Federal Greenhouse Gas Accounting and Reporting Guidance

Council on Environmental Quality
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Acronyms and Abbreviations

BBtu	Billion British Thermal Units
CAA	Clean Air Act
CAS	Chemical Abstract Service
CEQ	White House Council on Environmental Quality
CFC	Chlorofluorocarbons
CFR	Code of Federal Regulations
CHP	Combined Heat and Power
CH_4	Methane
CNG	Compressed Natural Gas
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
COP	Coefficient of Performance
DOC	Degradable Organic Carbon
DOD	Department of Defense
DOE	Department of Energy
DTMO	Defense Travel Management Office
DTS	Defense Travel System
EF	Emission Factor
eGRID	Emissions and Generation Resource Integrated Database
EIA	Energy Information Administration
EISA	Energy Independence and Security Act
E.O.	Executive Order
EPA	Environmental Protection Agency
EPAct	Energy Policy Act
EPCRA	Emergency Planning and Community Right-To-Know Act
ETS	E-Gov Travel Service
F-gas	Fluorinated Gas (HFCs, PFCs, SF_6)
FAST	Federal Automotive Statistical Tool
FEMP	Federal Energy Management Program
FIA	Forest Inventory and Analysis
FT	Full-Time Employees/Contractors

FY	Fiscal Year
GE	Goal-Excluded
GGE	Gasoline Gallon Equivalent
GHG	Greenhouse Gas
GHGRP	EPA's Greenhouse Gas Reporting Program (previously the Greenhouse Gas Mandatory Reporting Rule or MRR)
GOCO	Government-Owned, Contractor-Operated
GS	Goal-Subject
GSA	General Services Administration
GSF	Gross Square Feet
GWh	Gigawatt Hour
GWP	Global Warming Potential
HCFC	Hydrochlorofluorocarbons
HFC	Hydrofluorocarbon
HHV	Higher Heating Value
HVAC	Heating, Ventilating and Air Conditioning
IPCC	Intergovernmental Panel on Climate Change
KCUFT	Thousand Cubic Feet
KGal	Thousand Gallons
LandGEM	Landfill Gas Emission Model
LEV	Low Emissions Vehicle
LFG	Landfill Gas
LGO Protocol	Local Government Operations Protocol
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gases
MIS	Management Information Service
MMBtu	Million British Thermal Units
MSDS	Material Safety Data Sheet
MSW	Municipal Solid Waste
MT	Metric Tons
MWh	Megawatt Hour
NASA	National Aeronautics and Space Administration
NMOC	Non-Methane Organic Compounds

NF_3	Nitrogen Trifluoride
N_2O	Nitrous Oxide
OFEE	Office of the Federal Environmental Executive
OMB	Office of Management and Budget
PFC	Perfluorocarbon
PNR	Passenger Name Record
POC	Point of Contact
POV	Personal Vehicle
PT	Part-Time Employees/Contractors
REC	Renewable Energy Certificate
SCF	Standard Cubic Feet
SF_6	Sulfur Hexafluoride
SUV	Sport Utility Vehicle
T&D	Transmission and Distribution
TMC	Travel Management Center
USFS	U.S. Forest Service
VE	Vehicles and Equipment
WBCSD	World Business Council for Sustainable Development
WTE	Waste-to-Energy
WRI	World Resources Institute
WWTP	Wastewater Treatment Plant

1.0 Introduction

On March 19, 2015, the President issued Executive Order (E.O.) 13693, *Planning for Federal Sustainability in the Next Decade[1]*, which set forth ambitious climate, energy, and environmental sustainability goals for Federal agencies over the next decade. Executive departments and agencies have been among our Nation's leaders as the United States works to build a clean energy economy that will sustain our prosperity and the health of our people and our environment for generations to come. Federal leadership in energy, environmental water, transportation fleets, buildings, and acquisition management will continue to drive national greenhouse gas (GHG) reductions and support preparations for the impacts of climate change. The Federal Government has the opportunity to reduce agency direct greenhouse gas emissions by at least 40 percent over the next decade while at the same time fostering innovation, reducing spending, and strengthening the communities in which our Federal facilities operate.

Section 9(c) of E.O. 13693 specifies that Agency Chief Sustainability Officers are responsible for "reporting annually to the Chair of CEQ and Director of OMB a comprehensive inventory of progress towards the greenhouse gas emissions goals." This *Federal Greenhouse Gas Accounting and Reporting Guidance*[2] (or Guidance) provides direction that agencies shall follow in calculating and reporting GHG emissions in accordance with these Federal GHG reporting directives.[3]

The Federal Greenhouse Gas Accounting and Reporting Guidance was originally established by section 9 of Executive Order (E.O.) 13514, *Federal Leadership in Environmental, Energy, and Economic Performance* (74 Federal Register 52117). Section 9 of E.O. 13514 directed the Department of Energy's (DOE's) Federal Energy Management Program (FEMP), in coordination with the Environmental Protection Agency (EPA), Department of Defense (DOD), General Services Administration (GSA), Department of the Interior (DOI), Department of Commerce, and other agencies as appropriate to develop recommended Federal GHG reporting and accounting procedures. Those recommendations served as the basis for the original Guidance document released in October 2010. The Guidance was updated in June 2012, based on recommendations developed by the Federal Working Group on GHG Accounting and Reporting, co-chaired by DOE-FEMP, EPA, and DOD, with input from working group members from various agencies in 2011.

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[1] The text of Executive Order 13693 is located at: www.whitehouse.gov/the-press-office/2015/03/19/executive-order-planning-federal-sustainability-next-decade and the Implementing Instructions for E.O. 13693 issued on June 10, 2015, are located at:
www.whitehouse.gov/sites/default/files/docs/eo_13693_implementing_instructions_june_10_2015.pdf.

[2] Section 4(g) of E.O. 13693 directs that the Chair of CEQ shall "revise, as necessary and in coordination with the Director of OMB, [the] Federal Greenhouse Gas Accounting and Reporting Guidance [Revision 1] of June 4, 2012."

[3] This guidance is not a rule or regulation, and the recommendations it contains may not apply to a particular situation based upon the individual facts and circumstances. This guidance does not change or substitute for any law, regulation, or other legally binding requirement and is not legally enforceable. The use of non-mandatory language such as "guidance," "recommend," "may," "should," and "can," is intended to describe White House Council on Environmental Quality (CEQ) policies and recommendations. The use of mandatory terminology such as "must," "shall," and "required" is intended to describe controlling requirements under the terms of relevant statutes and regulations and implementing instructions pursuant to E.O. 13693, but this document does not establish legally binding requirements.

After the release of E.O. 13693: *Planning for Federal Sustainability in the Next Decade,* the White House Council on Environmental Quality (CEQ) and DOE-FEMP convened working groups to update the Guidance to reflect changes in GHG accounting in the Federal sector. As a result of those updates, the Guidance document and Technical Support Document (TSD) have been consolidated into a single document to streamline the reporting documentation. The TSD was originally a supplement to the Federal Greenhouse Gas Accounting and Reporting Guidance (or Guidance) to provide detailed information on the inventory reporting process, emission factors, and accepted calculation methodologies.

The Federal Government seeks to continually improve both the quality of data and methods for calculating GHG emissions. Over time additional categories, methodologies, and procedures may be included in subsequent updates to this document to improve the Federal Government's overall ability to accurately account for and report GHG emissions.

1.1. Purpose of This Guidance

This Guidance provides direction for calculating and reporting GHG emissions in accordance with E.O. 13693 directives. Agencies shall follow this Guidance to ensure consistent and transparent reporting of Federal GHG emissions. This Guidance is accompanied by appendices that provide more detailed information on inventory reporting, calculation methodologies, and emission factors.

This Guidance is not designed for quantifying the reductions from individual GHG mitigation projects, nor does it include strategies for reducing GHG emissions. If an agency identifies a GHG emissions reduction activity or practice that is not covered in this guidance document, and wishes to receive GHG emissions reduction credit for such an activity or practice, the agency should consult with CEQ and the Office of Management and Budget (OMB) to receive documented approval of the proposed activity or practice and the accounting methodology beforehand.

1.2. Greenhouse Gas Accounting and Reporting Under Executive Order 13693

Federal agencies initially reported comprehensive GHG inventories for fiscal year (FY) 2010 and the FY 2008 base year on January 31, 2011[4], to the CEQ Chair and OMB Director, and have continued reporting for each subsequent year. Data for an agency-wide inventory are drawn from multiple levels throughout an agency's organizational structure. This Guidance has been developed to provide Federal agency users, whether representing facility-level activities or headquarters-level functions, with the necessary information to develop a comprehensive GHG inventory. While intended to be used at all levels, agencies shall aggregate data to the agency level for reporting.

Agencies are not precluded from using other agency-specific tools to assist them in better managing and maintaining data necessary to compile and submit inventories across their

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[4] Agencies were not required to submit a comprehensive inventory for FY 2009, but could do so at their discretion.

enterprises. However, agencies shall ensure that any agency-specific tools are appropriately aligned with this Guidance and the factors in the Annual GHG Data Report workbook.

If other GHG calculation tools are used, agencies shall ensure that they conform to the methods and procedures described in this section and in the appendices. Because different tools may produce dissimilar results depending on the calculation methodologies used, agencies should evaluate their calculation tools carefully prior to use and ensure that they are consistent with the methods used in the Annual GHG Data Report workbook.

1.2.1. Carbon Dioxide Equivalent Applied to Greenhouse Gases

The GHGs covered by E.O. 13693 and this Guidance are carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, nitrogen trifluoride, and sulfur hexafluoride. These GHGs have varying heat trapping abilities and atmospheric lifetimes. To facilitate comparison among GHGs, a global warming potential (GWP) value is assigned to each GHG. The GWP represents the heat-trapping impact of a GHG relative to carbon dioxide (CO_2), which has a GWP of 1.0, and functions as a warming "index." For instance, methane (CH_4) has a GWP of approximately 25 based on the latest update to GWPs, so each metric ton of CH_4 emissions has 25 times the impact on global warming (over a 100-year time horizon) as one metric ton of CO_2 emissions. GWP factors for GHGs are documented at the EPA Center for Corporate Climate Leadership GHG Emission Factor Hub[5] along with citations, where appropriate, of primary sources of scientific data EPA used. The factors are incorporated in the Annual GHG Data Report workbook in the "E. GWP Key" worksheet.

To provide a single metric that embodies all GHGs, emissions are reported in metric tons (MT) of carbon dioxide equivalent (CO_2e). To calculate CO_2e, the mass of emissions of each GHG is multiplied by the appropriate GWP for that GHG.[6]

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[5] EPA Center for Corporate Climate Leadership GHG Emission Factor Hub: www.epa.gov/climateleadership/center-corporate-climate-leadership-ghg-emission-factors-hub.

[6] For additional information about GWP values and associated lifetimes, see the EPA's website at: https://www.epa.gov/ghgemissions/understanding-global-warming-potentials.

Table 1: Greenhouse Gases, Common Sources, and Global Warming Potential Factors

Greenhouse Gas	Common Sources/Uses	GWP (at Publication Date of This Guidance)
Carbon dioxide (CO_2)	Mobile and stationary combustion	1
Methane (CH_4)	Coal mining, fuel combustion, landfills, wastewater treatment	25
Nitrous oxide (N_2O)	Fuel combustion, fertilizers	298
Hydrofluorocarbons (HFCs)	Refrigerants, fire suppressants, various manufacturing processes	12 – 14,800
Perfluorocarbons (PFCs)	Electrical equipment, various manufacturing processes, refrigerants, medicine	7,390 – 12,200
Sulfur hexafluoride (SF_6)	Electrical equipment, various manufacturing processes, tracer in air modeling, medicine	22,800
Nitrogen Trifluoride (NF_3)	Industrial processes, primarily produced in the manufacture of semiconductors and LCD (Liquid Crystal Display) panels, and certain types of solar panels and chemical lasers	17,200

† Many different individual gases constitute HFCs and PFCs, so there is a range of GWP values associated with each. When reporting on these gases, an agency should use the GWP value for the specific gas given in the EPA GHG Emission Factors Hub or document any other source needed for gases not included in the Emission Factors Hub.

1.2.2. Federal Reporting Requirements

E.O. 13693 builds upon several existing Federal statutory and earlier executive orders related to energy and environmental management. Existing mandates include the National Energy Conservation Policy Act (NECPA) of 1978 (Pub. L. No. 95-619), the Energy Policy Act of 2005 (EPAct 2005; Pub. L. No. 109-58), and the Energy Independence and Security Act (EISA) of 2007 (Pub. L. No. 110-140). These mandates have established various goals for facility and mobility energy management, renewable energy use, and other activities that may reduce GHG emissions.

This Guidance also considers the EPA GHG Reporting Program (GHGRP), which covers reporting of GHG emissions from large sources and suppliers in the United States, and is intended to collect accurate and timely emissions data to inform future policy decisions. Where practicable, this Guidance references calculation methodologies and emission factors in the GHGRP. Although efforts have been made to streamline these reporting instructions by adopting or

referencing elements of the GHGRP, this Guidance is separate and distinct from those of the GHGRP.[7]

1.2.3. Distinguishing Between GHG Reporting and Reduction

Section 2 of E.O. 13693 directs agencies to develop agency-wide targets for emission reductions ("reduction of GHG target emissions"). Section 9 of E.O. 13693 directs agencies to compile and submit comprehensive inventories of GHG emissions ("reporting") for assessing progress toward the GHG reduction targets. These are two separate and discrete tasks. An inventory is an accounting of emissions and sinks that can improve over time as agencies gain more complete understanding of the methods, underlying processes, and activities. A number of categories of emissions and sinks, both direct and indirect, are not included in this version of the Guidance but may be included in later versions as methods and data become available.

It is important to recognize that while certain sources of Federal GHG emissions are excluded from agency GHG emissions reduction targets (GHG Non-Target), these emission sources are also reported in agency comprehensive GHG inventories. For example, an agency's emissions reduction target may exclude "direct emissions from excluded vehicles and equipment and from electric power produced and sold commercially to other parties in the course of regular business," but these sources are still reported in the agency's GHG inventory.

Additionally, some GHG sources and sinks are included in this Guidance but are not at present included in reduction targets. Setting emission reduction goals necessarily requires making pragmatic policy decisions about which sources and sinks should be included given the availability and quality of data from the inventory, and the maturity of accounting approaches that will accurately reflect the true environmental outcome of Federal agency efforts to reduce emissions.

1.2.4. Opportunities, Limitations, and Exemptions under Executive Order 13693

Section 18 of E.O. 13693 authorizes agency heads to exempt certain activities from the mandates in the Executive Order, including GHG reporting. Alternatively, agencies may elect to inventory GHGs not specified under the Executive Order. For example, they could consider inventorying high-GWP, ozone-depleting substances (e.g., chlorofluorocarbons [CFCs]) if they are prevalent due to manufacturing or other processes. In addition, agencies may report types of GHGs that are not specifically mentioned in Executive Order 13693. For example, agencies may voluntarily report non-covered GHGs with high global warming potentials.

Similarly, including international emissions in inventories and reduction targets is voluntary. Certain agencies have overseas facilities and operations, often integrally related to the agency's mission and representing a significant portion of the agency's portfolio. Other agencies may already report international energy use to meet statutory requirements and therefore report associated emissions to maintain consistency in their data collection. As a result, these agencies

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[7] For additional information on the GHGRP, see https://www.epa.gov/ghgreporting.

may elect to voluntarily include these facilities and operations in their reporting as key to an overall emissions reduction strategy.

1.2.5. Federal Greenhouse Gas Accounting and Reporting Workgroup

CEQ may convene a Federal GHG Accounting Workgroup to address implementation issues and ongoing development of procedures and guidance, as well as to:

- Serve as a forum for information exchange and promote agency implementation of the Guidance,

- Develop GHG accounting and reporting guidance recommendations that foster the successful development of GHG inventories in the Federal sector,

- Develop technical guidance and tools to support implementation of the Guidance,

- Update data collection processes and emission factors needed to support GHG accounting best practices.

The GHG Workgroups convened in FY 2010, FY 2011, and FY 2016 to provide recommendations to CEQ to update and improve the Guidance, and will continue to coordinate with other executive order working groups and relevant government programs to contribute to future revisions of the Guidance. The Workgroup consists of participants from Federal agencies and meets and forms subcommittees, as necessary.[8]

1.2.6. Electronic Greenhouse Gas Accounting and Reporting Capability (Annual Greenhouse Gas Data Report Workbook)

As originally assigned by Section 9(b) of E.O. 13514, DOE-FEMP develops and updates, in coordination with other Federal agencies, an electronic GHG accounting and reporting instrument

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[8] Examples of topics addressed by subcommittees in the past included vendor and contractor emissions, leased assets, and emissions and biological sequestration from land management techniques.

(Annual GHG Data Report workbook) for agencies to use in reporting energy and other GHG source and inventory information. Where practicable, the Annual GHG Data Report workbook automatically calculates emissions, using methodologies contained in the Appendices, from aggregated agency-level energy and activity data entered in native units. This reduces the burden on reporting agencies and facilitates comparable and consistent inventories. The Annual GHG Data Report workbook aggregator tool does not preclude agencies from using tools of their choosing to compile and manage GHG inventory data across their regions and sub-agencies. However, all final reporting shall be submitted through the Annual GHG Data Report workbook. Chapter 5 of this Guidance and the Appendices provide additional information about the Annual GHG Data Report workbook.

The most recent version of the Annual GHG Data Report workbook is located at: http://energy.gov/eere/femp/downloads/annual-greenhouse-gas-and-sustainability-data-report.

1.2.7. Relationship of the Guidance to Other Greenhouse Gas Reporting Requirements and Protocols

The information below is intended to provide an overview of GHG reporting requirements, separate from accounting and reporting under this Guidance, which may be relevant to Federal agencies. Agencies are responsible for ensuring they are aware of reporting requirements outside of the scope of this Guidance.

State and Regional Programs

In addition to Executive Order directives and the EPA's GHGRP, some agency facilities may be subject to state-level GHG emissions reporting or reduction requirements. Several states have adopted legislation that requires GHG emissions reporting above specified thresholds, or they incorporate GHG reporting as part of permitting processes.

Some of the state-based GHG reporting requirements are also used in reporting for regional programs. For example, the Regional Greenhouse Gas Initiative (RGGI), a cooperative effort by 10 states in the Northeast and Mid-Atlantic regions, utilizes individual state programs and regulations to function as a single regional compliance market for carbon emissions. Agencies are only impacted by the regional reporting requirements insofar as they lead to state-based reporting to which facilities may be subject.

National Reporting

Currently, the U.S. Forest Service (USFS) estimates net carbon stock changes in all managed forests in the United States, consistent with Intergovernmental Panel on Climate Change (IPCC) guidance. This information is incorporated into the Inventory of US Greenhouse Gas Emissions and Sinks report (see below) for the United Nations Framework Convention on Climate Change (UNFCCC). The USFS and the U.S. Geological Survey (USGS) are working together to combine satellite data with surface measurements to improve the quality and timeliness of carbon stock changes on public and private lands. USGS is also planning to provide information on emissions and removals on federal lands. Federal agencies that own or manage public lands should obtain the necessary data from the USFS, in coordination with USGS, for public reporting. In the future,

this information may be reported through the Annual GHG Data Report workbook. See Section 3.3 for further details.

