



# Greenhouse Gas Emission Inventories

## What Is a Greenhouse Gas Inventory?

A greenhouse gas (GHG) inventory is an accounting of the amounts and sources of GHG emissions from the existence and operations of a business or organization. Inventories are typically completed every year and begin with the baseline year, which can be the current year or can date back as far as data is available (unless federal rules exist requiring a specific date).

## Why Conduct a GHG Inventory?

It is difficult to manage what you do not measure. A GHG inventory is a way to measure things you might want to manage in the future. Additionally, the completion of an inventory provides an essential foundation for understanding the following:

- How much a business or organization indirectly and directly contributes to climate change relative to similar operations
- Trends over time of energy use in the forms of electricity, natural gas, and fuel
- Costs associated with energy, raw materials, waste disposal, and opportunities for savings through efficiency and waste prevention
- Progress made over time as a result of efficiency and waste prevention initiatives

## Greenhouse Gas Emission Sources and Scopes

Depending on the level of detail required or wanted in a GHG inventory, a business or organization can include three levels or scopes consisting of direct and indirect sources of emissions.

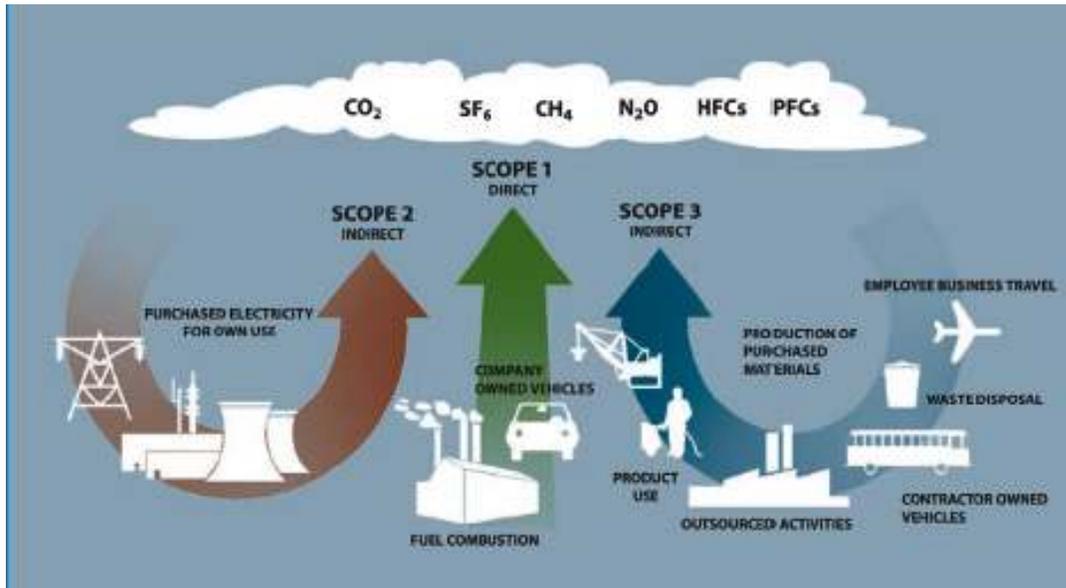
**Scope 1** emissions are direct emissions such as those from on-site combustion and fuel consumed in facility-owned fleets and equipment. Scope 1 emissions can be subdivided into the following four categories:

1. *Stationary combustion* to produce electricity, steam, heat or power using equipment in a fixed location.
2. *Mobile combustion* of fuels in transportation sources (e.g., cars, trucks, marine vessels and planes) and emissions from non-road equipment used in construction, agriculture, and forestry.
3. *Physical and chemical processes* other than fuel combustion (e.g., for the manufacturing of cement, aluminum, adipic acid, ammonia, etc.).
4. *Fugitive sources* are unintentional releases from the production, processing, transmission, storage, and use of fuels and other substances that do not pass through a stack, chimney, vent, exhaust pipe or other functionally-equivalent opening (such as releases of sulfur hexafluoride from electrical equipment; hydrofluorocarbon releases during the use of refrigeration and air conditioning equipment; and methane leakage from natural gas transport).<sup>1</sup>

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<sup>1</sup> Source: Climate Registry

Scope 1 emissions should be calculated based on the purchased quantities of commercial fuels (such as natural gas, gasoline, and heating oil) multiplied by relevant published emissions factors.<sup>2</sup>



