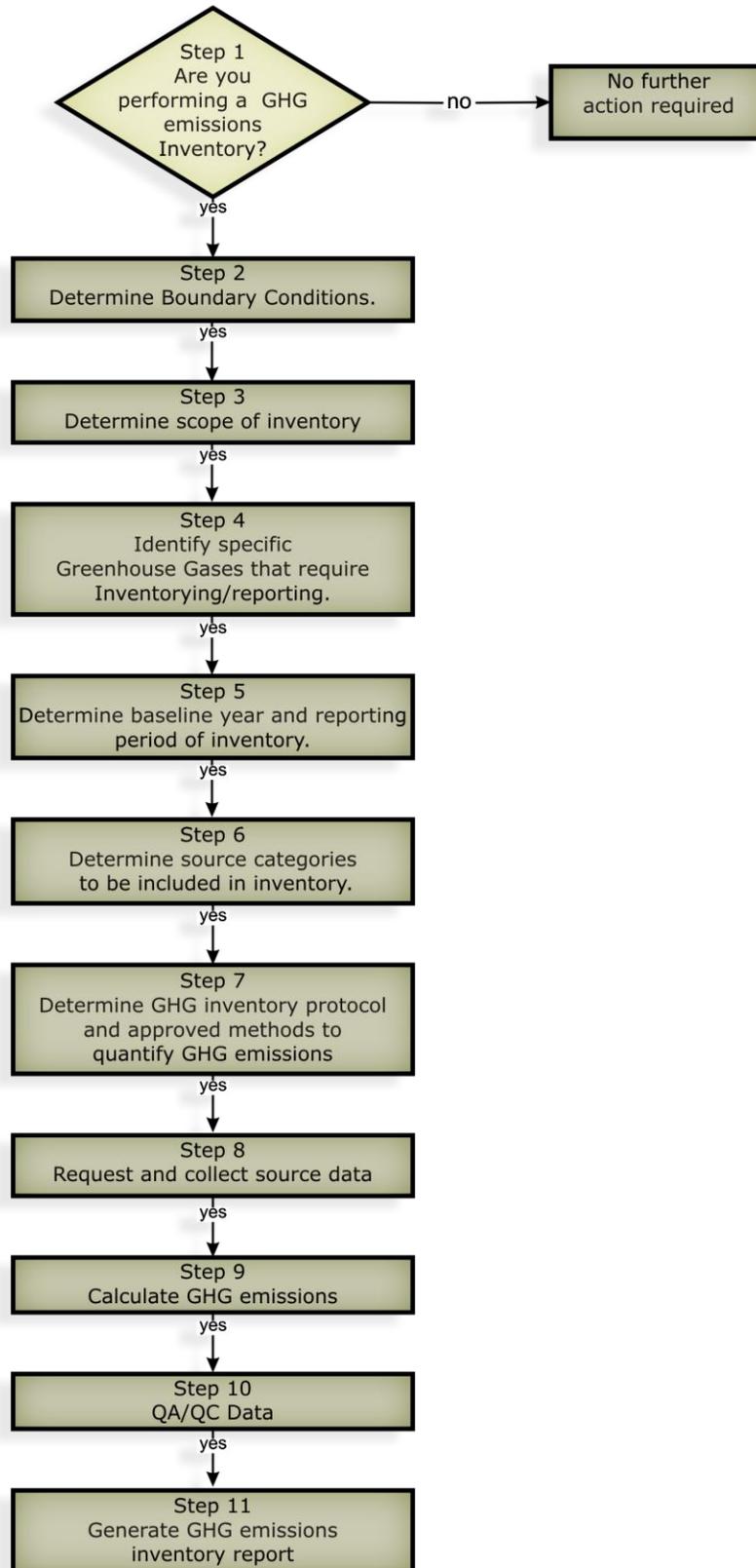


# Process Flowchart for Green House Gas Inventory



# Process Flowchart for Green House Gas Inventory

## Step 1: Are you performing a GHG Inventory?

Gases that trap heat in the atmosphere are often called greenhouse gases. Some greenhouse gases such as carbon dioxide occur naturally and are emitted to the atmosphere through natural processes and human activities. Other greenhouse gases (e.g., fluorinated gases) are created and emitted solely through human activities. The principal greenhouse gases that enter the atmosphere because of human activities are carbon dioxide, methane, nitrous oxide and fluorinated gases.