International Reporting

In June 1992, the United States signed, and later ratified, the United Nations Framework Convention on Climate Change (UNFCCC). The provisions of UNFCCC, which entered into force on March 21, 1994, establish reporting of national GHG inventories of emissions and removals. As a result, some Federal agencies provide information regarding GHG emissions that is incorporated into the Inventory of US Greenhouse Gas Emissions and Sinks, prepared each year by the Environmental Protection Agency and submitted by the U.S. Department of State. This inventory includes five sectors (energy, industrial processes and product use, agriculture; land use, land use change and forestry, and waste) and six gases (CO_2, CH_4, N_2O, PFCs, HFCs, SF_6 and NF_3). The Paris Agreement, which the U.S. joined on September 3 2016, includes provisions on the reporting of national GHG inventories of emissions and removals, as well as on tracking progress towards the implementation of nationally determined contributions (targets).

1.2.8. The Public Sector Greenhouse Gas Accounting and Reporting Protocol

While this Guidance is meant to be a stand-alone document that details procedures for Federal agencies to comply with Executive Order directives, it follows the basic guidelines found in the *GHG Protocol for the US Public Sector* (US Public Sector Protocol, or PSP).[9] The PSP is intended to offer flexibility to its public-sector users while establishing certain core principles and methodologies that ensure consistent, complete, and comparable inventories.

For the purposes of Federal GHG reporting and accounting, this Guidance takes precedence over all other established GHG accounting protocols and standards.

2.0   Setting Organizational and Operational Accounting Boundaries

Setting organizational and operational accounting boundaries is necessary to develop a consistent agency-wide GHG inventory. Typically, organizational boundaries are defined by either the operational or financial control an entity has over its various activities. Operational control is generally defined as the authority to introduce and implement operating policies.[10] Financial control is the authority to direct the financial and operating policies of the operation with a view to gaining economic or other benefits from its activities.

This Guidance sets agency boundaries using an operational control approach to the extent practicable. Agencies shall report emissions from operations over which they have operational control. Due to the complexity of the Federal Government and existing data collection systems,

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[9] The Public Sector Protocol was developed jointly by the Greenhouse Gas Protocol Initiative at the World Resources Institute (WRI) and Logistics Management Institute (LMI) through an inclusive stakeholder review process which included significant input from US Federal agencies. For more information, go to www.ghgprotocol.org

[10] See Chapter 3, Public Sector Protocol for more information on organizational boundaries and operational control.

the Guidance may deviate slightly from a pure operational control approach. This chapter outlines setting organizational and operational boundaries to ensure compliance with Executive Order directives. The approach avoids double counting and gaps in GHG accounting.[11]

2.1. Organizational Boundaries

The specific categories of emissions to be inventoried include Scope 1, Scope 2, and specified Scope 3 emissions that fall within agencies' organizational boundaries, as defined by this Guidance, as well as other emissions that may be voluntarily included in an agency's emissions inventory (such as international operations).

While certain sources of Federal GHG emissions are excluded from agency GHG emissions reduction targets, these exclusions do not apply to the reporting of these emissions in agency comprehensive GHG inventories. For example, although an agency may exclude law enforcement vehicles from its reduction target, emissions from these vehicles are reported in the agency's comprehensive inventory as a target-excluded emissions source, unless exempted with CEQ approval in accordance with Section 18 of E.O. 13693. Federal agencies should be able to clearly account for any differences between the FY 2008 base year and annual GHG inventories in subsequent years.

For annual inventories, agencies are to report emissions associated with the following:

- **Facility energy related to the operation or use of real property which the agency owns and operates or which the agency leases and operates and pays the energy bill(s) (see Section 2.1.1).** Data needed to calculate these emissions were formerly reported to FEMP for compilation in the Annual Report on Federal Government Energy Management (or FEMP Energy Report).[12] Energy bills include electricity, natural gas, fuel oil, hot/chilled water, and steam.

- **Operation of mobile sources for which the agency purchases fuel (see Section 2.1.2).** These mobile sources include Federal fleets, equipment, non-road vehicles, vessels, and aircraft. The activity data needed to calculate emissions from Federal fleets are reported in the Federal Automotive Statistical Tool (FAST) system, and the emissions from equipment, non-road vehicles, vessels, and aircraft are currently captured in the FEMP Energy Report.[13, 14]

- **All other emissions from activities over which the agency has operational control (see Section 2.1.3).** These include fugitive and process emissions as defined in Section 2.2.1. Data for these emissions are typically collected at the activity level. Specified Scope 3

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[11] Double counting occurs when two or more reporting organizations take ownership of the same emissions or reductions within the same scope.

[12] FEMP annual energy reporting includes government-owned/contractor-operated (GOCO) facilities.

[13] For comprehensive inventories, some tactical fuel information may only be available in other databases that are outside of FAST and the FEMP Energy Report.

[14] Federal fleet vehicles and low speed electric vehicles (LSEVs) are considered to be mobile sources. Guidance for electricity used in these vehicles is included in Section 2.2.2.

emissions associated with agency activities, but where the agency does not have full operational control, are described in Section 2.2.3.

- **Facility energy related to real property which the agency leases, but does not pay the utility bill, is mandatory starting in FY 2017 for leases, newly solicited in FY 2016 or later, over 10,000 rentable square feet (see Section 2.1.1).**[15] Agencies report emissions associated with lighting, plug load, and centralized systems as Scope 3.

2.1.1. Real Property

Where an agency directly pays the energy bills for real property the agency owns and operates or leases (including when the agency occupies GSA owned or leased space, or the agency leases from a private landlord), the agency reports the associated Scope 1 and 2 emissions.[16] Where GSA owns the facility and the tenant agency does not directly pay energy bills, GSA is responsible for reporting the Scope 1 and 2 emissions associated with those energy bills. This is consistent with the 2008 baseline and subsequent years' inventories. In this case the occupant will receive GHG emissions data from GSA and report these emissions as Scope 3.

Where an agency leases and operates a facility, but does not directly pay the utility bill, the agency reports associated emissions as Scope 3 in their inventory. This is mandatory reporting in FY 2017 and beyond for leases of 10,000 rentable square feet or greater that were newly solicited in FY 2016 and later. Agencies can, and are encouraged to, report these emissions for leases of less than 10,000 rentable square feet. If the landlord is a Federal entity (e.g., GSA), the Federal landlord should provide the tenant with data to calculate their emissions. For such leases with a private landlord, agencies should work with the landlord to obtain the necessary energy information at no additional cost to the government.

Where an agency has a lease in a multi-tenant building, the tenant agency should work with its landlord to determine its share of energy consumption for centralized building systems and common areas, as it will need to pro-rate its share of the building's total energy consumption in order to report Scope 3 emissions using modeling or other methodologies (in situations where the landlord is GSA, GSA will provide the pro-rated share to the tenant agency). Over time, agencies may wish to move to submetering systems to more accurately determine emissions. Agencies should clearly define the approach used to compile, estimate, and report GHG emissions from leased assets in their inventory qualitative statements to ensure quality assurance. Table 2 provides more information on accounting for emissions under different property arrangements that agencies may have.

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[15] In instances where GSA is the leaseholder with a private landlord and assigns space to a Federal tenant, GSA is responsible for collecting data from private landlords and will provide agencies with allocated data sufficient to report Scope 3 emissions. In instances where GSA has delegated its leasing authority to a Federal tenant and the Federal tenant leases directly with the private landlord, the Federal tenant reports Scope 3 emissions and is responsible for data collection from the landlord. The party responsible for paying the utilities reports Scope 1 and 2 emissions.

[16] Agencies also report related Scope 3 emissions, such as contracted waste and wastewater disposal (see Section 2.2.3).

Table 2: Emissions from Agency Property Arrangements

Type of Arrangement	Definition	Applicable Scopes
Single-net lease	Operating leases where the occupant pays a portion of the utility costs directly. Typically, the utilities netted from the lease do not include the building mechanical systems, but do include the electricity consumed by the occupant through lighting and plug load.	Occupant reports Scope 2 for building electrical use (i.e., that portion of building electrical use for which the occupant is billed directly). Occupant reports Scope 3 for emissions from centralized systems (mandatory). Agencies that are Federal landlords report Scopes 1 and 2 (for all building-related GHG emissions except what is reported by the occupant).
Triple-net lease	Operating leases for which the occupant has responsibility for operation and maintenance, including the payment of utilities, and including those associated with the building mechanical systems.	Occupant reports Scopes 1 and 2.
Fully serviced lease	Fully serviced leases where the landlord has responsibility for operations and maintenance, including the payment of all utilities.	Occupant reports all GHG emissions as Scope 3 (for newly solicited leases of 10,000 rentable square feet or greater). Agencies that are Federal landlords report emissions as Scope 1 or 2 (depending on the source).
Permit	The agency confers a permit to a private party for the use of government land.	Varies
Outgrant	A lease or license granted by the agency to a non-Federal entity for either temporary or permanent use.	Varies
Grant	The agency confers a grant permanently authorizing the use of a given right-of-way to a third party; grants usually involve a single payment for the land or transfer of land use rights.	Varies
Withdrawal from public use	The agency receives a permit to use land of another government agency for up to 20 years administratively, as long as the intended use does not involve destruction of the land (e.g., military uses, dams).	Scopes 1 and 2
Public-private partnership	Partnerships in which the agency and a private entity contribute various amounts of real property, financial capital, and/or borrowing ability for the purpose of establishing operating capacity.	Varies[*]

* Reporting of scopes depends on the agreements made between the partners, and varies from agreement to agreement. Agencies determine which scope to report, if any, based on whether or not they purchase energy or exercise operational control for the partnership. For instance, an agency may exclude emissions from certain cooperative research sites, such as a university, where the agency does not hold any control over operations or capital equipment, own the facility, or pay any utility bills.

Accounting for GHG emissions from newly-solicited full-serviced leased assets in the methods described above creates a new Scope 3 category. For FY 2017 this reporting is mandatory and emissions will be included in agencies' annual GHG and energy reporting submittal. To avoid re-calculating the FY 2008 Scope 3 baseline and associated reduction targets, progress for this category will be measured independently from the Scope 3 categories already being reported. This new category is outside the combined Scope 3 targeted reduction.

Greenhouse Gas Reporting Relationship to Facility Energy Reporting

To the extent practicable, this Guidance is consistent with the existing approach for FEMP's annual energy reporting, in which an agency reports energy use that it directly purchases from utilities and other providers. However, the E.O. allowable exclusions for GHG reduction targets, such as those described earlier in Section 1.2, are not the same as the allowable exclusions under FEMP's "Guidelines Establishing Criteria for Excluding Buildings" for the energy intensity reduction goal (25 percent reduction in Btu/square foot in 2025 compared to 2015).[17] The relationships between energy goal reporting exclusions and allowable GHG target exclusions are summarized in Table 3.[18]

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[17] This guidance can be found at http://energy.gov/eere/femp/downloads/guidelines-establishing-criteria-excluding-buildings-energy-performance.

[18] While E.O. 13693 and its Implementing Instructions may exclude certain sources of Federal GHG emissions from agency GHG emissions reduction targets, these exclusions do not apply to agency comprehensive GHG inventories. For example, an agency's target may exclude "direct emissions from excluded vehicles," but these sources are not excluded from the agency's inventory.

Table 3: Building Exclusions Comparison

Type of building/structure as defined in FEMP's "Guidelines Establishing Criteria for Excluding Buildings" for determining allowable energy intensity reduction goal exclusions	May these activities be excluded from E.O. GHG reduction targets?
Buildings that are privately owned, but are collocated on Federal lands or military installations and are not leased by the government.	Yes[*]
Buildings with fully serviced leases (where the private sector landlord is responsible for paying the energy bills).	Yes – through at least FY 2016[*]
Structures, such as outside parking garages, that consume essentially only lighting energy, yet are classed as buildings.	No
Federal ships that consume "Cold Iron Energy" (energy used to supply power and heat to ships docked in port) and airplanes or other vehicles that are supplied with utility-provided energy.	No
Buildings in which energy usage is skewed significantly due to reasons such as buildings entering or leaving the inventory during the year; buildings down-scaled operationally to prepare for decontamination, decommissioning, and disposal; and buildings undergoing major renovation and/or major asbestos removal.	No
Leased space where the Government may pay for some energy but not all; the space comprises only part of a building (i.e., leased space where rent is net of utilities); or the expiration date of the lease limits the ability to undertake energy conservation measures.	No
Separately metered energy-intensive loads that are driven by mission and operational requirements, not necessarily buildings, and not influenced by conventional building energy conservation measures.	No
Federal buildings excluded from Energy Performance Requirements, where (1) energy requirements are impracticable; (2) all Federally required energy management reports have been completed and submitted; (3) agency has achieved compliance with all energy efficiency requirements; and (4) agency has implemented all practicable, life cycle, cost-effective projects at the excluded buildings.	No**
* Reporting guidance on fully serviced leases is explained in Section 2.1.1.	
** Except where the finding of impracticability is based on performance of a national security function under Section 18, E.O. 13693.	

2.1.2. Purchased Fuel

Agencies are responsible for including in their inventories the emissions from mobile sources associated with the operation of vehicles and equipment for which they purchase fuel.

Greenhouse Gas Reporting Relationship to Federal Automotive Statistical Tool Reporting

The automobile fleet fuel data for calculating mobile combustion emissions is available in the FAST system. Owned and contracted vehicles that agencies *may* consider exempt from covered fleets are listed below:

- **Law enforcement fleets**
- **Emergency response vehicle fleets**
- **Military tactical vehicle fleets.** Motor vehicles (excluding general-purpose motor vehicles) designed to military specification, or a commercially designed motor vehicle modified to military specification to meet direct transportation support of combat or tactical operations and protection of nuclear weapons. These vehicles are inherently mission critical and are used for no other purpose.
- **Non-road vehicles.** Vehicles that are not licensed for use on all roads and highways
- **Motor vehicles used for motor vehicle manufacturer product evaluations or tests**
- **Vehicles owned and operated by the Central Intelligence Agency (CIA)**
- **Federally owned vehicles operated solely by Indian nations or state-run Fish and Wildlife services,** as applicable
- **Vehicles operated outside of the United States**
- **Contractor-owned vehicles where the contract is less than 12 months**, including all options and renewals.
- **Contractor vehicles where a central purpose of the contract is neither for providing vehicles nor for providing transportation services of people or materials on site (e.g., shuttle bus services are not exempt from Executive Order directives).** Examples of exempt contractor vehicles include vehicles used by electricians, plumbers, and computer repair technicians.

These are the same allowable exclusions for an agency's GHG targets, except for non-road vehicles as indicated below. While emissions from the excluded vehicles are reported as part of the comprehensive GHG inventory, they are not included in agency targeted emissions.

The data reported in FAST will be used to calculate GHG emissions using the methodologies outlined in Appendix A. In addition, emissions from the following mobile combustion sources (currently captured in FEMP energy reporting and not the FAST system), are subject to GHG reduction targets and are reported in the agency's comprehensive inventory:

- Small equipment (e.g., lawnmowers) and non-road vehicles (e.g., agriculture equipment)
- Vessels and aircraft that are not otherwise excluded for tactical, emergency, or law enforcement purposes (e.g., research aircraft and non-tactical ships)

Agencies may track some fuel purchases separately from those covered in the FEMP energy or FAST system data. For comprehensive inventories, agencies should consult any such data systems to ensure all fuels are appropriately accounted for.

2.1.3. All Other Activities

For all other agency activities, the operational control approach is used to determine their organizational boundaries. Agencies have operational control over an activity if they have operational responsibility for the activity or process and the authority to implement operating policies associated with the activity or process. These emissions include, but are not limited to, fugitive and process emissions sources (as defined in Section 2.2.1). For fugitive and process emissions, the agency that pays for the purchase and maintenance of the emitting equipment reports the emissions. Agencies should use existing data and document calculation methodologies and to improve, refine, and enhance data collection as appropriate to account for fugitive emissions within their inventory. Specified Scope 3 emissions in an agency's organizational boundary, where the agency does not have full operational control, are described in Section 2.2.3.

2.2. Operational Boundaries: Scopes

After agencies determine the operations that fall within their organizational boundaries, emissions sources are categorized as Scope 1, 2, or 3, as illustrated in Figure 1. The calculation methodologies for Scope 1, 2, and 3 emissions are detailed in the appendices. To avoid double counting, emissions from different agencies cannot be combined. One agency's Scope 1 or 2 emissions may be another agency's Scope 3 emissions.

Figure 1: Federal Greenhouse Gas Emissions Source by Scope

Common Sources of Federal Greenhouse Gas Emissions

CO_2 SF_6 NF_3 CH_4 N_2O HFCs PFCs

SCOPE 1: Greenhouse gas emissions from sources that are owned or controlled by a Federal agency.

SCOPE 2: Greenhouse gas emissions resulting from the generation of electricity, heat, or steam purchased by a Federal agency.

SCOPE 3: Greenhouse gas emissions from sources not owned or directly controlled by a Federal agency but related to agency activities.

*Additional, significant Scope 3 emission sources exist beyond the examples provided.

2.2.1. Scope 1

Federal emissions reporting includes all direct GHG emissions from sources that are owned or controlled by the Federal agency within this scope. While certain sources of GHG emissions are excluded from agency GHG emissions reduction targets, these excluded emissions are still reported in the agency comprehensive GHG inventory. For example, while an agency's reduction target may not include "direct emissions from excluded vehicles," these sources are still included in the agency's inventory.

Scope 1 emissions result primarily from the following types of activities when they are owned or controlled by the reporting agency:

- **Generation of electricity, heat, cooling, or steam**: Emissions that result from combustion of fuels in stationary sources (e.g., boilers, furnaces, turbines, and emergency generators), including CO_2, CH_4, and N_2O emissions from biomass combusted for production of electricity, heat, cooling, or steam.[19]

- **Mobile sources**: Emissions that result from the combustion of fuels in agency-controlled mobile combustion sources (e.g., automobiles, ships, and aircraft), including Federal fleet vehicles, such as GSA-leased, commercially leased, and agency-owned vehicles. These include CO_2, CH_4, and N_2O emissions from biofuel combustion.

- **Fugitive emissions**: For the purpose of this Guidance, emissions that result from intentional or unintentional releases of GHGs from within the agency's organizational boundary (e.g., equipment leaks from joints, seals, packing, and gaskets; landfills and wastewater treatment plants; HFC emissions from the use of refrigeration and air conditioning equipment; methane leaks from gas transport; SF_6 emissions from leaking electrical equipment; and CH_4 emissions from agency owned and operated coal mines, helium production, venting, etc.).[20]

- **Process emissions**: Emissions that result from the manufacturing or processing of chemicals and materials and from laboratory activities.

In addition, agencies may report types of Scope 1 GHGs that are not specifically mentioned in Executive Order 13693. For example, agencies may voluntarily report non-covered GHGs with high global warming potentials.

Biomass and biofuel combustion result in GHG emissions of CO_2, CH_4, and N_2O. Combustion-related CH_4 and N_2O are dependent on the combustion conditions, technology, and pollutant control policies, as well as fuel characteristics, rather than the ultimate source of the carbon in the

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[19] CO_2 emissions from stationary and mobile combustion of biomass (including biogas and biofuels) are identified and calculated but are accounted for separately in Scopes 1, 2, or 3 since biogenic emissions are not counted under GHG reduction targets.