Source: <http://www.yale.edu/sustainability/images/emissions.jpg>

**Scope 2** emissions are indirect emissions from the consumption of purchased or acquired electricity. Scope 2 emissions are a consequence of activities that take place within the organizational boundaries of the reporting entity, but that occur at sources owned or controlled by another entity<sup>3</sup>. For example, electricity consumption has no emissions associated with the point of use, but the emissions occur at the facility where the electricity is generated. Therefore, electricity is typically included in inventories because it is something businesses or organizations have the most control over and, as a result, want to know what those emissions are. Scope 2 emissions should typically be calculated from metered electricity multiplied by relevant published emissions factors associated with the power generation method (i.e., coal, oil, etc.).

**Scope 3** emissions include all other emissions not covered in Scope 2, such as emissions from the extraction and production of purchased materials and fuels, emissions from the transportation of purchased materials or goods, transport related activities in vehicles not owned or controlled by the reporting entity (e.g., employee commuting and business travel), use of sold products and services, outsourced activities, recycling of used products, waste disposal, etc. Scope 3 emissions should be calculated from activity factors such as passenger miles and published or third-party emissions factors. Scope emissions can be calculated from vehicle miles traveled, purchasing and sales records, waste and recycling invoices, etc. multiplied by relevant published emissions factors.<sup>4</sup>

Most GHG inventories contain scopes one and two. Adding scope three allows for a more holistic view of a business or organization's true emissions; however, it can be challenging to accurately quantify emissions from a source such as "production of purchased materials." Additionally, the issue of double-counting comes up when quantifying variables such as "production of purchased materials" or

<sup>2</sup> Source: U.S. Environmental Protection Agency

<sup>3</sup> Source: Climate Registry

<sup>4</sup> Source: U.S. Environmental Protection Agency

“employee business travel” as theoretically the company producing the materials and the airline or bus transporting employees will be quantifying the very same emissions in its inventory. An option to address this is to create a separate inventory for each scope so no emissions are ignored, but do not skew results. Working with your supply chain to determine a methodology for avoiding double-counting is also an option to address scope three emissions such as “production of purchased materials, product use, or contractor-owned vehicles.”

Completing a greenhouse gas inventory now can also help prepare for future federal reporting or cap and trade regulations without any time restrictions and plenty of time to begin making reductions if desired. GHG emissions inventories and associated actions are also appealing to the public and customers and can promote a positive public perception and improve marketing. Some corporations are beginning to put pressure on their supply chains to inventory GHG emissions and improve efficiency; doing so ahead of the crowd can create a competitive advantage.

## How to Calculate GHG Emissions

To calculate GHG emissions, parameters must be set to define the locations or facilities and scopes included and the baseline year, which can be the current year or can date back as far as data is available (unless federal rules exist requiring a specific date). Next, data must be collected from sources of scopes one, two or three emissions (see “What Is a Greenhouse Gas Inventory” section for detailed description of each scope) depending on which scopes were chosen to include in the inventory.

Possible sources for data include accounting, fleet management, or facility/property management systems, utility bills, travel logs, waste and recycling invoices, gas cards, employee credit cards, or acquisition reports. Data should reflect one year’s consumption levels, either calendar or fiscal. Ideally inventories should be completed and reported at the highest organizational level, but each company or business needs to determine what is possible for them.



Once the necessary data is collected, three primary options for calculating GHG emissions are:

1. **Direct Monitoring** – Direct monitoring involves monitoring exhaust stream contents in the form of continuous emissions monitoring (CEM) or periodic sampling. However, direct monitoring can prove expensive or be unavailable.
2. **Emissions Factors** – A common approach for calculating GHG emissions is through the application of documented emission factors. Emission factors are average emission rates that relate the quantity of a pollutant released to the atmosphere to a specific activity or source of pollution using units of available activity data (e.g., tons of fuel consumed, tons of product produced, vehicle miles travelled). In most cases, these factors are simply averages of all available data of an acceptable quality and are generally assumed to be representative of long-term averages. Some emission factors are more accurate than others, and some do not exist for certain activities or may not fit the activity you are looking for perfectly. So remain flexible when searching for emission factors, look for the best fit, and note the discrepancy.