As the largest energy user in the Federal government, GHG emissions legislation has a potential to have substantial impacts on Air Force activities. Greenhouse gas inventories that include analysis of GHG emissions are critical to the ability of Air Force bases to understand the nature and extent of the specific sources of GHG emissions at an installation. There are several reasons why an Air Force base would quantify its greenhouse gas emissions including: to identify and evaluate the potential missions, energy and environmental impacts that may occur from various legislative or regulatory climate change initiatives; track progress at reducing installation GHG emissions and to set GHG mitigation goals and targets for future reductions; provide information to contribute to the development of Air Force policies on climate change; as well as to address the challenges posed by predicted changes to our environment.

## Step 2: Determine Boundary Conditions

When conducting a GHG emission inventory it is important to clearly define the organizational and operational boundaries of emission inventory. That is, bases need to determine which sources of emissions to include in their report based on their location, organizational structure, and types of operations.

*Organizational boundary* considerations inform decisions on the types of operations, facilities and sources that should be included in the inventory. This includes all GHG emissions associated with the facilities owned and operated by the installation such as infrastructure and support equipment; aircraft, motor vehicles owned by the Air Force, GSA leased vehicles operated by the Air Force and management of solid waste and wastewater generated by the installation.

Important considerations in establishing organizational boundaries include whether the operations/emission sources are wholly controlled by Air Force, are controlled by others but attributable to or influenced by Air Force under agreed upon management structures, or are jointly controlled with other organizations.

*Operational boundary* issues are equally important in establishing an Air Force GHG inventory. They include whether the inventory should be limited to the six traditional GHGs whose reporting is mandatory under most existing GHG reporting programs, or expanded to include emissions of other pollutants with high global warming potential such as Class I or II ODS. In addition, consideration should be given on whether or not to include carbon sequestration initiatives and opportunities in the inventory.

In addition to Air Force owned emissions sources, installations should account for and report emissions from leased facilities and vehicles according to the type of lease associated with the facility or source and the organizational boundary approach selected. Standard GHG reporting protocols require organizations account for and report emissions from a facility or source under a finance or capital lease as if it is an asset wholly owned and controlled by the Air Force, regardless of the organizational boundary approach selected. With respect to facilities or sources under an operating lease (e.g., office space rentals and vehicle leases), the organizational boundary approach selected will determine whether reporting the asset's associated emissions is required or optional according to standard reporting protocols.

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## Step 3: Determine Scope of Inventory

Scope issues are related to the boundary issues discussed above, as well as the availability of data. An example of scope considerations would be whether to use a top-down or bottom-up approach, or a combination of the two, in developing the inventory. A bottom-up approach uses more comprehensive data, representing end use information and provides a more detailed picture. A bottom-up approach should be used for reporting emissions at the installation level. A top-down approach would be practical when conducting an inventory of a high-level Air Force-wide GHG emissions as it uses aggregated data compiled by the Air Force at a headquarters or MAJCOM level to provide a bigger picture view of total emissions.

Also in defining scope an installation will need to determine whether the inventory will capture *direct emissions* as well as *indirect emissions*. To separately account for direct and indirect emissions, they are categorized into “scopes”. Scope 1 are all *direct* GHG emissions (with the exception of direct CO<sub>2</sub> emissions from biomass combustion), Scope 2 are *indirect* GHG emissions associated with the consumption of purchased or acquired electricity, steam, heating, or cooling; and Scope 3 emissions are all other *indirect* emissions not included in Scope 2, such as upstream and downstream emissions, transport related activities in vehicles not owned or controlled by the Air Force, outsourced activities, and recycling of used products, waste disposal, etc.

*Direct emissions* are defined as those resulting from the operation of sources that are owned or controlled by Air Force. They include:

- Emissions from mobile transportation sources;
- Emissions from stationary combustion sources operated by Air Force for the production of electricity or steam for use by Air Force facilities and operations;
- Fugitive emissions that may occur from power or heating, ventilation, and air conditioning (HVAC) system leaks; and
- Carbon emissions associated with current land use management practices and activities (e.g., cultivation and forest management practices).

*Indirect emissions* are those that occur as a result of Air Force operations but are produced by sources owned or controlled by another entity. They may include emissions associated with:

- Consumption of electric energy generated by other entities; and
- Offsite waste disposal of Air Force-generated solid waste.

When establishing the scope and boundary conditions of the GHG inventory, bases should carefully consider the anticipated uses of the inventory, who the end users of inventory data are, the potential impact of any reported data to Air Force operations, and the level of effort required to obtain the data needed to conduct the inventory.