[20] Note that "fugitive emissions," as defined in this Guidance, are not intended to coincide with other statutory uses of the term.

fuel or connection to the carbon cycle.[21] These CH_4 and N_2O emissions are included under Scope 1 reporting, and are included in agency reduction targets.[22] CO_2 emissions from biomass and biofuel combustion are reported and accounted for separately. More discussion about CO_2 emissions related to biomass and biofuel combustion can be found in Section 3.

Emissions resulting from land use activities, fertilizer use, composting, manure management, and enteric fermentation when the animals are owned by the Federal agency may be reported voluntarily in Scope 1 at this time, but are separate from emissions targeted for reduction. See Section 3 for more information on biogenic emissions fluxes and the Appendices for information on reporting, calculation methods, data sources, and example calculations for biomass and biofuels.

2.2.2. Scope 2

Scope 2 reporting includes emissions associated with consumption of purchased or acquired electricity, steam, heating, or cooling as Scope 2. These emissions are a consequence of activities that take place within the organizational boundaries of the reporting agency, but the emission releases physically occur at the facility where the electricity, steam, heating, and/or cooling is generated.

Emissions related to the electricity purchased for Federal fleet electric vehicles, including low speed electric vehicles (LSEVs), are Scope 2 emissions and are assumed to be captured in agency facility electricity reporting. Agencies do not need to separately report electricity use in vehicles charging at the facility in the Annual GHG Data Report workbook. Current policies stipulate that the electricity used in these vehicles is reported as part of alternative fuel use through the FAST system. FAST is a separate reporting system from the Annual GHG Data Report workbook and electricity reported in FAST is not added to electricity reported in the non-FAST parts of the reporting Annual GHG Data Report workbook to avoid double counting of energy and emissions.[26]

In addition to CO_2, CH_4, and N_2O from fossil fuels, Scope 2 reporting includes CO_2 emissions associated with the portion of purchased electricity, steam, heating, or cooling generated from biomass or biofuels. Related CH_4 and N_2O are considered anthropogenic and are to be reported as targeted emissions along with fossil-based purchased electricity, steam, heating, or cooling, whereas biogenic CO_2 emissions are reported separately.

Purchased electricity results in indirect emissions associated with transmission and distribution (T&D) losses in Scope 2 only for the electricity T&D operations they control. Emissions associated with T&D losses from purchased steam and chilled water are reported as Scope 2 emissions, and are not reported separately. Indirect T&D electricity losses (i.e., those associated with electricity purchased from a utility or provider not under the operational control of the agency) are to be reported as Scope 3 emissions (see Section 2.2.3).

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[21] Revised 1996 IPCC Guidelines, Reference Manual, Section 1.1, Energy: http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch1ref1.pdf.

[22] See Chapter 3 for details on GHG accounting for biomass and biofuel combustion.

2.2.3. Scope 3

Scope 3 includes indirect emissions not included in Scope 2. Scope 3 emissions are a consequence of the agency's activities but are released from sources outside its organizational boundary.

Because efforts to account for Scope 3 emissions are recent and accepted methods for calculating emissions are evolving, this Guidance utilizes a phased approach for the inclusion of Scope 3 emissions in agency inventories. The goal of this approach is to continually improve Scope 3 data quality. Initial efforts focus on accounting for Scope 3 emissions categories for which reliable and accessible data are available for estimating emissions, and for which more detailed calculation methodologies have been established. As a result, substantial fractions of the Scope 3 emissions of many agencies will not initially be captured. Over time, new methodologies and procedures will be included in revisions to this document to improve the Federal Government's ability to account for and report GHG emissions through the inventory process.

Scope 3 categories include the following, if included in an agency's' Scope 3 baseline and reduction target:

- Federal employee business air travel
- Federal employee business ground travel
- Federal employee commuting
- Contracted solid waste disposal (i.e., municipal solid waste that is sent to a landfill not owned or operated by the agency)
- Contracted wastewater treatment (i.e., municipal wastewater that is sent to a wastewater treatment plant not owned or operated by the agency)[23]
- T&D losses associated with purchased electricity

Starting in FY 2017, a new category for newly-solicited, full-service leases of 10,000 rentable square feet or greater will be added to agency inventories, separate from the Scope 3 categories already subject to agency targets. Since this is accounted for as separate Scope 3 category there is no need to revise Scope 3 baselines or develop targets; the category is intended to allow agencies to isolate and track progress for this newly adopted emissions category.

Appendix C provides the calculation methodologies for each of these emissions categories.

Agencies will improve and update data associated with Scope 3 baselines over time as the Federal Government improves its ability to identify and account for these emissions. In addition, as data quality and methodologies improve and emerge, further guidance that specifically addresses Scope 3 may be provided.

Agencies may voluntarily report additional Scope 3 emissions resulting from unique activities. Voluntary reporting refers to the reporting of emissions that do not currently have a specified calculation methodology in the Appendix, or are not otherwise indicated as reported under this

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[23] Similar to the way other utilities are accounted for, contracted wastewater and solid waste should be reported by the party paying for the services (the Federal agency holding the lease will account for contracted waste and wastewater unless the agency pays for the service).

Guidance. Agencies may report emissions for these voluntary items, if they identify them and provide documentation for calculation methods used in the submission of the agency's inventory. These emissions are reported in the agency's qualitative statement and are not included in the standardized GHG inventory of targeted, excluded, and biogenic emissions in the Annual GHG Data Report workbook and FEMP's public data site. Some examples of such activities associated with land management agencies include emissions associated with the following:

- Visitors to Federal sites (e.g., National Parks, medical centers, national cemeteries, etc.)

- Third-party oil, gas, and coal mine leasing activities

- Enteric fermentation, when releases occur from livestock not owned by an agency but located on Federal land

- Manure management systems when the systems exist on Federal land, but are operated by others.

To the extent practicable, when agencies report voluntary Scope 3 emissions, they should use methodologies that are commonly accepted and can be replicated. This approach promotes consistent calculations that may be of use for additional emissions categories reporting in future years. An agency may report emissions in a category where no commonly accepted methodology is available, if it documents and submits the calculation methodologies used as part of its annual inventory. Once an agency reports voluntary Scope 3 categories, the baseline will be adjusted, and the agency should continue to report emissions in that category and include those emissions in the reduction target. There is no baseline adjustment for voluntary Scope 3 reporting that is not included as part of a reduction target, even if those emissions are included in the agency's qualitative statement. When determining whether or not to include optional Scope 3 categories in annual inventories, agencies should consider the following:

- Whether the emissions associated with the category are large enough to warrant measurement and tracking

- Feasibility and cost of collecting the data

- Level of influence that an agency may have in reducing associated emissions

- Estimated cost of measuring and making reductions

New methodologies may be included in revisions to this document to improve the Federal Government's ability to account for and report emissions within the inventory process. For example, while life cycle emissions associated with the production of biofuels (and other alternative fuels such as hydrogen) are not currently measured in Scope 3, these emissions may be considered in Scope 3 at a future date.

Examples of areas that may be added over time include emissions from the following:

- Activities of vendors, contractors, tenants, and concessionaires of Federal agencies

- Supply chain emissions.

As additional Scope 3 categories are included in future accounting and reporting, it may be necessary to adjust base year and annual inventories. This process is discussed in more detail in Section 5.5.

Supply Chain Greenhouse Gas Management

Vendor and contractor (supply chain) emissions are those associated with the services, materials, and products that an agency purchases, and are categorized as Scope 3. Agencies may voluntarily identify and report these emissions.

Efforts to inventory agency Scope 3 vendor and contractor emissions signals to industry that the government finds these relevant to managing emissions associated with Federal operations. To identify and ultimately reduce Scope 3 vendor and contractor emissions, agencies need to access relevant data, both internally and from vendors. Voluntary reporting of vendor and contractor emissions encourages agencies to begin to identify their supply chain vendors, and related procured products/services, so that agencies have the time to identify system limitations and develop processes to address them. Agencies interested in voluntarily reporting supply chain emissions should scope their activities so that the focus is on mapping their supply chain, identifying what was procured from identified vendors and obtaining necessary vendor GHG emissions data, so that the internal data gathering system and process changes are identified and implemented. Supplier emissions will be reported in the agency's comprehensive GHG inventory qualitative statement.

2.3. de minimis

In emissions accounting, *de minimis* refers to a minimum emissions accounting threshold below which reporting is not indicated. For the purposes of this Guidance, no *de minimis* reporting threshold exists for categories included in Federal GHG reporting. However, simplified estimation methodologies for particular categories are defined throughout the appendices to reduce the burden on both small and large agencies.

3.0   Sequestration and Emissions from Land Use, Agriculture, and Biogenic Sources

This chapter describes reporting and appropriate methodologies for several categories of GHG emissions and sequestration associated with agency land use management, agricultural practices, and other biogenic sources, like the combustion of biologically-derived materials.

For the purpose of this Guidance, two categories of biogenic CO_2 emissions[24] from combustion are to be reported: biofuel combustion and biomass combustion. Biomass is solid biological matter (e.g., trees, crops, grasses, tree litter, roots) that can be used as a fuel. Biofuels are liquid fuels containing biologically-derived substances combusted to generate energy. Examples include biodiesel and ethanol blended fuels.[25]

The Appendices provide information on reporting, calculation methods, data sources, and example calculations for the combustion of biofuels and biomass.

This chapter also includes a discussion of items that can be voluntarily reported, such as composting and emissions from agricultural management activities, including enteric fermentation, and manure management. These categories are not currently included in reporting. Agencies may report emissions for these voluntary items, but emissions reductions targets and demonstrated progress toward meeting those targets will not reflect these fluxes. Agencies may voluntarily report these items if they clearly identify them and provide documentation for calculation methods used in the submission of the agency's inventory.

3.1.   Biofuel and Biomass Combustion

Biomass and biofuel combustion result in GHG emissions of CO_2, CH_4, and N_2O. For the FY 2008 baseline and subsequent annual inventories the emissions associated with biomass and biofuel combustion are reported within the appropriate scope in which they occur. However, the CO_2 emissions from biomass and biofuel combustion are considered biogenic and are reported separately from fossil fuel-generated GHGs and biomass and biofuel-generated CH_4 and N_2O. Due to ongoing efforts to develop accounting approaches that appropriately reflect the net atmospheric contribution of biogenic emissions associated with biomass use for energy, these CO_2 emissions are accounted for outside the reduction targets under E.O. 13693. Biogenic CO_2 emissions are reported separately from other categories.[26] Accounting for biogenic emissions outside reduction targets also aligns with energy policy defining biomass as renewable energy.

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[24] Biogenic CO_2 emissions are emissions related to the natural carbon cycle as well as those resulting from the production, harvest, combustion, digestion, fermentation, decomposition, or processing of biomass.

[25] Biogases yielded from landfills are not explicitly discussed in this section, although they may be considered a biofuel.

[26] This Guidance establishes guidelines for Federal agencies in calculating and reporting GHG emissions fluxes from different sectors and sources associated with agency operations, and seeks to avoid double counting. Though its goals differ from those of the IPCC inventory (i.e., to develop a common system for countries to inventory all anthropogenic GHG emissions, including fossil and biogenic CO_2 emissions, across all sectors), both this effort and the IPCC inventory guidelines seek to avoid double counting. To that end, in IPCC inventories, carbon sequestration and CO_2 emissions within biological systems, including the growth and harvest of terrestrial biomass, are assigned to Land

CH$_4$ and N$_2$O emissions resulting from combustion of biomass and biofuel are not considered biogenic, and accounted for in the same manner as emissions of these gases from the combustion of fossil fuels. Combustion related CH$_4$ and N$_2$O emissions are dependent on the combustion conditions, technology, and pollutant control policies, as well as fuel characteristics, rather than the ultimate source of the carbon in the fuel or connection to the carbon cycle.[27] These CH$_4$ and N$_2$O emissions are accounted for as reduction-targeted emissions. All GHGs from the fossil fuel portion of biofuel blends, including CO$_2$, are to be reported within the appropriate scope.

3.2. Voluntary Land Use and Agricultural Emissions Reporting Categories

Composting

Composting may generate GHG emissions through the biodegradation of organic plant matter performed by bacteria, yeast, and fungi. Although composting of organic waste, such as food waste and grass clippings, is uncommon in many agencies, it remains an effective way to reduce landfill waste. Reporting the emissions from composting is voluntary at this time.

Nitrous Oxide Emissions Associated with Fertilizer Use

Nitrous oxide is produced in soils through the microbial processes of nitrification and denitrification both through anthropogenic and natural causes. Anthropogenic emissions of N$_2$O from agricultural soils consist of both direct and indirect emissions that result from managed inputs of N fertilizer, and management practices that lead to a greater release of mineral nitrogen to the soil on managed lands.

Reporting of N$_2$O emissions associated with fertilizer use on Federal lands is voluntary at this time, but encouraged.[37]

Enteric Fermentation

Enteric fermentation refers to fermentation that occurs in the digestive systems of ruminant animals (such as cattle, sheep, and goats) that have a large "fore-stomach," or rumen, within which microbial fermentation breaks down food into soluble products. The microbial fermentation that occurs in the rumen enables ruminant animals to digest coarse plant material for food, but also produces CH$_4$. Management of domesticated livestock is considered to result in anthropogenic emissions of GHGs. Conversely, emissions released by wild animals on Federal lands (e.g., a herd of elk in a National Park) are not considered anthropogenic.

Agencies may voluntarily report emissions from enteric fermentation, separately from reduction-target emissions and inventories. Reporting for these emissions may be included in future versions of this Guidance. If the emissions are reported and the livestock in question are owned by the

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Use, Land Use Change and Forestry (LULUCF) sector. Therefore, when biomass is burned for energy, the related biogenic CO$_2$ emissions are accounted for in the LULUCF sector where the carbon was stored and initially emitted via harvest, not the Energy sector. (IPCC, 2006)

[27] Revised 1996 IPCC Guidelines, Reference Manual, Section 1.1, Energy Accessed at: www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch1ref1.pdf.

Federal agency, these emissions are reported as Scope 1. If releases occur by livestock located on Federal land but not owned by an agency, these emissions may be voluntarily reported as Scope 3. Agencies are not to report releases by wild animals on Federal lands.

Manure Management

Manure in large quantities can pose a risk of pollution to waterways and ecosystems. As a result, large-scale livestock operations often store or stabilize manure with a manure management system. These systems can include anaerobic and aerobic lagoons, liquid slurry systems, storage pits, digesters, solid storage systems, dry lots, composting, incineration, and aerobic systems. Natural pasturing, manure land application, daily spread systems, or off-site composting are not considered manure management systems.

Agencies may voluntarily report emissions from manure management systems or other manure handling processes, separately from reduction-target emissions and inventories. If these systems are operated or controlled by the agency, the emissions may be voluntarily reported as Scope 1. If the activities take place on Federal land, but are operated by others, these emissions may be voluntarily reported as Scope 3.[28]

3.3.   Reporting: Net Carbon Stock Changes on Forest Land

When assessing GHG emissions fluxes associated with agency operations, agencies should examine how different land uses and related management techniques affect carbon sequestration and storage as well as GHG emissions. Sequestration refers to the process of increasing the carbon content of a reservoir/pool other than the atmosphere, including the removal of atmospheric carbon dioxide by biological processes, such as photosynthesis. Once sequestered via photosynthesis, carbon can be stored by plants or soils. When net carbon stocks decrease (such as when carbon is released into the atmosphere through combustion and decay, or harvest), this reflects a net emission, and conversely, when net carbon stocks increase (such as when carbon is stored during tree growth or through soil absorption), this represents net sequestration. These net fluxes[29] allow for estimation of GHG emissions and sequestration associated with land use and related management activities.

The U.S. Forest Service (USFS) estimates net carbon stock changes on managed lands to meet annual national GHG inventory requirements for the United Nations Framework Convention on Climate Change (UNFCCC).[30] The report includes the five main IPCC carbon pools reported in the U.S. GHG Inventory: aboveground biomass, belowground biomass, dead wood, litter, and soil. The USFS and the U.S. Geological Survey (USGS) are working together to combine satellite

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[28] If this source is elected, the recommended methodology is a Tier 1 approach as described in the IPCC 2006 Greenhouse Gas Guidelines. Methodologies, data sources, emission factors, and further discussion of these issues can be found in IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. Chapter 10: "Emissions from Livestock and Manure Management." The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T. Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

[29] The term "flux" is used to describe the net emissions of greenhouse gases to include both the emissions of CO_2 to and the removals of CO_2 from the atmosphere.

[30] See http://nrs.fs.fed.us/pubs/2394 for further details.

data with surface measurements to improve the quality and timeliness of estimations of carbon stock changes on public and private lands. The USGS is also planning to provide information on emissions and removals on Federal lands.

Federal agencies, in particular those that manage large segments of public land, should obtain the necessary data from the USFS, in coordination with USGS, and comply with established reporting requirements.

While reporting of carbon stock changes is not currently included in the Annual GHG Data Report workbook, it may be integrated into this reporting in the future. Agencies should continue to track emerging approaches that involve identifying, applying, evaluating, and reporting on land management practices that increase the sequestration of carbon on Federally-managed lands.

4.0 Renewable Energy and Carbon Offsets

Renewable energy is defined as energy derived from resources that are renewed indefinitely. Forms of renewable energy include solar, wind, sustainable biomass, landfill gas, ocean (including tidal, wave, current, and thermal), geothermal, municipal solid waste, or new hydroelectric generation capacity achieved from increased efficiency or additions of new capacity at an existing hydroelectric project.[36,37] While restrictions on placed-in-service dates for renewable energy projects in E.O. 13693 limit sources agencies can apply to renewable electricity and clean energy targets, they do not change how GHG emissions from these sources are calculated. CEQ has issued guidance for renewable energy certificates, which agencies should review for further guidance.[31]

GHG emissions from renewable energy sources are based on the actual emissions of the renewable energy sources at the point of generation, regardless of whether they are qualified as alternative energy or as renewable electric energy under the clean energy targets established by E.O. 13693, *Planning for Federal Sustainability in the Next Decade*, March 2015.[32] The clean energy targets direct agencies to consume a minimum amount of clean energy every year and do not specify special treatment in GHG emissions calculations. For example, while energy from municipal solid waste (MSW) is defined as renewable energy under EPAct, GHG emissions calculations from MSW recognize that a large share of the fuel content in MSW is from fossil sources such as plastics. Reporting the application of renewable energy to clean energy targets versus GHG inventories will be handled automatically in the Annual GHG Data Report workbook.

Clean energy targets include renewable electric energy, which has a minimum target each year, and alternative energy, which has no minimum target but can be used to meet the portion of the clean energy target not met by renewable electricity. Renewable electric energy includes solar, wind, biomass, landfill gas, ocean (including tidal, wave, current, and thermal), geothermal, geothermal heat pumps, micro-turbines, municipal solid waste, or new hydroelectric generation capacity achieved from increased efficiency or additions of new capacity at an existing hydroelectric project.[33] Alternative energy includes thermal renewable energy on site at Federal facilities if agencies retain corresponding renewable attributes. [34]

Agency renewable energy use, including the source of the renewable energy, shall be reported separately from conventional energy and fuel use. This chapter provides agencies with guidance on accounting for emissions from on-site agency-owned renewable energy consumption (Section

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[31] CEQ Renewable Energy Certificates Guide (June 16, 2016). Retrieved from: https://sustainability.gov/Resources/Guidance_reports/Federal-Renewable-Energy-Certificate-Guide-June-16-2016-Final-Version.pdf

[32] E.O. 13693, Sec. 3 (b).