There is no one-stop shop for emission factors, but there several resources are available including:

- **The Intergovernmental Panel on Climate Change Emission Factor Database (EFDB)**  
[www.ipcc-nggip.iges.or.jp/EFDB/main.php](http://www.ipcc-nggip.iges.or.jp/EFDB/main.php)

EFDB is meant to be a recognized library where users can find emission factors and other parameters with background documentation or technical references that can be used for estimating greenhouse gas emissions and removals.

— **Climate Registry General Reporting Protocol**

[www.theclimateregistry.org/resources/protocols/general-reporting-protocol/](http://www.theclimateregistry.org/resources/protocols/general-reporting-protocol/)

The General Reporting Protocol (GRP) outlines the policies of The Climate Registry and required reporting calculation methodologies for the majority of greenhouse gas (GHG) sources.

— **Web FIRE**

<http://cfpub.epa.gov/oarweb/index.cfm?action=fire.main>

The FIRE (Factor Information REtrieval System) application web site provides fast and complete access to the EPA's air emissions factors information.

— **AP 42**

[www.epa.gov/ttn/chief/ap42/index.html](http://www.epa.gov/ttn/chief/ap42/index.html)

AP 42 provides a compilation of air pollutant emission factors for stationary point and area sources.

— **MOBILE Model**

[www.epa.gov/otaq/m6.htm](http://www.epa.gov/otaq/m6.htm)

MOBILE Model links to information on the MOBILE vehicle emission factor model, which is a software tool for predicting gram per mile emissions of hydrocarbons, carbon monoxide, oxides of nitrogen, carbon dioxide, particulate matter, and toxics from cars, trucks, and motorcycles under various conditions.

— **NONROAD Model**

[www.epa.gov/otaq/nonrdmdl.htm](http://www.epa.gov/otaq/nonrdmdl.htm)

NONROAD Model links to information on the NONROAD emission inventory model, which is a software tool for predicting emissions of hydrocarbons, carbon monoxide, oxides of nitrogen, particulate matter, and sulfur dioxides from small and large nonroad vehicles, equipment, and engines.

3. **Tools or Modules** – Depending on the detail of your inventory, a variety of free tools or modules are available that will calculate emissions for you or provide methodology and emission factors depending on the sector or activity.

— **Greenhouse Gas Protocol Tools**

[www.ghgprotocol.org/calculation-tools/all-tools](http://www.ghgprotocol.org/calculation-tools/all-tools)

— **EPA Climate Leaders**

- Design principles guidance includes overall guidance on defining inventory boundaries, identifying greenhouse gas (GHG) emission sources, and defining and adjusting a base year. [www.epa.gov/stateply/resources/design-principles.html](http://www.epa.gov/stateply/resources/design-principles.html)
- Cross-sector guidance can be applied to many different sectors: stationary combustion, indirect electricity, mobile combustion, and HFC use in refrigeration and air-conditioning. [www.epa.gov/stateply/resources/cross-sector.html](http://www.epa.gov/stateply/resources/cross-sector.html)
- Sector-specific guidance, covers such industries as aluminum, iron and steel, cement, etc. [www.epa.gov/stateply/resources/sector-specific.html](http://www.epa.gov/stateply/resources/sector-specific.html)
- Option modules guidance includes optional emissions sources in which businesses or organizations have some control such as employee commutes. Emissions reductions from

offset investments and renewable energy purchases can also be calculated for goal-tracking purposes. [www.epa.gov/stateply/resources/optional-module.html](http://www.epa.gov/stateply/resources/optional-module.html)

- **Small Businesses and Low Emitters Tools** - Examples of low emitting businesses may include a service-industry company with 1,000 branch offices, a company with one small manufacturing plant, an owner of a single office building, a company that leases office space, or a branch of state or federal government.  
[www.epa.gov/stateply/resources/lowemitters.html#tools](http://www.epa.gov/stateply/resources/lowemitters.html#tools)

#### — **Other Greenhouse Gas Calculators**

*The Idaho Department of Environmental Quality is providing this list of calculators as a public service only, and does not certify or recommend any calculators on this list. Thoroughly research a calculator's methodology and accuracy before using it.*