## Step 4: Determine GHGs that require inventorying.

An Air Force GHG inventory should capture emissions of the six internationally recognized GHGs:

- Carbon dioxide (CO<sub>2</sub>)
- Methane (CH<sub>4</sub>)
- Nitrous oxide (N<sub>2</sub>O)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs) and
- Sulfur hexafluoride (SF<sub>6</sub>).

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Emissions for each pollutant should be accounted for separately and reported in annual metric tons units of each. All non-CO<sub>2</sub> emissions should also be reported in terms of their carbon dioxide equivalent (CO<sub>2</sub>e). CO<sub>2</sub>e is the internationally recognized measure of GHG emissions developed to allow scientists and policy makers to describe, for a given GHG, the amount of CO<sub>2</sub> that would have the same global warming potential (GWP) when measured over a specified timescale (generally 100 years.)

An installation may also choose to expand the scope of the inventory and also account for emissions associated with the use of Class I and Class II ozone depleting substances (ODS.)

## **Step 5: Determine baseline year and reporting period for inventory.**

A baseline or “base year” is a benchmark against which an entity’s emissions are compared over time. The purpose of having a base year is to have a standardized benchmark to illustrate the trends in a base’s emissions over time and allows emissions associated with operational changes to be tracked.

Although Air Force and most federal government agencies operate on a fiscal year schedule, most GHG reporting protocols use a calendar year approach. It’s recommended that Air Force data is collected and installations report GHG inventories on a calendar year basis according to recognized GHG reporting protocols.

## **Step 6: Determine source categories to be included in the inventory.**

Air Force Source categories can generally be categorized into the following types or sources:

- Stationary combustion to produce electricity, steam, heat;
- Combustion of fuels in mobile transportation sources such as aircraft and motor vehicles;
- Non-combustion process and fugitive emissions (operation and maintenance of heating, ventilation, and air conditioning (HVAC) equipment, weapon systems, and other mechanical devices);
- Solid waste management and domestic wastewater treatment associated emissions at Air Force-owned and -operated landfills and water treatment plants.
- Emissions from electric energy generated by other entities but consumed by the Air Force;
- Air Force-generated solid waste and domestic wastewater managed and treated at landfills and water treatment plants owned and operated by local municipalities and other non-Air Force organizations.

Other GHG emissions sources bases may want to consider in an inventory include:

- Solvent and Other Product Use
- Agriculture (animal and crop related)
- Land-Use Change and Forestry
- Industrial Processes (non-energy process emissions)

Typical source categories that should be captured in an Air Force GHG inventory include:

*Facility Energy Emissions* - GHG emissions associated with the energy that powers Air Force installations and built infrastructure, including conventional (electricity or steam), renewable and other power sources. For purposes of the GHG inventory, emissions associated with electricity use, imported steam, and renewable energy purchases are considered indirect emissions as the generating sources are neither owned nor operated by the Air Force. GHG emissions from stationary combustion of natural gas, fuel oil, coal, etc., are considered direct emissions as they are generated from sources owned and operated by the Air Force.

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*Mobile Source Energy Emissions*- GHG emissions originate from the operation of Air Force aircraft, ground transportation and related equipment. Aircraft consume kerosene-based jet fuel (JP-8) and aviation gasoline (AVGAS), while ground transportation vehicles and equipment may consume motor gasoline (MOGAS), diesel, JP-8, or other alternative fuels. For purposes of a GHG inventory, emissions associated with mobile source energy should be considered direct emissions as the mobiles sources and equipment generating the emissions are Air Force owned and operated. Vehicles owned by General Services Administration (GSA) but leased to and operated by the Air Force should also be included considered.

*Fugitive and Process Emissions* - non-combustion, fugitive and process emissions from the operation of Air Force stationary and mobile HVAC and refrigeration equipment, fire suppression equipment, electrical switchgear, and weapon systems applications. For purposes of a GHG inventory, fugitive emissions are considered direct emissions as the generating sources and operations are owned by the Air Force.

*Waste Management* - non-combustion GHG emissions from waste management activities including disposal of Air Force-generated non-hazardous municipal solid waste (MSW) in landfills, and the treatment of domestic wastewater generated on Air Force installations. The GHG produced by these waste management activities are CH<sub>4</sub> (from landfilling of solid waste) and CH<sub>4</sub> and N<sub>2</sub>O (from the treatment of domestic wastewater.) Because the Air Force sends waste to landfills and domestic wastewater treatment facilities that are owned and operated by the Air Force and local jurisdictions, resulting emissions could be classified as being both direct and indirect.