[33] EPAct 2005, Sec. 203 and E.O. 13693 Planning for Federal Sustainability in the Next Decade, March 2015, Sec. 19 (v).

[34] E.O. 13693 Sec. 3 (e) (i). Alternative energy also includes a portion of fuel cell and combined heat and power (CHP) systems that use fossil fuels, small modular nuclear reactors, and carbon capture and sequestration at fossil fuel plants, but none of these are considered renewable and being categorized as clean/alternative energy has no impact on GHG emissions calculations.

4.1) and emissions from the purchase or use of off-site renewable energy and/or purchase of renewable energy certificates (RECs) (Section 4.2).

To be consistent with current recommended inventory methods published in the *World Resources Institute GHG Protocol Scope 2 Guidance,* January 2015,[35] the Annual GHG Data Report workbook will use a dual accounting approach that shows agency inventories based on both location-based emission factors and market-based emission factors. "Avoided" emissions from purchases of RECs will no longer be calculated based on non-baseload Emissions and Generation Resource Integrated Database (eGRID) emission factors. Unbundled REC purchases and green energy purchases will be reported using the actual emissions from the renewable energy sources using market-based accounting methods.

This dual accounting approach will show agency Scope 2 GHG emissions without purchases of renewable energy and with purchases of renewable energy. The market-based method reflects emissions from electricity that agencies have purposefully chosen (or their lack of choice). It derives emission factors from contractual instruments, which include any type of contract between two parties for the sale and purchase of energy bundled with attributes about the energy generation, or for unbundled attribute claims. The market-based accounting provides an alternative measure of GHG emissions to the location-based method. The location-based method reflects regional or subnational emission factors reflected in eGRID, as a first preference, or national production emission factors, for example for electricity in other countries. The dual accounting approach for Scope 2 emissions will be added to the Annual GHG Data Report workbook as a supplement to existing tables showing agency target, non-target, international and total emissions as a way of increasing the transparency of the role renewable energy purchases play in agency emissions inventories.

Agencies are encouraged to allow third-party owned and/or operated renewable energy systems on Federal land to facilitate renewable energy generation with low GHG emissions. Section 4.3 of this chapter provides agencies with guidance related to reporting of renewable energy generated on Federal land. This chapter also describes the rationale for excluding the use of carbon offsets, which are covered in Section 4.4.

This Guidance considers the current legislative and regulatory environment with regard to renewable energy and carbon offsets. The enactment and promulgation of new laws and regulations related to climate change could affect the role of RECs and carbon offsets in meeting agency GHG targets. This Guidance will be updated as necessary to reflect changes in policies or regulations.

4.0.1. Reporting On-Site versus Off-Site Renewable Energy Use

It is important to report whether electricity consumed from a renewable energy generator is from a generator located on the site where it is consumed or whether the electricity is being delivered through the electric grid from off site. There are no Scope 3 transmission and distribution losses

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[35] *World Resources Institute GHG Protocol Scope 2 Guidance, found at* www.ghgprotocol.org/files/ghgp/Scope%202%20Guidance_Final.pdf.

associated with on-site projects.[36] For off-site projects (projects where power is transmitted through the electric grid), transmission and distribution losses are the same as electricity from a utility except for unbundled RECs which do not include the underlying energy and therefore have no transmission losses. Transmission and distribution GHG factors are included in Appendix C.

4.0.2. Retention of Renewable Energy Certificates

In all cases of agency consumption of renewable energy, if an agency does not own the RECs and environmental attributes for the renewable energy that it consumes, the consumed energy and associated emissions are considered and calculated the same as conventional energy from the electric grid or fossil fuels and are reflected as such in Scope 2 emissions. Once a REC has been used to make a claim of renewable energy use or reduced Scope 2 emissions from purchased electricity, the REC cannot be sold or transferred. Making a claim constitutes retirement of the REC and avoids the possibility of a claim by another party or double counting of the renewable energy. When RECs are not available for thermal renewable energy, agencies shall ensure they are the only organization making environmental or other claims based on renewable thermal energy to avoid double-counting of GHG attributes. For further guidance on RECs, see Section 4.2.[37]

4.0.3. Purchase of Energy from Biomass Combustion

Emissions from biomass or biofuels combustion are covered in Section 3.1. The FY 2008 baseline and subsequent annual inventories include reporting on biogenic combustion emissions associated with the biogenic portion of biofuel and biomass combustion.[38] If the facility is not owned by the agency, but the renewable electricity is consumed on-site, associated emissions, including CH_4 and N_2O and biogenic CO_2, are accounted for in Scope 2. Biogenic CO_2 and CH_4 and N_2O emissions from biomass combustion are accounted for in Scope 1 if the facility is owned by the agency. If the biomass-fueled electric generator is owned by the agency, see further guidance in Section 4.1.1.

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[36] This is the same for generation units that are in close proximity to the site of consumption and fed directly to the agency without passing through the grid.

[37] Renewable energy and environmental attributes are associated with an on-site renewable energy system even if a REC is not formally issued by a certification body or tracking system. Agencies shall ensure sole ownership of these attributes through other means, such as contractual language, and retain these RECs to make claims concerning renewable energy and GHG emissions. For further guidance *see Implementing Instructions for Executive Order 13693 Planning for Federal Sustainability in the Next Decade,* Sec. III A. 4, page 26 discussion of "Proof of Renewable Electric Consumption."

[38] Due to ongoing analysis, efforts to collect and synthesize data, and the development of accounting approaches that will appropriately reflect the true atmospheric impact of biogenic emissions, reporting includes biogenic biomass / biofuel combustion CO_2 emissions, but these emissions do not have to be included in reduction targets. Part or all of the carbon in these fuels is derived from material that was fixed by biological sources on a relatively short timescale. Depending on the full emissions impact of biomass production and use, these emissions may or may not represent a net change in atmospheric CO_2. This contrasts with carbon from fossil fuels, which was removed from the atmosphere millions of years ago.

The default calculation methodology for addressing the CH_4 and N_2O emissions from biomass can be found in Appendix A.2: Stationary Combustion: Biomass and Biofuel.

4.0.4. Purchase of Energy from Conversion of Landfill Gas

A common method for reducing anaerobic methane and other landfill generated GHG emissions is the collection and combustion of landfill gas. At some landfills, gas is combusted by flaring, while at others gas is combusted to produce energy or upgraded and injected into a gas transmission or distribution system. Emissions reductions from capturing and destroying landfill-generated GHGs prior to energy generation are not part of the agency's emissions reporting (unless the agency owns the landfill) as these emissions reductions are not conveyed to the purchasers of electricity, energy, or RECs from landfill gas to energy projects.

4.0.5. Energy from Municipal Solid Waste Combustion

The combustion of MSW at waste-to-energy (WTE) facilities is an eligible renewable resource under clean energy and renewable electricity targets. However, while MSW contains biogenic materials such as food, paper, and discarded wood products, a significant portion of MSW is non-renewable materials derived from fossil fuels, such as plastics. Therefore both fossil and biogenic emissions from WTE facilities are included in emissions reporting. The GHGRP requires large WTE facilities that are subject to the rule to separately report their biogenic CO_2 emissions and non-biogenic, or fossil-derived, CO_2 emissions.[39] Assumptions regarding biomass content in waste incorporated into the default WTE emissions approach are included in Appendix B, Section B.6: Quantifying Emission Reductions from Renewable Energy.

If renewable energy is based on waste-to-energy (WTE), CH_4 and N_2O emissions, as well as emissions from the non-biomass content in WTE, it is accounted for in Scope 1 if the facility is owned by the agency. If the facility is not owned by the agency, but the renewable electricity is consumed on site, associated emissions are accounted for in Scope 2.

For the FY 2008 baseline and subsequent annual inventories, agencies report Scope 2 CO_2 emissions associated with the biogenic portion of WTE projects. Fossil CO_2 and CH_4 and N_2O emissions resulting from combustion during generation of electricity are included in Scope 2 reporting and are not considered biogenic, and are therefore included in agency reduction targets.

WTE facilities reporting their biogenic CO_2 emissions and anthropogenic GHG emissions to EPA under the GHGRP should be able to provide this information to the electricity provider.

4.1. Agency-Owned On-Site Renewable Energy

4.1.1. Consumption of Renewable Electricity Generated On Site

If an on-site renewable energy system is used to generate electricity, the agency's Scope 1 GHG emissions will be lower than they would have been if the electricity had been produced by combustion of fossil fuel on site. If an on-site renewable electricity system is replacing electricity

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[39] More information about EPA's Greenhouse Gases Reporting Program can be found at
www.epa.gov/ghgreporting.

purchased from the grid, the agency's Scope 2 GHG emissions will be lower than they would have been if the energy had been purchased from the grid. Therefore, the agency should not have to make a separate calculation of its reduction in electricity use because the amount of conventional electricity reported will be lower.

As stated in Section 4.0.2, if the agency does not own the RECs and environmental attributes for energy generated and consumed by the agency, the electricity delivered to the agency and associated emissions are considered the same as conventional grid-supplied electricity and are to be reflected as such in Scope 2 emissions.

If agencies use on-site renewable energy systems, renewable energy use is reported separately from conventional energy and fuel use, and identified as on-site generation whether it is owned by the agency or by a third-party organization that is delivering the renewable energy and/or RECs from the system to the agency.

If the on-site renewable electricity system is based on biomass or WTE, CH_4 and N_2O emissions, as well as emissions from the non-biomass content in WTE, and the agency owns the facility, it is accounted for in Scope 1. See Sections 4.0.3 and 4.0.5 for more detail on biomass and WTE reporting. All on-site renewable energy lowers GHG emissions from transmission and distribution losses, which are accounted for under Scope 3.[40]

For agencies generating on-site renewable electricity that reduces on-site natural gas use or other fossil fuel combustion, the lower fossil fuel use resulting from the system is automatically reflected in reduced Scope 1 emissions when the agency reports less fossil fuel use. The agency does not need to calculate separate GHG emissions for the fossil fuel displaced by the renewable electricity.

For fully serviced leases, if the landlord obtains all or a portion of the electricity from renewable sources, and retains ownership of the RECs associated with the renewable electricity, the tenant agency would report only the emissions from the electricity which is not renewable. For example, if the landlord purchases 100% renewable electricity, the tenant would report no Scope 3 emissions from that electricity use.

4.1.2. On-Site Renewable Energy Systems That Don't Generate Electricity

On-site renewable energy systems that do not generate electricity but produce thermal energy, such as solar water heating, geothermal heat pump, and geothermal direct use, may be cost-effective ways to reduce fossil fuel use for thermal loads and, thus, GHG emissions. Whether the agency owns the on-site systems, or pays for them under an authorized procurement mechanism, there are no special steps required to report emissions. Such systems reduce the agency's generation and/or purchase of electricity, natural gas, or other conventional energy sources. The lower emissions associated with the reduced combustion of natural gas or other fossil fuel on-site would be reflected in the agency's Scope 1 emissions, while the reduced purchase of electricity or conventional non-electric energy would be reflected in the agency's Scope 2 emissions. These

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[40] This is the same for generation units that are in close proximity to the site of consumption and fed directly to the agency without passing through the grid.

system characteristics are reported in the Annual GHG Data Report workbook as part of the EPAct 2005 GHG emissions reporting and E.O. 13693 clean energy target reporting. These systems also lower GHG emissions by avoiding Scope 3 transmission and distribution losses if they reduce the purchase of electricity.

Scope 1 emissions of agencies that own on-site systems using biomass to produce non-electric energy (heat) include emissions from the on-site biomass conversion system. Emissions from biomass or biofuels combustion are covered in Section 3.1. Biomass combustion involves fuels whose production and delivery (even from on-site wastes) can produce GHG emissions, especially CH_4 and N_2O. If the conversion equipment is owned by another entity that delivers steam, heated air, or hot water as the product, the emissions from the system are reported as Scope 2 emissions (see Appendix B for calculations).

4.1.3. Agency-Owned Renewable Energy Generation Where the Agency Does Not Own Renewable Energy Certificates but Does Use Energy

Energy from a renewable energy source is not considered "renewable energy" if the agency does not own the RECs that signify ownership of the renewable and other attributes of the output separate from the energy per Sec. 3(d) of E.O. 13693, which stipulates that credit for renewable energy use requires "retaining corresponding renewable energy certificates (RECs)." If an agency consumes this "null power" it is treated as non-renewable energy for purposes of GHG accounting. For electricity the emissions are calculated using the same emissions factors and methodology that are applied to conventional electricity based on the location of the renewable energy generator. For thermal renewable energy in this situation the default assumption for GHG emissions calculations is equivalent to that from the same amount of energy provided by natural gas. If a fuel other than natural gas would be the most likely substitute agencies can adjust the "null power" emissions to match the actual substitute fuel.

4.2.   Renewable Energy Purchases and Use of Renewable Energy Certificates to Meet Greenhouse Gas Reduction Targets

Federal agencies may reduce their GHG emissions by purchasing renewable energy and/or acquiring and retaining (or requiring retirement of) RECs. RECs are essential to claims concerning renewable energy and adjustments to GHG emissions. RECs may be acquired with purchased or produced electricity generated from renewable energy sources, or by purchasing RECs separate from the delivery of energy (unbundled RECs). For the purposes of this Guidance, the term "consumption" means the use of renewable energy acquired through authorized procurement mechanisms. Whatever acquisition method is used, the agency can claim the environmental attributes only if it owns the REC, which avoids double counting. RECs are applied to Scope 2 emissions. Therefore, if the agency does not own the RECs and environmental attributes for the renewable energy produced by the generation system, the electricity delivered to the agency and associated emissions are the same as conventional grid-supplied electricity and are reflected as such in Scope 2 emissions. Purchases of bundled or unbundled RECs will be included in the market-based accounting but not location-based accounting. They are used to measure agency progress toward GHG reduction targets.

For electricity, a REC is a tradable commodity created when one megawatt-hour (MWh) of electricity is generated from a renewable energy source. In many cases, RECs are formally issued to generators by state or regional electronic tracking systems that support verification of the generation and provide clear documentation of REC ownership. Even if they are not included in a formal REC issued by a certification program or tracking system, renewable energy and environmental attributes are nevertheless created by generation from a renewable energy source and may be tracked by contracts between parties and other methods.[41] RECs are generally defined by states and certification organizations to contain the "environmental attributes" of electricity generated from renewable energy sources. This allows REC owners to claim to be using renewable energy as well as the attributes of renewable energy (e.g., GHG emissions benefits) for renewable energy projects placed in service within the previous 10 years when compared with conventional electricity or energy. By paying attention to the specific attributes, buyers can purchase RECs based on the generation resource (e.g., wind, solar, geothermal), generator vintage, year of generation, and location of generation. For purposes of Federal clean energy targets and GHG accounting, only RECs produced by sources of renewable energy placed into service within 10 years prior to the start of the fiscal year in which they are applied to an agency GHG inventory can be counted.[42]

Power purchase agreements with renewable energy facilities do not automatically convey RECs to the purchaser of the power. Agencies purchasing electricity from renewable energy facilities should make clear in any contractual or lease arrangement which party, the buyer or the seller, will own the RECs and associated environmental attributes for the purpose of emissions inventories under this Guidance. The REC qualifies for Scope 2 emissions reporting and calculating progress toward GHG reduction targets only if it owned by the agency. Likewise, agencies with on-site renewable energy systems, whether the agency owns the facility or the facility is third-party owned, should be explicit in any agreement about which party owns the RECs.[43]

RECs can be used to help meet GHG reduction targets regardless of whether the agency purchases RECs bundled with energy or unbundled. Emissions from the projects/resources supplying the bundled and unbundled REC purchases will be allocated to an agency's market-based inventory by the Annual GHG Data Report workbook. In some cases, renewable energy tracking systems assign unique serial identification numbers to each qualified REC generated by facilities in the region, state, or province covered by the system, and enable secure transfer and retirement of RECs amongst account holders within the system. When available, agencies should request serial numbers of purchased RECs for tracking purposes.

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[41] For further guidance see *Implementing Instructions for Executive Order 13693 Planning for Federal Sustainability in the Next Decade*, Sec. III A. 4, page 26 discussion of "Proof of Renewable Electric Consumption," www.whitehouse.gov/sites/default/files/docs/eo_13693_implementing_instructions_june_10_2015.pdf.
[42] EO 13693, Sec. 19 (v).
[43] Guidelines for eligible RECs are defined in the *Federal Renewable Energy Certificate Guide*: https://sustainability.gov/Resources/Guidance_reports/Federal-Renewable-Energy-Certificate-Guide-June-16-2016-Final-Version.pdf and E.O. 13693.

As noted in Section 4.0.1, it is important to report whether a renewable energy generator is on the site where the renewable electricity is consumed or is being delivered through the electric grid because there are no Scope 3 transmission and distribution losses associated with on-site projects.[44] For off-site projects (projects where power is transmitted through the electric grid), transmission and distribution losses are the same as electricity from a utility. Transmission and distribution GHG factors are included in Appendix D.

Agency purchases of renewable energy and REC purchases cannot exceed their equivalent electricity use for electrical sources, or fossil fuel use for non-electric sources, in calculating location-based Scope 2 GHG emissions (i.e., overall agency GHG emissions adjusted for market-based purchases may not be reported as less than zero). RECs may be used for market-based accounting of Scope 2 emissions associated with purchased electricity. All market-based renewable energy (such as purchase of RECs) is excluded from calculation of agencies' FY 2008 baseline.

4.3.   Third-Party Operated Renewable Energy Generation on Agency Land

An on-site renewable energy system may be built on Federal land without an agency owning or operating the system. In this case, the agency is facilitating renewable energy production, but the agency may or may not be purchasing the energy or the associated RECs.[45] For the purpose of this Guidance, this arrangement is referred to as "third-party operated" renewable energy generation.

4.3.1. Third-Party Operated Renewable Energy Generation Where the Agency Purchases Energy and/or Renewable Energy Certificates

If the agency purchases renewable energy or RECs from a third-party renewable electricity generator at a Federal site (e.g., through a Power Purchase Agreement or other authorized procurement method), the power is treated the same as any renewable electricity purchase (see Section 4.2) and is reported as generated on site. Because the on-site system is not owned or operated by the agency, all associated emissions from electricity consumed by the agency is reported under Scope 2. As with any renewable electricity purchase, if the agency does not own the RECs for the renewable electricity produced by the system, the electricity delivered to the agency and associated emissions are the same as conventional grid-supplied electricity and are reflected as such in Scope 2 emissions.

In some cases, such as enhanced use leases, the third party may be contractually authorized to sell electricity or energy to entities other than the agency, but the agency may own the RECs from the

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[44] This is the same for generation units that are in close proximity to the site of consumption and fed directly to the agency without passing through the grid.

[45] Accounting for emissions associated with third-party generation of electricity on Federal land from conventional generation (e.g., through combustion of fossil fuel) and for emissions reductions associated with third-party generation from renewable energy sources is not currently addressed in this Guidance. While accounting for emissions reductions associated with third-party operated renewable energy generation is not addressed in the Guidance, Section 4.3.1 provides guidance on calculating adjustments to be applied against Scope 2 emissions for purchase of renewable energy generated by a third-party operator. Additional guidance for emissions reporting for energy generated by systems operated by a third-party systems may be included in future versions of this Guidance.

project. Because the agency owns the RECs for the energy produced by the system, the agency is allowed to include the RECs in market-based GHG calculations.