- The Nature Conservancy Carbon Calculator  
[www.nature.org/initiatives/climatechange/calculator/](http://www.nature.org/initiatives/climatechange/calculator/)
- American Forests Calculator  
[www.americanforests.org/resources/ccc/index.php](http://www.americanforests.org/resources/ccc/index.php)
- Environmental Defense Fund Fleet Calculator  
<http://innovation.edf.org/page.cfm?tagID=37020>
- Environmental Defense Fund Paper Calculator  
[www.edf.org/papercalculator/](http://www.edf.org/papercalculator/)
- Ratcliff GHG Calculator  
[www.ratcliffarch.com/ghgcalc/](http://www.ratcliffarch.com/ghgcalc/)
- terrapass Carbon Balanced Business Calculator  
[www.terrapass.com/business/email.html](http://www.terrapass.com/business/email.html)
- Carbon Fund Business Calculator  
[www.carbonfund.org](http://www.carbonfund.org)

#### — **Related Tools**

- **Durable Goods Calculator (DGC)**

[www.epa.gov/climatechange/nycd/waste/calculators/DGC\\_home.html](http://www.epa.gov/climatechange/nycd/waste/calculators/DGC_home.html)

The DGC was developed for individuals and companies that want to make informed decisions regarding the GHG and energy impacts they will have by disposing of durable household goods; it also calculates the GHG and energy benefits of increasing the recycling rates of goods disposed.

- **NRC Environmental Benefits Calculator**

[www.nrc-recycle.org/theconversionator/shell.html](http://www.nrc-recycle.org/theconversionator/shell.html)

The National Recycling Coalition's Environmental Benefits Calculator helps determine the GHG and energy benefits of current waste disposal practices. Users enter data on the amount of various waste materials they landfill, recycle, and incinerate, and the tool calculates how that waste disposal scenario compares with one in which all waste is landfilled. The tool reports the benefits in terms of GHGs and other air emissions, energy use, quantity of oil and gas consumed, waterborne wastes, and other metrics. Results are also displayed according to economic sector and life-cycle stage, and automatically-generated charts and graphs provide an illustrated view of the results. This versatile tool can be used by businesses, universities, and government agencies and may be useful in demonstrating the benefits of recycling programs.

- **NERC Environmental Benefits Calculator**

[www.nerc.org/topic\\_areas/environmental\\_benefits\\_calculator.html](http://www.nerc.org/topic_areas/environmental_benefits_calculator.html)

The Northeast Recycling Council's Environmental Benefits Calculator is a free tool for states, counties, municipalities, schools, businesses, and institutions to measure the environmental benefits from their recycling efforts. NERC's Calculator measures these benefits in terms of savings in air emissions, energy use, quantity of oil and gas consumed, cars off the road, household energy use, waterborne pollutants, and other metrics. In addition, NERC's calculator measures the energy savings from reusing or recycling computers. NERC also provides fact sheets to use with calculator results for marketing and outreach purposes.

- **ENERGY STAR Portfolio Manager**

[www.energystar.gov/benchmark](http://www.energystar.gov/benchmark)

Portfolio Manager is an interactive energy management tool that tracks and assesses energy and water consumption across an entire portfolio of buildings in a secure online environment. Whether you own, manage, or hold properties for investment, Portfolio Manager can help set investment priorities, identify under-performing buildings, verify efficiency improvements, and receive EPA recognition for superior energy performance.

- **eGRIDweb**

[www.epa.gov/cleanenergy/energy-resources/egrid/index.html](http://www.epa.gov/cleanenergy/energy-resources/egrid/index.html)

The Emissions & Generation Resource Integrated Database is a comprehensive inventory of environmental attributes of electric power systems. The preeminent source of air emissions data for the electric power sector, eGRID is based on available plant-specific data for all U.S. electricity generating plants that provide power to the electric grid and report data to the U.S. government. eGRID integrates many different federal data sources on power plants and power companies from three different federal agencies: EPA, the Energy Information Administration (EIA), and the Federal Energy Regulatory Commission (FERC). Emissions data from EPA are carefully integrated with generation data from EIA to produce useful values like pounds per megawatt-hour (lb/MWh) of emissions, which allows direct comparison of the environmental attributes of electricity generation. eGRID also provides aggregated data by state, U.S. total, company, and three sets of electric grid boundaries.