## **Step 7: Determine GHG inventory protocol and approved methods to quantify GHG emissions.**

Base personnel responsible for completing the GHG Inventory should select appropriate emissions calculation methodologies and activity factors and identify necessary calculation tools.

As there is no official federal climate change legislation, national regulations that define how to implement a GHG inventory, or specific Air Force guidance, an Air Force installation preparing to develop a GHG emissions inventory can choose from a number of protocols created by voluntary GHG registries and reporting programs. These include:

World Resources Institute Greenhouse Gas Protocol <http://www.ghgprotocol.org/>

EPA Climate Leaders Program <http://www.epa.gov/climateleaders/>

DOE's Voluntary Reporting of Greenhouse Gases 1605(b) Program  
<http://www.eia.doe.gov/oiaf/1605/frntvrgg.html>

The California Climate Action Registry <http://www.climateregistry.org/>

The Climate Registry <http://www.theclimateregistry.org/>

Due to the unique nature of the particular emission sources of interest to the Air Force and lack of any overarching federal or state regulations for addressing GHG emissions inventory development, bases may chose to conduct there emissions inventories using more than one protocol and their associated emissions factors.

Note. The top-down inventory being prepared by SAF/IEE for world-wide Air Force operations is based largely on The Climate Registry protocol.

## **Step 8: Request/Collect Source Data**

Before any data can be collected, installation staff responsible for conducting the inventory should develop an appropriate data collection plan and associated data collection templates.

In order to calculate the emissions needed to assemble a GHG inventory, certain data inputs are required for each source. Air Force and DoD information management systems already collect a significant amount of

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information in areas relevant to the development of a GHG inventory, such as energy and fuel consumption, materiel consumption, and environmental performance. A significant portion of the required data may be obtained using tools and processes currently employed to track energy consumption and comply with Federal agency energy and environmental reporting requirements. DoD and Federal agencies report information that is rolled up from the installation and MAJCOM level to comply with regulations and annual reporting requirements including: DOE Federal Energy Management Report, U.S. GHG Emissions Inventory Report, The Energy Policy Act, and Executive Order 13423, Strengthening Federal Environmental, Energy, and Transportation Management. Other sources of information may include installation Air Emissions Inventories and other documentation used to comply with reporting requirements of state and local environmental agencies. To maximize the efficiency of an inventory initiative, existing data should be leveraged to the greatest extent possible.

## **Step 9: Calculate GHG emissions**

Emissions of GHGs are calculated by multiplying a process activity rate or underlying material base quantity by a GHG-specific emission factor. Emissions of combustion-related GHG emissions (i.e., CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O) are dependent upon the type of fuel and its carbon content, the amount of the fuel consumed, and the type of combustion technology and/or emissions control technology employed. Annual emissions are converted to metric tons using standard conversion factors, and non-CO<sub>2</sub> combustion-related emissions (CH<sub>4</sub>, and N<sub>2</sub>O) reported as CO<sub>2</sub>e by applying the appropriate GWP. In calculating fugitive, non-combustion GHG emissions a logistical mass balance approach based on the amount and type of refrigerant, fire suppressant or cleaning agent consumed was used to estimate annual releases, and appropriate GWPs applied to allow reporting of CO<sub>2</sub>e values.

Calculation methods for mobile sources may differ depending on the availability and quality of data. GHG emissions for mobile combustion can be estimated using various calculation methodologies from one of the GHG protocols noted in Step 7.

It's important for base personnel responsible for conducting GHG emission inventory development to disclose any relevant assumptions and make appropriate references to the accounting and calculation methodologies and data sources used.

## **Step 10: QA/QC Data**

Review all emissions calculations to ensure calculation methods are valid and emissions totals are accurate and make sense for the sources inventoried. Check all calculations and if possible request a third party independent review of the methodology and underlying data to ensure the inventory is complete, consistent and accurate.

## **Step 11: Generate a GHG emissions inventory report**

Results of the emissions inventory should be compiled in a report format for review. The report may include an overview of the procedures and approaches used to determine GHG emissions, results of the installation's calculated GHG emissions by source category. The report may also discuss lessons learned from the process of identifying, collecting, and analyzing GHG emissions data. This information can be valuable when shared with other Air Force organizations completing GHG inventories and for responding to future requests for inventory development as GHG and climate change related actions are initiated.