4.3.2. On-Site Renewable Energy Generation Where the Agency Does Not Own Renewable Energy Certificates

Section 3(e)(vii) of E.O. 13693 provides that renewable energy that qualifies for the DOD renewable electricity goal under section 2852 of the National Defense Authorization Act for Fiscal Year 2007 as amended by section 2842 of the National Defense Authorization Act for Fiscal Year 2010, will be considered "alternative" energy under E.O. 13693 clean energy targets. A portion of the renewable energy DOD uses to meet this agency-specific goal is from renewable energy systems owned and operated by DOD or by third parties on DOD land, where DOD does not own the environmental attributes of the sources and may or may not use the energy.

In recognition of this unique DOD requirement and the incentive it provides to develop renewable energy projects on DOD land, and the indirect effect these sources have on the emissions profile of the country's energy supply, DOD may earn credit toward achievement of Scope 3 targets through allowing renewable energy projects on its land even when it does not own the RECs. Other agencies may receive this credit with prior approval from CEQ. This credit is accounted for as "Scope 3 percentage point" reductions and does not represent emissions reduction claims; rather, the intent is create a mechanism to quantify and recognize agency efforts to develop renewable energy projects on Federal land. This was formerly referred to as the renewable energy hosting credit.

The Scope 3 percentage point reductions associated with renewable energy generation on land are reported separately from emissions in the Annual GHG Data Report workbook. The points will not be used to adjust reported absolute Scope 3 emissions. The points shall be calculated by comparing the lower emissions from the renewable sources on land to the emissions used to calculate location-based GHG emissions for the same amount of energy. For example, for electricity the credit is calculated based on the avoided GHG emissions from the displaced conventional grid-supplied electricity that the annual renewable generation of the hosted RE project replaces (location-based emissions). The difference between actual emissions and location-based emissions is then compared to baseline Scope 3 emissions as a percentage of the baseline. These percentage points are then subtracted from current year progress for Scope 3 GHG reductions.

The amount of the subtraction for DOD's clean energy in this category is capped at DOD's Scope 3 GHG reduction target for the fiscal year 2025. For example, if DOD is able to meet or exceed its Scope 3 reduction target with improvements in other Scope 3 categories, the Scope 3 percentage adjustment for renewable sources on DOD land would be zero.

4.3.3. Third-Party Operated Renewable Energy Generation Where the Agency Does Not Own Renewable Energy Certificates but Does Use Energy

Energy from a renewable energy source is not counted as renewable energy if the agency does not own the RECs that signify ownership of the renewable and other attributes of the output separate from the energy. If an agency consumes this "null power" it is treated as non-renewable energy

for purposes of GHG accounting. For electricity, the emissions are calculated using the same emission factors and methodology applied to conventional electricity based on the location of the renewable energy generator. For thermal renewable energy in this situation the default assumption for GHG emissions calculations is equivalent to that from the same amount of energy provided by natural gas. If a fuel other than natural gas would be the most likely substitute agencies can adjust the "null power" emissions to match the actual substitute fuel.

4.3.4. Summary of Renewable Energy Greenhouse Gas Accounting

Table 4 shows the major fossil fuel and renewable energy transactions that fall into Scope 2 and are included in the Annual GHG Data Report workbook, and how they relate to location- and market-based reporting categories and emissions.

Table 4: Location- and Market-Based Reporting for Scope 2

Reporting Categories	Location-Based	Market-Based	Scope	T&D Losses
Electricity from Grid Supplier	Yes	Yes	2	Yes
Thermal or Other Energy from a Supplier, Fossil Fueled	Yes	Yes	2	Yes
Agency Owns Energy and RECs from Project	No	No	1	No (all Scope 1, dual accounting only for Scope 2)
Green-Energy Purchase	No	Yes	2	Yes
REC-Only Purchase	No	Yes	2	No
Hosted Project (Green Energy)	No	Yes	2	No (On User Site), Yes (Not on User Site)
Hosted Project (RECs)	No	Yes	2	No
RECs Transferred but Energy Used by Agency	Yes	No/Yes	1 or 2	No (On User Site), Yes (Not on User Site)

Additional explanations of the reporting categories and the application of the location- and market-based GHG accounting for Scope 2 is included in Appendix B, and links to more detail on what is involved in each of the Reporting Categories in the Worksheet 2.1 RE instructions of the FEMP Annual GHG Data Report workbook.

4.4. Carbon Offsets

A carbon offset is an instrument that represents the sequestration, destruction, or reduction of one metric ton of carbon dioxide equivalent outside an organization's boundary and may be used to compensate for emissions produced inside the organization's boundary.

The area of carbon offsets is broad, encompassing multiple organizations and validation/certification processes as well as a broad range of interventions ranging from electric power station technology to biosequestration. The market for carbon offsets and the use of those offsets is evolving through multiple efforts in both the public and private sectors, as is the potential for application within Federal GHG accounting and reporting

If an agency identifies a carbon offset activity or practice that achieves clearly documented GHG emissions reductions, and wishes to receive GHG emissions reduction credit for such an activity or practice, the agency shall consult with CEQ and OMB and receive documented approval of the proposed activity or practice and the accounting methodology beforehand. An agency should consult its own general counsel to determine agency authorities for purchasing offsets.

5.0 Reporting Greenhouse Gas Emissions

This chapter outlines the Federal GHG reporting approach and the associated Annual GHG Data Report workbook and includes descriptions of:

- Qualitative information to report

- Use of emission factors as applied throughout the Annual GHG Data Report workbook

- Procedures for baseline adjustments and inventory recalculations.

5.1. Reporting Process

5.1.1. Annual Date for Reporting

Annual submittal of energy data and comprehensive GHG emissions inventories to CEQ and FEMP for each fiscal year is due by January 31 of the following year. Agencies may submit any corrections or adjustments to their FY 2008 baseline inventory of subsequent years on the same date, where necessary.

5.1.2. Electronic Greenhouse Gas Accounting and Reporting Capability (Annual Greenhouse Gas Data Report)

As originally assigned by Section 9(b), E.O. 13514, DOE-FEMP, in coordination with other agencies, provides the necessary electronic reporting capability so that agencies can report their GHG inventories in a consistent and accurate manner. The Annual GHG Data Report workbook is used to submit annual GHG inventories.

The Annual GHG Data Report workbook will accurately represent current GHG reporting guidelines and provide GHG calculation functionality for the default calculation methodologies described in this section and the Appendices. Other Federal energy and water reporting is integrated into the Data Report to reduce the reporting burden for agencies. FEMP works to enable data sharing with other relevant Federal data systems; for example, streamlining input of FAST vehicle fleet data into the Annual GHG Data Report workbook, and making the annual data for all agencies easily accessible via the FEMP Comprehensive Annual Energy Data and Sustainability Performance website.[46] See Table 5 for a summary of GHG reporting by scope and emissions category. This table also summarizes those emissions categories for which the Annual GHG Data Report workbook will automatically calculate GHG emissions based on activity-level data entered by agencies.

Table 5: Summary of Greenhouse Gas Reporting

Scope	GHG Emissions Category	Does the Annual GHG Data Report workbook auto-calculate emissions based on activity-level data?

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[46] FEMP Comprehensive Annual Energy Data and Sustainability Performance: http://ctsedwweb.ee.doe.gov/Annual/Report/Report.aspx.

Scope 1	Stationary Combustion (Agency Owned and Controlled Electricity, Heat, and Steam)	Yes
	Mobile Fossil Fuel (Agency Owned and Controlled Vehicles, Aircraft, Etc.)	Yes
	Fluorinated Gases (HFCs, PFCs, SF_6, NF_3)	Yes
	Wastewater Treatment (Agency Owned and Controlled)	Yes
	Solid Waste/Landfill (Agency Owned and Controlled)	Yes
	Other Fugitive and Process Emissions	No*
Scope 2	Purchased Electricity	Yes
	Purchased Steam, Hot Water, or Chilled Water	Yes
	Purchased Combined Heat and Power	Yes
	Purchased Steam	Yes
	Renewable Power Purchases and REC Purchases	Yes
Scope 3	Grid Electricity Transmission and Distribution Losses	Yes
	Commuter Travel	Yes
	Contracted Wastewater Treatment	Yes
	Facilities Operated Under Private Sector and GSA Full Service Leases of 10,000 Rentable Square Feet or Larger, Newly-Solicited in FY 2016 and Later (Mandatory FY 2017)	Yes**
Third-Party Renewable Generation on Federal Land	Scope 3 Percentage Points to be Applied toward Meeting Agency Scope 3 Goals Relative to Base Year (FY 2008)	Yes

* Appendix A does not include a calculation methodology.
** A separate Leased Space Data Report workbook will be used to calculate these emissions for FY 2017.

5.1.3. Reporting Approach

Emissions are categorized as described in Chapters 2 and 3. Voluntary reporting refers to the reporting of emissions that do not currently have a specified calculation methodology in the Appendices, or are not otherwise identified as part of annual reporting within this Guidance. Agencies may report emissions for these items, if they clearly identify them and provide documentation for calculation methods used in the submission of the agency's inventory. Over time, new methodologies and procedures will be included in revisions to this document and supporting documents to improve the Federal government's ability to account for and report GHG emissions.

The Appendices provide existing default and alternative calculation methodologies for GHG emissions accounting and reporting. For each category, there exists one "**default**" methodology where activity data can be directly entered into the Annual GHG Data Report workbook. If using the default methodology, agencies typically input energy in native units and other activity data, some of which can be drawn from existing programs and collection systems. Calculation methodologies and emission factors will be built into the Annual GHG Data Report workbook. To the greatest extent practicable, the Annual GHG Data Report workbook provides calculation of GHG emissions associated with items that are already reported by Federal agencies, such as annual energy reporting and FAST data.

For many emissions categories, "**alternative**" methodologies are also available, which can provide more accurate GHG accounting or use other available input data. Agencies may report using these alternative methodologies *instead* of or in some cases combined with the default methodologies in cases where the agency is compiling data from multiple sub-agencies or locations. Agencies are encouraged to utilize the alternative methodologies to increase the accuracy of their inventories. Agencies may use alternative methodologies if they include a detailed description of the methodologies in their qualitative statement for review by FEMP. If the Annual GHG Data Report workbook does not provide an appropriate alternative methodology, agencies will need to calculate the emissions, manually enter the quantities of each GHG emitted in units of metric tons, and report the combination of default and alternative methodologies used.

Alternative Calculation Example:
On-Site Landfill

To illustrate how an alternative methodology could be used, consider an agency that manages a total of five landfills at different facilities, all of which are maintained and reported as part of the facilities' Clean Air Act (CAA) Title V permits. The agency's GHG lead works with each facility's air program manager to determine the site-specific variables for each landfill that are readily available. During this process, the agency determines that the landfills have been closed for several decades and emit lower amounts of CH_4 than reflected when using the Scope 1 default methodology. Given that the data are available, the agency GHG lead decides to use the alternative GHG calculation methodology to calculate emissions at each of the five landfills, and to report the total metric tons of CH_4 emissions under the Solid Waste/Landfill emissions category in the Annual GHG Data Report workbook.

Refer to the Appendices for detailed descriptions of default and alternative calculation methodologies. As noted in Chapters 2 and 3, certain categories of emissions may also be voluntarily reported. However, the Annual GHG Data Report workbook will not calculate emissions for voluntary categories nor include them in the standardized inventory calculated by the workbook. A breakdown of voluntarily reported emissions by emission source and a description of calculation methodologies for all voluntary emissions should be included in the reporting agency's qualitative statement.

5.1.4. Other Greenhouse Gas Calculation Tools

Although selected qualitative and quantitative GHG data are submitted annually using the Annual GHG Data Report workbook, this Guidance does not stipulate the use of any other particular enterprise-wide GHG inventory compilation tool. Agencies may have preferred tools to assist with performing calculations and managing GHG information. This Guidance is designed to integrate energy and other activity data for GHG accounting and reporting with other reporting, allowing agencies to leverage existing tools and databases when possible.

Agencies are not precluded from using other agency-specific tools to assist them in managing and maintaining data necessary to develop an inventory, if such tools are appropriately aligned with this Guidance.

Agency-specific tools may include, but are not limited to:

- Headquarters-level, "top-down" centralized data system aggregation and analysis
- Facility-level, "bottom-up" data acquisition, entry, calculation, and/or management
- Emissions category/source data acquisition, calculation, and/or analysis
- Project-level data capture, calculation, and analysis.

5.2. Reporting Qualitative Content

This section describes the information included in the qualitative statement, which should be aligned with Annual GHG Data Report workbook submissions as summarized in Table 6 below.

Table 6: Greenhouse Gas Inventory Qualitative Reporting

Qualitative Reporting Category	Information to be Included
Agency Reporting POCs	• Agency • POC information of agency staff responsible for the GHG inventory
Reporting Period Information	• Fiscal year • Population data including number of employees, on-site contractors, and/or visitors • Number of square feet for goal-subject (GS) and goal-excluded (GE) buildings*
Allowable Exclusions from GHG Targets**	• Emission sources and categories excluded from the reduction target • Justification for excluded emissions
Inventory Calculations for Current Reporting Year	• Emissions categories inventoried • Data sources and uncertainty in data quality • Tools and calculation methodologies used, if other than Annual GHG Data Report workbook methodologies
Changes in GHG Inventory	• Description of changes since prior reporting period • Anticipated future changes in inventory
Verification and Validation	• Documentation of inventory development process, data collection procedures, and points of contact as described in Section 6.1 of the Guidance • Description of verification and validation process, including the process for identifying and correcting errors • Known or potential double-counting • Second- or third-party verifier, if applicable
Other Information	• Other information as necessary to explain reported findings
* Given the combined energy and GHG reporting, this information aligns with existing FEMP Energy Report guidance on the determination of energy GS and GE buildings. This includes leased space where the agency directly pays for the utilities. Further information on determination of GE buildings can be accessed at http://energy.gov/eere/femp/downloads/guidelines-establishing-criteria-excluding-buildings-energy-performance. ** These are emissions excluded from GHG targets; they are not excluded from comprehensive inventory reporting.	

Agency Reporting POC

Although each agency's Chief Sustainability Officer is ultimately responsible for submitting the agency GHG inventory and certifying its accuracy, designated agency staff serving as POCs are responsible for addressing general and technical questions regarding the agency's GHG inventory.

Reporting Period Information

Identify the fiscal year of the data reported. Agencies will report how many employees, on-site contractors, and/or visitors they have to supplement data findings and allow for analysis and normalization over time. These data may also be necessary for some methodologies, such as those related to emissions from waste water treatment. Facility square footage data, which is already reported for energy reporting, will likewise facilitate data normalization and analysis.

Inventory Calculations for the Current Reporting Year

For each emissions category, include the following:

- Whether the emissions category is currently excluded from agency GHG reduction targets

- Sources of data used

- Any uncertainty in data quality, including potential errors or known omissions in the data[47]

- Any additional tools or methodologies utilized for alternative methodology or voluntary reporting.

Changes in GHG Inventory

Agencies shall describe the degree to which the following potential changes from the prior reporting year have impacted their inventory and explain the key reasons for these changes:

1. **Changes in calculation or estimation methods:** Indicate whenever calculation methodologies changed and estimate the impact of that change. If an agency wants to employ a different methodology from that stipulated in this Guidance or its Appendices, the agency shall first present the proposal to CEQ and OMB. Note that estimation method changes may require base year and intervening year recalculations as stipulated in item 3 below.

2. **Changes in organizational boundary:** Describe how the list of exclusions and exemptions reported, as well as other factors, may have changed the agency's organizational boundary. Note that organizational boundary changes may require base year and intervening year recalculations as stipulated in item 3 below.

3. **Base year and subsequent year corrections:** Summarize corrections to base year and subsequent year calculations.[48] Agencies may also describe how any updates to emission factors, especially Emissions and Generation Resource Integrated Database (eGRID) output emission rates, affected their performance versus prior years, if warranted.[49]

4. **Other changes in emissions:** Agencies may summarize other changes in emissions from mission or footprint changes that did not trigger a base year recalculation.

5. **Anticipated changes for next reporting period:** Indicate any known or anticipated changes in organizational footprint or boundaries or mission tempo in future years that may affect the inventory. For instance, long-term or planned-temporary changes in an agency's

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[47] Both the utility and accuracy of a GHG emissions report depend on the quality of the data available. Agencies should give particular attention to any data problems, including missing data, means used to evaluate data quality, and procedures used to ensure data accuracy.

[48] Agencies may consider recalculating annual or baseline inventories when significant changes within a given scope occur. Consult CEQ to determine whether a recalculation is warranted. See Section 5.3.1 in the Guidance for further detail and E.O. 13693 Sec. 9, Duties of the Agency Chief Sustainability Officers, subsection (f).

[49] Agencies should not recalculate base year or annual inventories when the emission factors that were available at the time the inventories were originally prepared are subsequently updated. For example, FY 2008 base year inventories should not be recalculated to adjust for updates to eGRID subregion factors released in FY 2011.

mission or operations may significantly impact GHG emissions. Agencies should report such changes to the extent they consider them relevant to understanding the high-level summary and trends of emissions reported.

Verification and Validation

The qualitative statement includes steps taken to develop the inventory, the processes used to collect the inventory data, and agency points of contact. In addition, the qualitative report shall discuss the approach for verification and validation, whether any change is foreseen in this approach for the next reporting year, and any known or potential double-counting within the inventory. If an agency used second- or third-party verification, list the verifier's contact information. See Chapter 6 of this Guidance document for more information on verification and validation.

5.3. Quantitative Inventory Data

Agencies report energy use and activity data inputs and/or GHG emissions for each emissions category through the FEMP Annual GHG Data Report workbook. For most categories, agencies may choose between the default and or alternative methodology. In determining which methodology is most appropriate, an agency should consider what data are available and how the methodology will impact tracking progress year-on-year toward meeting GHG reduction targets.

This section lists the default data elements for reporting Scope 1, 2, and 3 emissions, biogenic CO_2 emissions for Scope 1, 2, and 3 activities, and voluntary reporting.[50] Data reported by the agency shall be summed to the highest level within the agency to encompass all operating units. Agencies shall maintain records of the underlying data inputs that feed into the agency-level aggregated GHG inventory. The Annual GHG Data Report workbook-of-record for each agency and for each year reported will be maintained by FEMP and uploaded to each agencies' OMB MAX GHG emissions page. The annual GHG inventories for each agency and year are also available in terms of CO_2e emissions on FEMP's website.[51]

Scope 1 Data

Agencies shall report all direct GHG emissions from sources that are owned or controlled by the Federal agency within this scope. It is important to recognize that whereas an agency's target may exclude, "direct emissions from excluded vehicles and equipment and from electric power produced and sold commercially to other parties in the course of regular business," these sources are not excluded from being reported in the agency's comprehensive inventory. Scope 1 emissions reporting covers three major categories: stationary and mobile fuel combustion, fugitive emissions, and process emissions.