## Carbon Dioxide Equivalents

A carbon dioxide equivalent is the common metric used to compare various GHG emissions based on their global warming potential (GWP). GWP values allow for a comparison of the impacts of emissions and reductions of different gases. For example, the global warming potential for methane is 21. This means that emissions of one million metric tons of methane are equivalent to emissions of 21 million metric tons of carbon dioxide. Other GHGs may be converted to CO<sub>2</sub>e based on their global warming potential. (See Global Warming Potential Graph.)

## GHG Inventory Tips

- Begin with a base year. It can be the current year or can date back as far as data is available. Baselines create a starting point to look for trends and a benchmark to measure future progress.
- Decide what the physical, organizational, and operational boundaries are going to be. The three scopes graphic can help. Consider not only which direct or indirect emissions to include, but also if you have multiple buildings or fleets in different locations whether each should have its own inventory, if they should be combined, or if possibly you want to do one at a time over a multiple-

year period. Consider also which specific gases should be included and in what unit they will be measured and reported.

- Consider using current accounting systems to track emissions. For example, if electricity and fuel consumption are already tracked, work with the accounting team to link these records with carbon dioxide information.
- If you rent space, reference the example consent form in order to gain access to utility information. Many utilities will only release averages to those who are on the account, so you will need to work with your landlord to request written permission for detailed consumption data.
- Understand that not all data is perfect and assumptions must be made. For example, when determining the kilowatt hours consumed over a year for a space that is shared by two separate entities with only one meter, a reasonable approach is to apply the percentage of square footage used to the total kilowatt hours consumed for the entire building while taking into consideration the occupancy rate and activities of other tenants. Assumptions are okay as long they are documented and remain consistent. Even if your methods are imperfect, keeping the methodology consistent year after year will produce accurate trends.
- Inventories should be verifiable, transparent, and consistent. All assumptions and methodologies should be documented to maintain consistency when personnel turnover occurs.
- Set goals and targets for future reductions. Once the baseline inventory is complete, develop reasonable goals and a timeline for achieving them. Consider drafting an action plan including steps for how goals will be achieved and when. Remember to take small steps so that goals are likely to be achieved, but continue setting additional goals as your business or organization evolves.
- If your business grows or changes production between emissions inventories, compare inventories based on greenhouse gas emissions per unit of production or per customer as two examples.
- Track progress in reducing emissions. GHG emissions inventories are typically completed once a year. Be consistent with inventory timelines.
- Understand that it could take a few years to normalize data for uncharacteristically cold winters or hot summers. Also, when tracking costs take into account rising prices when reporting savings.
- Look for other reports within your industry sector to compare results.
- Consider reporting publicly through a registry or on your Web site.

## **What Do GHG Inventory Results Mean?**

GHG inventory results may seem obscure initially. You may wonder, “Do we release a lot of emissions?” or “What does one metric ton of CO<sub>2</sub>e mean in everyday terms?” To address this, EPA has developed a greenhouse gas equivalency calculator. This equivalency calculator may be useful in communicating your greenhouse gas reduction strategy, reduction targets, or other initiatives aimed at reducing GHG emissions. The calculator can be found at [www.epa.gov/RDEE/energy-resources/calculator.html](http://www.epa.gov/RDEE/energy-resources/calculator.html). Consider also comparing results with like businesses, or if a member of an association, fellow members.

## **What Is the Difference Between an Inventory and a Registry?**

A greenhouse gas inventory is an accounting of emissions sources and sinks (such as forests or oceans which absorb and store more carbon than released), whereas a GHG registry is a collection of

inventories. A registry is used to record emissions and/or emission reductions by the registry's members, each of which submits an inventory. (EPA)

- The Climate Registry  
[www.theclimateregistry.org](http://www.theclimateregistry.org)
- The Carbon Disclosure Project  
[www.cdproject.net/responses/index.asp](http://www.cdproject.net/responses/index.asp)
- The Climate Group  
[www.theclimategroup.org](http://www.theclimategroup.org)
- EPA Climate Leaders  
[www.epa.gov/climateleaders](http://www.epa.gov/climateleaders)

### **Third-Party Verification and Certification**

Consider verifying results with a third party, preferably outside your organization or business unless quality assurance staff is available in-house. Certification can be beneficial to assure that your inventory is high quality, complete, consistent, and transparent. Certification is an important option to consider when deciding on the level of rigor you are trying to achieve and may be required for participation in some GHG registries.<sup>5</sup>

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<sup>5</sup> Source: U.S. Environmental Protection Agency