study of an emissions profile for the food and beverage industry, outlining the key GHG sources.

Research papers:

Alexander Damkær Hansen, Takeshi Kuramochi, Birka Wicke. 2022. The status of corporate greenhouse gas emissions reporting in the food sector: An evaluation of food and beverage manufacturers. Journal of Cleaner Production, Volume 361 (free, open access). https://www.sciencedirect.com/science/article/pii/S0959652622018832?via%3Dihub

Reavis, Megan, Ahlen, Jenny, Rudek, Joe, and Naithani, Kusum. *Evaluating Greenhouse Gas Emissions and Climate Mitigation Goals of the Global Food and Beverage Sector*. *Frontiers in Sustainable Food Systems*. Authors examined the GHG emissions reporting practices and climate goals of the top 100 global food and beverage companies (as ranked by Food Engineering). (open access, free publication) https://par.nsf.gov/servlets/purl/10352666

About This Resource: This document is produced by Waste Reduction Partners, a program of Land of Sky Regional Council under contract by the U.S. Department of Environmental Protection Agency. Any opinion, findings, or recommendations expressed herein are those of the author(s), and do not necessarily reflect the views of the U.S. EPA. Online version: wastereductionpartners.org — June 2025