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[50] It is recognized that not all data elements will be available. In such cases, proxy data may be used to estimate values for these elements, if the methodologies used for proxy data calculations are included in the inventory reports.
[51] See:
http://ctsedwweb.ee.doe.gov/Annual/Report/ComprehensiveGreenhouseGasGHGInventoriesByAgencyAndFiscalYear.aspx

Stationary and Mobile Fuel Combustion

All agency Scope 1 stationary and mobile fuel combustion emissions data are reported in the native units of the fuel type indicated in the Annual GHG Data Report workbook. Fuel use and total of each GHG emitted is to be used if using the alternative method for mobile sources.[52] Because the Annual GHG Data Report workbook is also used for FEMP energy reporting, the workbook will calculate emissions in four main end-use sectors: Goal-Subject facility energy, Goal-Excluded facility energy, non-fleet vehicles and equipment (VE), and fleet vehicles separately (data captured in FAST), according to the definitions previously established under the National Energy Conservation Policy Act, as amended.

Fugitive Emissions

Scope 1 fugitive emissions data is to be reported in units as indicated in the "Default Data" column of Table 7. If alternative methodologies are used, the agency Scope 1 fugitive emissions is to be reported in metric tons (MT) for each GHG emitted.

Process Emissions

Agency Scope 1 process emissions are to be reported in MT for each GHG type emitted. There are no default methodologies for process emissions because they are site- and/or process-specific. Instead, Appendix A.8 lists methodology references for specific types of process emissions. If agencies have process emissions to which the list of methodology references does not apply, they may consult with CEQ and OMB to identify an appropriate methodology. Agencies are encouraged to use available data and document methodologies applied to estimate fugitive or process emissions.

Some agencies may find that supporting data on their process emissions are already used to prepare their reports under the Clean Air Act (CAA) Title V, EPA's GHGRP, EPCRA 313 (Toxic Release Inventory), and other programs. Agencies are encouraged to leverage data directly from their existing regulatory compliance data collection and calculation efforts, as appropriate.

Agencies may voluntarily report additional Scope 1 emissions resulting from unique activities that do not currently have a methodology in Appendix A. Voluntary reporting refers to the reporting of emissions that do not currently have a specified calculation methodology in the Appendices, or are not otherwise included in reporting within this Guidance. Agencies may report emissions for these voluntary items, if they clearly identify them and provide documentation for calculation methods used in the submission of the agency's inventory. For example, agencies may voluntarily report non-covered GHGs with high global warming potentials.

Table 7: Data Needed for Reporting: Scope 1 Fugitive Emissions

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[52] For each category using an alternative method, agencies will report the energy activity data and the calculated total quantity of CO_2, CH_4, and N_2O in metric tons, respectively.

Emissions Category	Default Data	Potential Sources of Data	Alternative Methodology Available?
Fluorinated Gases (F-gases): hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), NF_3	• Mixed refrigerant and/or F-gas material type • Amount charged or issued [lb] • Amount returned to the supply system, including recovered from equipment [lb]	• Facility Title VI reporting materials • Procurement records • Facility hazardous material management	Yes
On-Site Wastewater Treatment	• Population served (includes employees, on-site contractors, and visitors) • Type of wastewater treatment system	• Facility human resource records • Facility security records	Yes
On-Site Landfill/MSW	• Landfill open date • Landfill close date • Total mass of MSW disposed on site [short tons] • Past waste disposal	• Facility Title V reporting materials • E.O. 13693 solid waste and diversion reporting	Yes
Other Fugitive Emissions	• Agency- and facility-specific data required	• Facility Title V, GHGRP, and/or Emergency Planning and Community Right-To-Know Act (EPCRA) reporting	Yes

Scope 2 Data

Scope 2 emissions reporting includes five major categories: purchased electricity, purchased steam, purchased hot water or chilled water, purchased combined heat and power, and purchased steam. When reporting combined heat and power, agencies should select the most appropriate method, which depends on whether it purchased electricity, steam, and/or hot water. Agency Scope 2 emissions data are to be reported in units as indicated in the "Default Data" column of Table 8.

Table 8: Data Needed for Reporting: Scope 2 Emissions

Emissions Category	Default Data	Alternative Methodology Available?
Purchased Electricity*	• Electricity consumed in Energy Goal-Subject and Goal-Excluded facilities [megawatt hour, MWh] by eGRID subregion and U.S Territory	No
Purchased Steam and Hot Water, or Chilled Water	• Steam and hot water consumed [Billion Site-Delivered Btu] • Cooling demand [Billion Site-Delivered Btu or Ton Hours]	Yes
Combined Heating and Power*	• GS and GE electricity consumed [MWh] by eGRID subregion • Steam or hot water consumption [Billion Site-Delivered Btu]	Yes
Renewable Energy Purchases and RECs Purchases*	• Renewable energy, or RECs, purchased [MWh] • eGRID subregions in which the renewable energy was generated • Generator on- or off-agency site and whether on the agency side of meter, separately metered, or off grid	No

*Requires source location information for eGRID subregion level.

Data should be tracked separately for each calculation methodology.[53] For purchased electricity, data is to be reported separately for each eGRID subregion and U.S. Territory, and emissions will be calculated by the Annual GHG Data Report workbook using the most current eGRID subregion output emission rate factors available at the time for each reporting year. Because agencies will also be using the Annual GHG Data Report workbook for FEMP energy reporting, Goal-Subject and Goal-Excluded facility energy are reported separately according to the definitions previously established under the National Energy Conservation Policy Act, as amended.

FEMP uses the same data classifications as existing Federal energy reporting to the extent possible. If agencies utilize the default category, the Annual GHG Data Report workbook will use the reported activity data to automatically calculate emissions for each of the respective types of GHGs separately and express the total in MT CO_2e. Otherwise, the data entered into the alternative methodology categories should consist of both the energy used and the MT for each GHG emitted.

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[53] Agencies that produce power for facilities collocated with power production facilities may develop their own emission factors. This allowance recognizes this would necessitate unique determination of transmission and distribution (T&D) losses. FEMP will work with agencies in these situations to avoid double counting.

Agencies report purchased renewable energy separately (including REC purchases unbundled from electricity) in the renewable energy section of the Annual GHG Data Report workbook to ensure consistency with existing renewable energy guidance and Chapter 4 of this Guidance. The following information is to be reported for all RECs purchased:

- Fuel/technology and placed in service date
- Amount of renewable energy associated with the REC [MWh or in million Btu]

Scope 3 Data

This Guidance utilizes a phased approach to inclusion of Scope 3 emissions in agency inventories. Initial efforts focus on accounting for Scope 3 emissions categories for which reliable and accessible data are available for estimating emissions, and for which more detailed calculation methodologies have been established. The key is to continually improve Scope 3 data quality. Over time, additional Scope 3 categories and new methodologies may be added to provide more comprehensive GHG inventories.

Starting in FY 2017, a new category for emissions from landlord-purchased energy used in full-service leased space of 10,000 rentable square feet, or greater, will be added to agency inventory reporting, separate from the Scope 3 categories subject to agency targets. Since this is a separate category there is no need to revise the Scope 3 baseline emissions or revise reduction targets. This is intended to allow agencies to track progress in this category outside the pre-established Scope 3 target categories.

Agencies shall report emissions for those Scope 3 target categories where the agency quantified a baseline (in terms of MT CO$_2$e).[54] These Scope 3 categories include the following:

- Federal employee business air travel

- Federal employee business ground travel

- Federal employee commuting

- Contracted solid waste disposal (MSW that is sent to a landfill not owned or operated by the agency)

- Contracted wastewater treatment (Municipal wastewater that is sent to a wastewater treatment plant (WWTP) not owned or operated by the agency)

- T&D losses associated with purchased electricity.[55]

Appendix C provides the calculation methodologies for each of these emission categories.

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[54] Base year inventories should be provided for all of emissions categories reported. Refer to Chapter 5.3 of the Guidance for more information on calculating base year inventories when FY 2008 data is not available.

[55] Emissions associated with T&D losses from purchased steam, hot water, and chilled water are categorized as Scope 2 emissions.

Scope 3 emissions data is to be reported in units as indicated in Table 8, and agencies should use information from E-Gov Travel Service 2 (ETS2)[56] or Defense Travel System (DTS)[57] vendor reports, or consult with travel agents, to obtain employee air travel data by segment type. For ground business travel (such as rail, bus, and/or rental vehicle), agencies should coordinate with travel agents and accounting departments to determine data availability. Information on commuter travel should come from agency- or site-specific commuter surveys using the default methodology or the alternative methodology based on average commuter activity by mode of travel and information on the number of commuters/commuter days per year in an agency (i.e., if all personnel are on 4-day work weeks commuter days would be adjusted for this work pattern).

For contracted solid waste, the default methodology in the Annual GHG Data Report workbook will use the tons disposed of and the default values provided in Appendix C.3.1. Agencies may alternatively coordinate with their waste contractors for site-specific emission factors. For contracted wastewater treatment, the Annual GHG Data Report workbook will use the number of employees served and the default values provided in Appendix C for the default methodology. Agencies may alternatively coordinate with their facility-level providers for the variables necessary to calculate alternative emission estimates. T&D losses from purchased electricity will be automatically calculated in the Annual GHG Data Report workbook because emissions are based on the emission factors for Scope 2 data already submitted.

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[56] http://www.gsa.gov/portal/content/104378
[57] http://www.defensetravel.osd.mil/

Table 9: Data Needed for Scope 3 Emissions Reporting

Emissions Category	Default Data	Current Reporting	Alternative Methodology Available?
Federal Employee Business Air Travel	• Number of trips by segment categorized by short-, medium-, and long-haul	• Agency Travel Reporting	No
T&D Losses	• Purchased electricity [MWh] by eGRID subregion	• Derived from agency electricity and thermal data	No
Contracted MSW Disposal	• MSW disposed [short tons]	• Guidance for Calculating Compliance with E.O. 13693 Waste Diversion Goals	Yes
Federal Employee Business Ground Travel	• Mode of transportation • Distance-traveled data, in miles	• Agency Travel Reporting	Yes
Federal Employee Commuting	• Mode of transportation • Agency average number of commuting days (by mode) • Roundtrip distance (by mode) [mi] • Numbers of commuters by mode	• Commuter Survey or Alternative methodology based on commuter patterns	Yes
Contracted Wastewater Treatment	• Number of employees served	• Estimated of national mix of treatment methods	Yes
Fully Serviced Leased Space	• Electricity use by facility and zip code, and other energy use by facility	• Same methods as comparable Scope 1 and 2 categories	Yes*

*An alternative methodology is provided for fully serviced leases in Appendix C.

See Chapter 2.2.3 for more information on Scope 3 reporting.

Biogenic Emissions Reporting

Biogenic CO_2 emissions are generated during the combustion of biofuels and biomass. CO_2 emissions associated with the biogenic portion of biofuel and biomass combustion for Scope 1, 2, and 3 activites are calculated in GHG emissions inventories. These biogenic emissions are not subject to agency reduction targets at this time.[58] Agencies shall account for and report the

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[58] Due to ongoing analysis, efforts to collect and synthesize data, and the development of accounting approaches that will appropriately reflect the true atmospheric impact of biogenic emissions, reporting includes biogenic GHG emissions, but these emissions need not be included in reduction targets under E.O. Part or all of the carbon in these fuels is derived from material that was fixed by biological sources on a relatively short timescale. Depending on the full emissions impact of biomass production and use, these emissions may or may not represent a net change in

biogenic CO_2 emissions generated by these combustion activities, where data are available. However, it is important that biogenic CO_2 emissions from Scope 1, 2, and 3 activities are clearly identified and reported separately within an agency's inventory. Agencies using alternative methodologies shall ensure they calculate and report biogenic emissions in those categories, as applicable.

Voluntary Scope 3 Reporting

Agencies may voluntarily report additional Scope 3 emissions resulting from unique activities that do not currently have a methodology in Appendix C, or are not otherwise identified for reporting purposes in the Guidance. Agencies may report emissions for these voluntary items, if they clearly identify them and provide documentation for calculation methods used in the submission of the agency's inventory.

For other voluntary categories, to the extent possible, agencies shall use methodologies that are commonly accepted. This approach promotes consistent calculations that may be of use for emissions categories added to reporting in future years. If an agency reports emissions in a category where no commonly accepted methodology is available, calculation methodologies are to be submitted as part of its annual inventory. Over time, new methodologies may be included in revisions to this document to improve the Federal Government's ability to account for and report Scope 3 emissions. The Annual GHG Data Report workbook includes a worksheet (3.19) for reporting voluntary Scope 3 categories.

5.4. Emission and Conversion Factors

To ensure accurate GHG inventories, it is necessary to apply appropriate and consistent emission and conversion factors. The most current calculation methodologies and emission factors available at the time should be used to prepare the GHG inventory for each reporting year. This Guidance will be revised as needed to incorporate the current, accepted calculation methodologies and source links to the latest, accepted emission factors. The FEMP workbook will be the source of annual updates to data sources and factors as needed, including updated links to the latest, accepted emission factors and technical improvements to methodologies. For emission factors other than those for Scope 2 purchased electricity, agencies may develop activity-specific or local emission factors, if they fully document the justification and methodology. This includes any emission factors not provided in Appendix D. Agencies may also substitute emission factors in Appendix D with data from their operations utilizing continuous emissions monitoring (CEM) equipment. This is particularly applicable where on-site operators are familiar with the operating conditions and equipment characteristics. Examples include combined heat and power facilities that generate electricity, steam, and/or hot water; and waste-to-energy plants. Agencies shall fully document the justification and methodology for developing emission factors not provided in Appendix D.

Emission factors and methodologies referenced in this Guidance were selected because of their applicability to Federal operations, technical authority, and documented acceptance in other

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atmospheric CO_2. This contrasts with carbon from fossil fuels, which was removed from the atmosphere millions of years ago.

widely-recognized GHG reporting programs. The calculation methods and emission factors were leveraged from existing GHG regulatory and voluntary inventory protocols, with the EPA GHGRP given priority wherever applicable, followed by other Federal sources. Appendix D provides sources used for selected methodologies.

5.5. Base Year and Subsequent Year Inventories

E.O. 13514 established and E.O. 13693 reaffirmed FY 2008 as the base year for Federal agency GHG emission reduction targets. Agencies calculated and submitted base year (baseline) inventories using the methodologies and the reporting format outlined in this Guidance.

In some cases, agencies did not have access to quality FY 2008 data, particularly for the Scope 1 fugitive emissions and some Scope 3 emissions categories. As such, agencies were authorized to use the earliest year for which data are available to include in the FY 2008 baseline inventory. For example, if an agency's employee commuting data became available in 2012, those emissions could be used as a basis for the FY 2008 baseline.

Reduced emissions from renewable energy purchases and RECs purchased in FY 2008 were excluded from the agency FY 2008 baseline Scope 2 inventories.

Agencies with cyclical operations or events may have found that FY 2008 was not representative of their Scope 1 fluorinated gas fugitive emissions (i.e., HFCs, PFCs, and SF_6), particularly when limited to material procurement record data. In these situations, agencies may have calculated a 3-year average baseline value for their specific Scope 1 fluorinated fugitive emissions. In such a case, the FY 2008 baseline will be the average Scope 1 fluorinated gas fugitive emissions for FY 2006, FY 2007, and FY 2008. If an agency used a 3-year average baseline for fugitive emissions, the rolling average is also to be used in subsequent reporting years. Using this approach, agencies will use a rolling average to determine their inventories for a given year. For example, FY 2010 reporting would use an average of FY 2008, FY 2009, and FY 2010. Future targets will be evaluated relative to the average value calculated for FY 2008. Use of this rolling average approach should be noted in the "Other Information" section of the agency's qualitative statement. Agencies may only use the rolling average approach for the fluorinated gas fugitive emissions category, but not for their entire comprehensive inventory.

5.5.1. Recalculations to Amend or Normalize Baseline

To ensure a consistent comparison against a baseline that is representative of ongoing agency activities, it may be necessary to recalculate the base year and subsequent inventories. In the future, CEQ may direct an overall recalculation of baseline emissions due to significant improvements in emissions calculation methodologies, or the need to normalize data across the Federal sector. Similarly, agencies may identify the need for an agency-specific recalculation of its baseline emissions. Agencies should consider recalculating their base year and subsequent year emissions when one of the following occurs:

- Agency structural changes significantly increase or decrease emissions relative to the base year. A structural change involves the transfer of control of emissions-generating activities or operations from one agency to another, or to private industry. While a single structural change may not significantly impact base year emissions, the cumulative effects of a

number of minor structural changes can create an impact.[59] Examples of structural changes include the following:

- o Reorganization, division, consolidation, or significant change of organizational activities.
- o Significant outsourcing or insourcing of activities.
- o Significant change in mission.

- New emissions categories are added to the inventory.
- Additional data and/or calculation methodologies become available. For example, data may become available in FY 2013 for fugitive emissions that were not captured in FY 2010.
- Changes in calculation methodology, or improvements in the accuracy of emission factors or activity data, that significantly change calculated emissions relative to the base year.[60]
- Errors, or a number of cumulative errors, are discovered that significantly increase or decrease emissions relative to the base year.
- A combination of the above result in a significant increase or decrease emissions relative to the base year.

Because determining the significance of such changes in emissions is difficult to stipulate for the full range of government operations, it is necessary to for agencies individually develop and monitor internal processes for comparing annual emissions in relation to the occurrence of the events listed above. Such a comparison should take into account the complexities of the agency's operations and serve to highlight the possible need to perform a recalculation of base year emissions and subsequent years' emissions, as appropriate. Where an agency's emissions for Scope 1 and 2 combined or Scope 3 change by 5 percent or greater, the agency can initiate a discussion with CEQ to determine the need to recalculate the FY 2008 baseline. However, this threshold does not preclude instances of baseline corrections where emissions changes are less than 5 percent. Section 9(f) of E.O. 13693 specifies as a duty of the agency Chief Sustainability Officer to represent "the agency in any requests to the Chair of CEQ and Director of OMB to amend or normalize a baseline for goals established in this order due to change of greater than 5 percent as a result of agency space consolidation, a change in mission tempo, or improved data quality." Agencies should consult CEQ and OMB if they are uncertain if a baseline recalculation is warranted. If it is determined that a baseline adjustment is necessary, FEMP will work in collaboration with the agency to update the data as appropriate.

Agencies that identify or anticipate the need to make significant changes to base year and subsequent inventories should provide CEQ and OMB with sufficient notice to allow for a timely determination as to whether the change is necessary and what change needs to be made. Agencies may also find it necessary to make smaller, routine changes to the base year and subsequent year inventories to reflect minor corrections to erroneous data. Agencies do not need to notify CEQ

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[59] Generally, routine changes in workforce size and addition or closing of new facilities without a significant change in mission or structural change does not warrant a baseline recalculation.

[60] Agencies should not recalculate base years or previous annual inventories when updates to eGrid subregion factors are released, or when other similar updates are made to account for changes in technologies, fuels, etc. over the years.

and OMB regarding minor corrections, but should still document all changes and provide necessary explanation in subsequent inventory submissions.

GHG baseline *corrections* reflecting actual data/energy use are always allowed to improve accuracy of FY 2008 and subsequent year data. GHG baseline *adjustments* to accommodate significant variances in facility footprint and/or mission-related tempo of operations in later years shall be approved by CEQ and OMB. When an adjustment is approved, the agency actual GHG baseline inventory will be maintained to ensure accuracy of rolled-up Government-wide GHG inventory in FY 2008. Baseline adjustments will be shown in data tables of agency inventories as an absolute increase (or decrease) in terms of $MTCO_2e$ next to the accounting of actual FY 2008 target emissions and the re-calculated Approved Adjusted Baseline. Approved Adjusted Baseline will be used to determine percentage reduction/increase for the most-recent reported year. Baseline adjustments may not be made in advance of the facility footprint/mission tempo variances, but in the year those variances occur.

Below is an outline of the mechanics for reporting baseline adjustments:

1. Agency re-submits its FY 2008 Annual GHG Data Report Workbook-of-record with annotated changes reflecting the energy use/operational data of the new facilities/operations in the current year

    a. For example, the new facility uses 500,000 kW of electricity in FY 2017; 500,000 kWh is added to the FY 2008 workbook in the appropriate sheet and cell with a comment noting the change reflects facility expansion/mission variance greater than 5 percent in the current year.

    b. As new facilities/operations are added and approved in later years, the baseline adjustment is recalculated.

2. The agency's actual FY 2008 inventory is maintained in the government-wide data set

3. The baseline adjustment is the difference between the actual baseline $MTCO_2e$ and the adjusted baseline emissions from the re-submitted FY 2008 workbook

    a. Using the example above, 216 $MTCO_2e$ (the difference as calculated by the two workbooks) is added to the actual baseline to get the Approved Adjusted Baseline.

    b. By measuring the most-recent year progress from the Approved Adjusted Baseline, the percentage reduction is normalized to remove the expanded operations, allowing the agency to keep its original reduction target without penalty.

The CEQ Chair, in consultation with the OMB Director, shall review and approve agency reduction targets. As outlined in this section, an agency's Scope 3 baseline emissions may change significantly, and thus alter considerations that went into the formulation of the agency's initial Scope 3 reduction target. To the extent that the agency believes the initial Scope 3 target should be amended as a result of baseline changes, the agency shall request approval of any proposed changes to the target from CEQ, who, in coordination with OMB, will respond to the agency. The Scope 1 and 2 reduction target may not automatically be changed due to baseline recalculations.

6.0 Verification and Validation of Greenhouse Gas Emissions

The purpose of GHG accounting verification is to provide confidence that reports of GHG emissions are complete, accurate, consistent, transparent, and without significant errors.

6.1. Agency Responsibilities

As part of their qualitative report, agencies should accurately describe the steps taken to develop the inventory, document the processes used to collect the inventory data, and include points of contact. The qualitative report should: provide a description of the verification process, which may be internal to the agency; provide a process for identifying and correcting errors; and may discuss areas of improvement for future inventories.[61] In addition to a qualitative report, agencies may use one of the verification processes described below and identify the entity in its annual reporting:[62]

1. **Second-Party Verification**: Any verification that is performed by an entity within the agency is termed second-party verification. An entity that performs second-party verification is defined as one independent of those responsible for reporting the GHG emissions inventory. The verifying entity is identified in annual reporting.

2. **Third-Party Verification**: If verification is performed by an entity external to the agency, it is termed third-party verification. Entities performing third-party verification for the agency are defined as independent of those responsible for reporting the GHG emissions inventory.

Agencies are encouraged to use either second- or third-party verification for future annual inventories. Entities performing the verification process for an agency may refer to the principles and requirements of ISO 14064-3:2006 for additional guidance on this process, as needed.[63]

6.2. Federal Energy Management Program Responsibilities

FEMP will also review the data submitted by the agency and follow up with agency representatives, as appropriate, to clarify questions on data quality. This data review is not the same as verification and does not substitute for or duplicate the verification that the agency performs. Some of the data review conducted by FEMP will be incorporated within the GHG Data Report workbook as automated checks.

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[61] For more information on managing inventory quality, see Chapter 7, Public Sector Protocol (PSP). See footnote 9 for website link.

[62] For more information on validation and verification of GHG emissions, see Chapter 10, PSP.

[63] ISO 146064-3:2006: Greenhouse gases—Part 3: Specification, provides guidance for the validation and verification of greenhouse gas assertions.

Appendices

Appendix A: Calculating Scope 1 Emissions

- Establishes "default" and "alternative" methodologies and data inputs for calculating Scope 1 emissions

Appendix B: Calculating Scope 2 Emissions

- Establishes "default" and "alternative" methodologies and data inputs for calculating Scope 2 emissions

Appendix C: Calculating Scope 3 Emissions

- Establishes "default" and "alternative" methodologies and data inputs for calculating specified Scope 3 emissions

Appendix D: Emission and Conversion Factors

- Provides emission and conversion factors used in calculation of Scope 1, 2, and 3 emissions

Appendix E: Definitions

- Provides accepted definitions for terms used in the Guidance document.

Appendix A. Calculating Scope 1 Emissions

This appendix describes the Scope 1 emissions sources most commonly operated by Federal agencies, default and alternative calculation methodologies, data, and recommended data sources.

This appendix provides calculation methodologies for the following:

- Stationary combustion: electricity, steam, heating
- Stationary combustion: biomass and biofuels
- Mobile combustion: fossil fuels
- Mobile combustion: biofuels
- Fugitive emissions: fluorinated gases
- Fugitive emissions: wastewater treatment
- Fugitive emissions: landfills and solid waste facilities
- Industrial process emissions.

A.1. Stationary Combustion: Electricity, Heating, and Steam

Description

Scope 1 stationary combustion emissions result from the generation of electricity, heat, or steam from sources owned and controlled by the agency. This includes emissions from use of boilers, furnaces, turbines, and emergency generators. This section only includes emissions from fossil fuel combustion. Emissions from biomass combustion and other renewable fuels are calculated in A.2.

A.1.1. Default Methodology (to be Calculated by Annual GHG Data Report Workbook)

Data Sources

The default methodology is a fuel-use method, rather than direct emissions monitoring (i.e., continuous emissions monitoring) or direct sampling, as fuel use is already tracked and reported to FEMP annually.[64] If a source is not currently reported to FEMP but within an agency's operational control, these data may be available in bulk fuel or delivery receipts, contract or agency purchase records, stock inventory documentation, or maintenance records on turbines or emergency generators, furnaces, and boilers (see Table A-1).

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[64] In the EPA GHGRP, this approach is considered a Tier 1 method.

Table A-1: Stationary Combustion – Electricity, Heating, and Steam Default Data Sources

Data Element	Preferred Source
Electricity Generation: Total amount of natural gas, coal, fuel oil, diesel, gasoline, propane, and other fuels consumed by generators and/or turbines	Energy use data collected in Annual GHG Data Report workbook
Steam Production: Total amount of fuels consumed	Energy use data collected in Annual GHG Data Report workbook
Heat: Total amount of fuels consumed	Energy use data collected in Annual GHG Data Report workbook
Emission Factor	CO_2: see Appendix D by fuel type CH_4 and N_2O: see Appendix D

Calculation Steps[65]

The methodology used to calculate Scope 1 emissions from stationary combustion is described below. Using the default methodology, agencies will enter the activity data from step 1 into the Annual GHG Data Report workbook. To the greatest extent feasible, the Annual GHG Data Report workbook will conduct steps 2 through 5.

1. Determine the amount of fuel consumed annually
2. Determine the appropriate CO_2 emission factors for each fuel
3. Determine the appropriate CH_4 and N_2O emission factors for each fuel
4. Calculate each fuel's GHG emissions and convert to MT
5. Convert CH_4 and N_2O emissions to MT CO_2e and determine the total emissions.

Step 1: Determine the amount of fuel consumed annually

Identify all fuels combusted at the agency's facilities. Much of these data should already be collected and reported at the agency level and are available to be entered into the Annual GHG Data Report workbook. The Annual GHG Data Report workbook will convert the fuel-use data from physical units (mass or volume) to energy units (million Btu, or MMBtu) using the Higher Heating Values (HHVs) available in the sources in Appendix D.[66] When needed or applicable, the agency should input other fuel-use data in physical units and other HHVs not provided in the Annual GHG Data Report workbook.

Equation A-1: Stationary Combustion Fuel Consumed

Fuel consumed [MMBtu] = Fuel consumed [units of fuel type] ● HHV [MMBtu/units of fuel type]

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[65] Primary reference: EPA, Technical Support Document for Stationary Fuel Combustion Emissions: Proposed Rule for Mandatory Reporting of Greenhouse Gases (previously the Greenhouse Gas Mandatory Reporting Rule or MRR), 40 Code of Federal Regulations (CFR) 98, Subpart C, January 30, 2009.

[66] Also see Appendix D for links to current emissions factors.

Step 2: *Determine the appropriate CO_2 emission factors for each fuel*

The Annual GHG Data Report workbook will identify the CO_2 emission factors by fuel type (see Appendix D).

Step 3: *Determine the appropriate CH_4 and N_2O emission factors for each fuel*

The Annual GHG Data Report workbook will identify the CH_4 and N_2O emission factors by fuel type (see Appendix D).[67]

Step 4: *Calculate each fuel's GHG emissions and convert to MT*

The Annual GHG Data Report workbook will multiply the annual fuel consumed (step 1) by the emission factors for CO_2 (step 2), as well as the fuel consumed by emission factors for CH_4 and N_2O (step 3). Units are then converted into MT.

Equation A-2: Stationary Combustion GHG Emissions[68]

CO_2 emissions [MT] =
Fuel consumed [MMBtu] ● CO_2 emission factor [kg/MMBtu] ● 0.001 [MT/kg]
CH_4 Emissions [MT] =
Fuel consumed [MMBtu] ● CH_4 emission factor [kg/MMBtu] ● 0.001 [MT/kg]
N_2O Emissions [MT] =
Fuel consumed [MMBtu] ● N_2O emission factor [kg/MMBtu] ● 0.001 [MT/kg]

Step 5: *Convert CH_4 and N_2O emissions to MT CO_2e and determine the total emissions*

The Annual GHG Data Report workbook will use the 100-year global warming potential (GWP) values (found in Appendix D) to convert CH_4 and N_2O emissions to units of CO_2e. The Annual GHG Data Report workbook will sum emissions from all three gases to determine total MT CO_2e.Equation A-3: Stationary Combustion MT CO_2e Emissions.

CO_2e Emissions [MT CO_2e] = MT CO_2 + (MT CH_4 ● CH_4 GWP) + (MT N_2O ● N_2O GWP)

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[67] If the agency wishes to pursue an alternative approach, it may substitute site-specific emission factors using data that consider the end-use sector (such as commercial or industrial) or other considerations when applicable. Emission factors are also identified for specific types of combustion equipment for sites with significant stationary emissions. The Climate Registry, *Local Government Operations Protocol* (2008), Table G.4.

[68] For clarity, the symbol "●" has been used to indicate multiplication instead of symbols such as "×".

Example A-1: Stationary Combustion

Step 1: *Determine the amount of fuel consumed annually*
An agency consumes 1,000 CCF (hundred cubic feet) of natural gas; (equivalent to 100 MCF [thousand cubic feet or KCUFT].[69]

Equation A-1: Stationary Combustion Fuel Consumed

Fuel consumed [MMBtu]	= Fuel consumed [scf] ● HHV [MMBtu/scf[70]] = (100 [KCUFT] ● 1,000 [scf/KCUFT]) ● 1.028×10^{-3} [MMBtu/scf] = 102.8 [MMBtu]

Step 2: *Determine the appropriate CO_2 emission factors for each fuel*

The CO_2 emission factor for natural gas is 53.02 kg CO_2/MMBtu.

Step 3: *Determine the appropriate CH_4 and N_2O emission factors for each fuel*

The natural gas emission factors for CH_4 and N_2O are 1.0×10^{-3} and 1.0×10^{-4} kg/MMBtu.

Step 4: *Calculate each fuel's GHG emissions and convert to MT*

Equation A-2: Stationary Combustion GHG Emissions

CO_2 Emissions [MT]	= Fuel consumed [MMBtu] ● CO_2 emission factor [kg/MMBtu] ● 0.001 [MT/kg] = 102.8 [MMBtu] ● 53.02 [kg/MMBtu] ● 0.001 [MT/kg] = 5.450 [MT CO_2]
CH_4 Emissions [MT]	= Fuel consumed [MMBtu] ● CH_4 emission factor [kg/MMBtu] ● 0.001 [MT/kg] = 102.8 [MMBtu] ● 1.0×10^{-3} [kg/MMBtu] ● 0.001 [MT/kg] = 1.028×10^{-4} [MT CH_4]
N_2O Emissions [MT]	= Fuel consumed [MMBtu] ● N_2O emission factor [kg/MMBtu] ● 0.001 [MT/kg] = 102.8 [MMBtu] ● 1.0×10^{-4} [kg/MMBtu] ● 0.001 [MT/kg] = 1.028×10^{-5} [MT N_2O]

Step 5: Convert CH_4 and N_2O emissions to MT CO_2e and determine the total emissions

Equation A-3: Stationary Combustion MT CO_2e Emissions

CO_2e Emissions [MT CO_2e]	= MT CO_2 + (MT CH_4 ● CH_4 GWP) + (MT N_2O ● N_2O GWP) = 5.450 + (1.028×10^{-4} ● 25) + (1.028×10^{-5} ● 298) = 5.450 + 2.159×10^{-3} + 3.063×10^{-3} = **5.455 [MT CO_2e]**

Note: Example has been provided for demonstration purposes only and has rounding imposed throughout each of the calculation steps above. Factors are for illustration. The most recent emission factors can be found in the Annual GHG Data Report workbook where their original sources will also be documented. As such results from this example may differ slightly from results generated using the Annual GHG Data Report workbook.

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[69] EFs and HHVs are based on standard fuels and conditions. If a fuel is known to differ significantly from standard conditions agencies may override HHV or MMBtu calculations to be more accurate. EFs are based on emissions/MMBtu so adjustments should be designed to create the most accurate MMBtu estimate. For example, standard cubic feet of natural gas is temperature and pressure dependent and therefore Btu/volume may vary. The emission factors, HHV and other conversion factors reflect current standard assumptions.
[70] Standard cubic feet (SCF).

No alternative methodologies for stationary combustion are available for reporting.

A.2. Biomass Combustion and Other Renewable Fuel Scope 1 Emissions Calculations

Description

All Scope 1 and 2 renewable energy use/emissions for facility and other non-transportation applications are reported in Worksheet 2.2 Renewable Energy Data of the Annual GHG Data Report workbook. Worksheet 3.3 Scope 1 FEMP VE Energy and 3.4 Scope 1 FAST Mobile Energy capture all renewable transportation fuels using the methods documented in Section A.4 Mobile Combustion -- Biofuels.

Wind and solar technologies have zero emissions at the point of generation. Biomass combustion technologies such as boilers, backup generators, wood stoves, and incinerators produce CO_2 emissions that are considered biogenic for reporting and CH_4 and N_2O emissions that are considered anthropogenic because they are a product of combustion interactions. Renewable energy fuels/technologies incorporated into the Annual GHG Data Report workbook include the following:

Table A-2: Renewable Fuel/Technology Choices

	Non-Transportation	Transportation	Carbon Emissions Assumption
Wind	Yes	No	0
Solar Photovoltaic	Yes	No	0
Concentrating Solar Power (CSP)	Yes	No	0
Incremental Hydropower	Yes	No	0
Ocean (Thermal, Wave, Tidal, Other)	Yes	No	0
MSW for Electricity, Input Btus	Yes	No	Biogenic and Fossil
MSW for Thermal, Output Btus	Yes	No	Biogenic and Fossil
Wood and wood residuals	Yes	No	Biogenic
Agricultural byproducts	Yes	No	Biogenic
Solid byproducts	Yes	No	Biogenic
Biogas (captured methane)	Yes	No	Biogenic
Ethanol (100%)	Yes	No	Biogenic
E-85 (85% Ethanol)	Yes	Yes	Biogenic and Fossil
Biodiesel (100%)	Yes	Yes	Biogenic
B-20 (20% biodiesel)	Yes	Yes	Biogenic and Fossil
Rendered animal fat	Yes	No	Biogenic
Vegetable oil	Yes	No	Biogenic
Solar Thermal (including water and space conditioning)	Yes	No	0
Geothermal (Electric)	Yes	No	0
Geothermal (Direct Use)	Yes	No	0
Ground Source Heat Pumps	Yes	No	0
Ocean/Aquifer	Yes	No	0
Mechanical (i.e., direct water pumping)	Yes	No	0
Daylighting	Yes	No	0

Emission factors may be unavailable for certain types of biomass, including certain types of waste materials. Such sources, including regulated medical waste and confiscated materials, should be

included in an agency's GHG inventory (at minimum, in the qualitative statement), but may be difficult to quantify in the absence of operational data and analysis.[71]

For fuels that combine fossil fuels and renewable fuels such as MSW, B-20 (20% biodiesel), and E-85 (85% ethanol) the emissions from the renewable portion of the fuel are calculated and reported as emissions from renewable energy, using the same methodology and factors that apply to a pure renewable fuel. The emissions from the fossil part of the fuel is reported as emissions form fossil fuels, using the standard methodology and emission factors for the type of fossil fuel. Calculations for most renewable blended fuels are incorporated into the 2.2 Renewable Energy Data worksheet in the Annual GHG Data Report workbook.

In emission inventory calculations the efficiency of conversion from fuel to delivered energy has little impact on total GHG emissions. A highly efficient plant that combusts 1,000 tons of biomass into heat or electricity emits very nearly the same amount of carbon as an incinerator that combusts 1,000 tons of biomass and doesn't produce any useable heat and electricity. Where efficiency values are cited in the methodologies in this document they are primarily to convert outputs into estimated fuel energy inputs in order to use standard emission factors. Efficiencies are important to many elements of energy reporting but the calculations and methods used for that reporting is not included in this document, but are in the appropriate worksheets in the Annual GHG Data Report workbook.

A.2.1. Default Methodology (to be Calculated by Annual GHG Data Report Workbook)

These calculations mirror the stationary combustion method (see Appendix A.1) and are summarized here. The Annual GHG Data Report workbook will separately calculate and clearly identify Scope 1 biogenic emissions (biomass CO_2) from Scope 1 CH_4 and N_2O emissions (see Table A-3).

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[71] There are three options for an agency to use:

1. Use the same emission factor for regulated medical waste as for municipal solid waste.
2. Fine-tune emission factors for municipal solid waste, based on an analysis of the agency's regulated medical waste stream.
3. Employ customized methods and emission factors for the agency's specific regulated medical waste stream and facilities, if the methods are detailed in an agency's inventory report.

Agencies do not have to report emissions from an incinerator if the sole purpose of the incinerator is exempt for reporting purposes. If the incinerator is also used for non-exempt activities, then the entire GHG emissions amount should be included.

Table A-3: Stationary Combustion – Biomass and Biofuel Default Data Sources

Data Element	Preferred Source
Biomass by type: Total amount in MMBtu or tons where energy is not produced (i.e., combustion for waste disposal)[72]	• Agency records
Emission Factor	• CO_2: see Appendix D for tables by fuel type • CH_4 and N_2O: see Appendix D for tables by fuel type
Biomass fraction of MSW	• Agency records, or default value of 53%[73]

Calculation Steps

The default methodology includes the following steps. The Annual GHG Data Report workbook will use the data entered by the federal manager in step 1 to complete steps 2 through 5.

1. Determine the amount of fuel consumed annually
2. Determine the appropriate CO_2 emission factors for each fuel
3. Determine the appropriate CH_4 and N_2O emission factors for each fuel
4. Calculate each fuel's GHG emissions and convert them to MT
5. Convert CH_4 and N_2O emissions to MT CO_2e and determine the total emissions.

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[72] To estimate Scope 1 emissions from waste incineration where incineration is not used as a fuel for energy generation, an agency should estimate the quantity of waste incinerated and apply EFs for waste as a feedstock (found in Appendix D) to the mass of the waste processed by that facility. Values based on energy content should be converted to values based on mass or volume. For municipal solid waste, for example, the appropriate factor to use is 902.47 $kgCO_2$/short ton of MSW sent to the incinerator (e.g., 9.95 MMBtu/short ton x 90.7 $kgCO_2$/MMBtu = 902.47 $kgCO_2$/short ton).

[73] eGRID Technical Support Document, Table 3-2, assuming Mass Burn, based on heat input and generation. https://www.epa.gov/sites/production/files/2015-10/documents/egrid2012_technicalsupportdocument.pdf.

Example A-2: Biomass Combustion

Step 1: *Determine the amount of fuel consumed annually*

A facility burned 134 tons of wood waste in a biomass boiler to reduce its natural gas use.

Equation A-1: Stationary Combustion Fuel Consumed

Fuel consumed [MMBtu]	= Fuel consumed [short tons] ● HHV [MMBtu/ton]	
	= 134 [short tons] ● 15.38 [MMBtu/short ton]	
	= 2,060.92 [MMBtu]	

Step 2: *Determine the appropriate CO_2 emission factors for each fuel*

The CO_2 emission factor for this example is 93.80 kg/MMBtu.

Step 3: *Determine the appropriate CH_4 and N_2O emission factors for each fuel*

The wood waste emission factors for CH_4 and N_2O are 0.032 and 0.0042 kg/MMBtu.

Step 4: *Calculate each fuel's GHG emissions and convert them to MT*

Equation A-2: Biomass Combustion GHG Emissions

CO_2 Emissions [MT]	= Fuel consumed [MMBtu] ● CO_2 emission factor [kg/MMBtu] ● 0.001 [MT/kg]
	= 2,060.92 [MMBtu] ● 93.80 [kg/MMBtu] ● 0.001 [MT/kg]
	= 193.31 [MT CO_2]

CH_4 Emissions [MT]	= Fuel consumed [MMBtu] ● CH_4 emission factor [kg/MMBtu] ● 0.001 [MT/kg]
	= 2,060.92 [MMBtu] ● 3.2×10^{-2} [kg/MMBtu] ● 0.001 [MT/kg]
	= 6.59×10^{-2} [MT CH_4]

N_2O Emissions [MT]	= Fuel consumed [MMBtu] ● N_2O emission factor [kg/MMBtu] ● 0.001 [MT/kg]
	= 2,060.92 [MMBtu] ● 4.2×10^{-3} [kg/MMBtu] ● 0.001 [MT/kg]
	= 8.66×10^{-3} [MT N_2O]

Step 5: *Convert CH_4 and N_2O emissions to MT CO_2e and determine the total emissions*

Equation A-3: Biomass Combustion MT CO_2e Emissions

➢ *Reported as Scope 1 emissions:*

CO_2e Emissions [MT CO_2e]	= (MT CH_4 ● CH_4 GWP) + (MT N_2O ● N_2O GWP)
	= (0.0659 [MT CH_4] ● 25) + (0.0087 [MT N_2O] ● 298)
	= 1.384 [**MT CO_2e**] + 2.596 [**MT CO_2e**]
	= 3.984 [**MT CO_2e**]

➢ *Reported as biogenic in Scope 1:*

CO_2e Emissions [MT CO_2e]	= MT CO_2
	= **197.39 [MT CO_2]**

Note: Example has been provided for demonstration purposes only and has rounding imposed throughout each of the calculation steps above. Factors are for illustration. The most recent emission factors can be found in the Annual GHG Data Report workbook where their original sources will also be documented. As such results from this example may differ slightly from results generated using the Annual GHG Data Report workbook.**

A.3. Mobile Combustion: Fossil Fuels

Description

Vehicle fleets are the primary source of mobile fossil fuel emissions, but they can also come from non-highway vehicles (such as agriculture equipment), research aircraft, and waterborne vessels. Fuel types include gasoline, diesel, aviation gas, Jet-A, compressed natural gas (CNG), liquefied petroleum gases (LPG), liquefied natural gas (LNG), and other fuels derived from fossil fuel sources.[74]

Most CO_2 emissions, which account for the majority of emissions from mobile sources, can be calculated using fuel consumption data already reported to the FAST system for both the default and alternative methodology. CH_4 and N_2O emissions calculations vary depending on emission control technologies and distance traveled. FAST system fuel consumption data are used for the default methodology. Agencies may utilize specific fleet composition and fuel consumption to report using the alternative methodology

A.3.1. Default Methodology (to be Calculated by Annual GHG Data Report Workbook)

Data Sources

The default methodology uses the data already reported in FAST and potentially other analogous agency-specific systems. The Annual GHG Data Report workbook will use default factors to automatically calculate the CH_4 and N_2O emissions to the greatest extent feasible (see Table A-3).

Table A-4: Mobile Combustion – Fossil Fuels Default Data Sources

Data Element	Preferred Source
Annual Fuel Consumption: by type [Gallons of Gasoline Equivalent or GGE]*	• FAST system • Other analogous agency-specific systems
Emission Factor	• CO_2: see Appendix D for tables by fuel type • CH_4 and N_2O: see Appendix D for sources of emission factors by fuel type

* This methodology applies to highway vehicles and alternative fuel vehicles, but not to non-highway vehicles such as ships and aircraft. For those vehicles, estimation of CH_4 and N_2O emissions is also based on fuel consumption.

Calculation Steps[75]

To calculate Scope 1 emissions from mobile combustion of fossil fuels, agencies' vehicle fuel consumption data available in the FAST system is entered in the Annual GHG Data Report workbook (step 1). Similar import arrangements may be possible with other analogous agency-specific systems, as necessary. The Annual GHG Data Report workbook will, to the greatest extent feasible, automatically perform steps 2 through 6.

1. Determine the total amount of energy consumed by fuel

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[74] The term "fossil fuels" in the Guidance is not synonymous with the definition of "petroleum and alternative fuels" used by FAST.

[75] EPA Center for Corporate Climate Leadership Technical Guidance, *Direct Emissions from Mobile Combustion Sources*, May 2008.

2. Determine the appropriate CO_2 emission factors for each fuel
3. Determine the appropriate CH_4 and N_2O emission factors for each fuel using default assumptions
4. Calculate the total CO_2 (biogenic and anthropogenic), CH_4, and N_2O emitted for each fuel
5. Calculate the total CO_2e emissions for each fuel
6. Convert kg CO_2e emissions to MT CO_2e and determine the total emissions.

Step 1: Determine the total amount of energy consumed by fuel

The FAST system includes agency-level information on fuel consumption per fuel type on a GGE basis. Agencies should review this data for accuracy prior to input into the Annual GHG Data Report workbook. The agency can modify the data to correct inaccuracies or to include mobile fleet emissions sources not currently included in FAST system but under the operational control of the agency. The Annual GHG Data Report workbook will automatically convert GGEs to gallons using the conversions in Appendix D. The Annual GHG Data Report workbook will calculate the total energy consumed [MMBtu] for each fuel by multiplying the total amount of fuel consumed [GGE] for each fuel by the default HHV [MMBtu/GGE].

Equation A-4: Amount of Energy Consumed (for Each Fuel)

Amount of Energy Consumed [MMBtu] =
   Total annual consumption [GGE] ● 0.125 [MMBtu/GGE]

Step 2: Determine the appropriate CO_2 emission factors for each fuel

The Annual GHG Data Report workbook will apply the appropriate biogenic and anthropogenic CO_2 emission factors [kg CO_2/MMBtu] for each fuel. Appendix D shows sources of CO_2 emission factors by fuel including links to the appropriate worksheets in the Annual GHG Data Report workbook.

Step 3: Determine the appropriate CH_4 and N_2O emission factors for each fuel using default assumptions

The Annual GHG Data Report workbook will apply the appropriate converted CH_4 and N_2O emission factors [kg/MMBtu] for each fuel. Default CH_4 and N_2O emission factors are developed in grams per mile. Because the FAST system does not correlate fuel use by type of vehicle or mileage, this methodology requires significant assumptions about the mobile inventory. It conservatively estimates the amount of CH_4 and N_2O emissions from mobile sources by using a high emission factor under available control technology for the entire fleet.[76] The default emission factors are calculated as: (Vehicle Advanced Emission Control emissions in g/mile/1000)[77] ●

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[76] The Annual GHG Data Report workbook will use values from 5 years prior to the reporting year, as GSA leases vary from 3 to 8 years, depending on type and fuel.

[77] EPA Center for Corporate Climate Leadership, *Mobile Combustion Sources*, May 2008, Tables A-1, A-6, and A-7.

national average MPG for vehicle type[78] ● reciprocal of the HHV for the fuel type. The converted emission factors are calculated by dividing the product of the default emission factors and the default fuel efficiency by the HHV [gal/MMBtu].

Agencies with more detail on the vehicle fleet composition connected to fuel use can choose to use the alternative calculation methodology described after this section, either with full data or weighted averages per vehicle and fuel type.

Step 4: Calculate the total CO_2 (biogenic and anthropogenic), CH_4, and N_2O emitted for each fuel

To determine CO_2, CH_4, and N_2O emissions from mobile combustion, the Annual GHG Data Report workbook will multiply fuel use (step 1) by the biogenic and anthropogenic CO_2 emission factors (step 2), and the CH_4 and N_2O emission factors (step 3) for each fuel.

Equation A-5: Mobile Combustion CO_2, CH_4, and N_2O Emissions (Fossil Fuels)

CO_2 emissions [kg] =   Amount of Energy Consumed [MMBtu] ● CO_2 emission factor [kg/MMBtu]
CH_4 emissions [kg] =   Amount of Energy Consumed [MMBtu] ● CH_4 emission factor [kg/MMBtu]
N_2O emissions [kg] =   Amount of Energy Consumed [MMBtu] ● N_2O emission factor [kg/MMBtu]

Step 5: Calculate the total CO_2e emissions for each fuel

The Annual GHG Data Report workbook will use the GWP values (sources found in Appendix D) to convert CO_2, CH_4, and N_2O emissions to units of CO_2e. The Annual GHG Data Report workbook will sum emissions from all three gases to determine total kg CO_2e for each fuel.

Equation A-6: Mobile Combustion kg CO_2e Emissions (Fossil Fuels—Default)

CO_2e emissions [kg CO_2e] =   (kg CO_2 ● CO_2 GWP) + (kg CH_4 ● CH_4 GWP) + (kg N_2O ● N_2O GWP)

Step 6: Convert kg CO_2e emissions to MT CO_2e and determine the total emissions

The Annual GHG Data Report workbook will convert kg CO_2e to units of MT CO_2e for each fuel. The Annual GHG Data Report workbook will then sum emissions from all fuels to determine total MT CO_2e.

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[78] U.S. Department of Transportation, Federal Highway Administration, Highway Statistics 2005, Table VM-1. See www.fhwa.dot.gov/policy/ohim/hs05/pdf/vm1.pdf. Factors are for illustration.

Equation A-7: Mobile Combustion Total MT CO₂e Emissions (Fossil Fuels—Default)

Total CO₂e emissions [MT CO₂e] =
 ∑ (kg CO₂e ● 0.001 [MT/kg])

Example A-3: Mobile Combustion (Fossil Fuels—Default Methodology)

Goal: Determine the total MT CO_2e Emissions

The agency fleet consumed 500,000 GGEs of gasoline

Step 1: Determine the total amount of energy consumed

Equation A-4: Amount of Energy Consumed (for Each Fuel)

Amount of Energy Consumed [MMBtu]	= Total Consumption [GGE] ● 0.125 [MMBtu/GGE]
	= 500,000 [GGE] ● 0.125 [MMBtu/GGE]
	= 62,500 [MMBtu]

Step 2: Determine the appropriate CO_2 emission factors for each fuel

The default anthropogenic emission factor for gasoline is 70.22 kg CO_2/MMBtu.

Step 3: Determine the appropriate CH_4 and N_2O emission factors for each fuel using default assumptions

The emission factors for CH_4 and N_2O are 0.001918 kg CH_4/MMBtu and 0.002035 kg NO_2/MMBtu.

Step 4: Calculate the total CO_2 (biogenic and anthropogenic), CH_4, and N_2O emitted for each fuel

Equation A-5: Mobile Combustion CO₂, CH₄, and N₂O Emissions (Fossil Fuels)

CO₂ emissions [kg]	= amount of energy consumed [MMBtu] ● CO₂ emission factor [kg/MMBtu]
	= 62,500 [MMBtu] ● 70.22 [kg/MMBtu]
	= 4,388,750 [kg]
CH₄ emissions [kg]	= amount of energy consumed [MMBtu] ● CH₄ emission factor [kg/MMBtu]
	= 62,500 [MMBtu] ● 0.002035 [kg/MMBtu]
	= 119.88 [kg]
N₂O emissions [kg]	= amount of energy consumed [MMBtu] ● N₂O emission factor [kg/MMBtu]
	= 62,500 [MMBtu] ● 0.002035 [kg/MMBtu]
	= 127.19 [kg]

Step 5: Calculate the total CO_2e emissions for each fuel

Equation A-6: Mobile Combustion kg CO₂e Emissions (Fossil Fuels-Default)

CO₂e emissions [kg CO₂]	= (kg CO₂ ● CO₂ GWP) + (kg CH₄ ● CH₄ GWP) + (kg N₂O ● N₂O GWP)
	= (4,388,750 [kg] ● 1) + (119.88 [kg] ● 25) + (127.19 [kg] ● 298)
	= 4,429,649.62 [kg CO₂e]

Step 6: Convert kg CO_2e emissions to MT CO_2e and determine the total emissions

Equation A-7: Mobile Combustion Total MT CO₂e Emissions (Fossil Fuels—Default)

Total CO₂e emissions [MT CO₂e]	= ∑ (kg CO₂e ● 0.001 [MT/kg])
	= 4,429,649.62 [kg CO₂e] ● 0.001 [MT/kg]
	= 4,429.65 [MT CO₂e]comm

A.3.2. Alternative Methodology (User Calculated)

Data Sources

The alternative calculation methodology uses data on annual mileage and fleet composition to find fleet-specific emissions totals for CH_4 and N_2O (Table A-4). The Annual GHG Data workbook does not have any cells or tables to populate for the alternative methodology, but does provide emission factors (g/mile) for the mobile fuels and vehicle combinations shown in Table A-6. Agencies can use these factors in their own tools for applying the alternative methodology and then report the steps, data sources and results in their Annual GHG Data Report Narrative and add the emissions to the appropriate cells in the Annual GHG Data Report workbook. Appendix D provides directions to the sources for emission factors and to the appropriate Annual GHG Data Report workbook sections.

Table A-5: Mobile Combustion – Fossil Fuels Alternative Data Sources

Data Element	Preferred Source	Alternate Source
Annual fuel consumption data by type	• FAST system • Other agency resources, such as the operating and support management information system, when applicable • Agency non-fleet VE records	• Dollars spent on fuel and average price per unit of volume • Annual mileage and vehicle fuel economy reported • Hours operated (off-road vehicles)
Annual mileage by vehicle type, emission control technology, and fuel type* (for CH_4 and N_2O calculation only) [mi]	• Agency data on miles traveled	• Miles traveled estimates based on hours traveled and fuel economy • Weighted average percentages of vehicle type and efficiency data from vehicle population • Hours operated (off-road vehicles)
Emission factor	• CO_2: see tables in Appendix D by fuel type • CH_4 and N_2O: see Tables D-1 for sources by fuel type, vehicle type, and combustion technology	

* This applies to highway vehicles and alternative fuel vehicles, but not to non-highway vehicles such as ships and aircraft. For those vehicles, CH_4 and N_2O emissions are estimated from fuel consumption rather than distance traveled.

Table A-6: Mobile Fuel and Vehicle Emission Factors Available in Annual GHG Data Report Workbook

Gasoline Fuel/Vehicles	Diesel Fuel Vehicles	Other Fuels/Vehicles
Gasoline-Default	Diesel-Default	LPG/Propane
Gasoline-Passenger Cars-Tier 2	Diesel-Passenger Cars - Advanced	CNG
Gasoline-Passenger Cars-Tier 1	Diesel-Passenger Cars - Moderate	LNG
Gasoline-Passenger Cars-Tier 0	Diesel-Passenger Cars - Uncontrolled	Ethanol
Gasoline-Passenger Cars-Oxidation catalyst	Diesel-Light Trucks-Advanced	Biodiesel
Gasoline-Passenger Cars-Non-catalyst	Diesel-Light Trucks-Moderate	B20
Gasoline-Passenger Cars-Uncontrolled	Diesel-Light Trucks-Uncontrolled	Methanol
Gasoline-Light-Duty Trucks-Low emission vehicles	Diesel-Heavy-Duty Trucks-Advanced	Aviation Gas
Gasoline-Light-Duty Trucks-Tier 2	Diesel-Heavy-Duty Trucks-Moderate	Jet Fuel
Gasoline-Light-Duty Trucks-Tier 1	Diesel-Heavy-Duty Trucks-Uncontrolled	Navy Special
Gasoline-Light-Duty Trucks-Tier 0		Methanol-Light Duty
Gasoline-Light-Duty Trucks-Oxidation catalyst		CNG-Light Duty
Gasoline-Light-Duty Trucks-Non-catalyst		LPG-Light Duty
Gasoline-Light-Duty Trucks-Uncontrolled		Ethanol-Light Duty
Gasoline-Heavy-Duty Trucks - Tier 2		Methanol-Heavy-Duty
Gasoline-Heavy-Duty Trucks - Tier 1		CNG-Heavy-Duty
Gasoline-Heavy-Duty Trucks - Tier 0		LNG-Heavy-Duty
Gasoline-Heavy-Duty Trucks - Oxidation catalyst		LPG-Heavy-Duty
Gasoline-Heavy-Duty Trucks - Non-catalyst		Ethanol-Heavy-Duty
Gasoline-Motorcycles-Non-Catalyst		Methanol-Buses
Gasoline-Motorcycles-Uncontrolled		CNG-Buses
		Ethanol-Buses

Calculation Steps for CO$_2$ Emissions

See Appendix A.3.1, steps 1, 2, and 5 of the Default Methodology, for CO$_2$ emissions. To convert from GGEs, use the conversions in Annual GHG Data Report workbook.

Equation A-8: Fuel Consumption GGE Conversion

Total fuel consumption [gal] = Total fuel [GGE] ÷ GGE factor [GGE/gal]

Calculation Steps for CH$_4$ and N$_2$O Emissions

Agencies with additional alternative activity data (i.e., fleet fuel consumption by vehicle class) can choose to utilize this alternative methodology to more accurately estimate their fleet emissions. This increased accuracy can be used to better estimate (and get credit for) reductions obtained through certain fleet management strategies (such as creating a "cleaner" mix of fleet vehicles). Alternatively, if data on specific control technologies are not available, or are too labor intensive to generate, agencies can estimate CH$_4$ and N$_2$O emissions using a weighted average of available control technologies by model year and apply the sums to the alternative calculation methodology (see Appendix D or Annual GHG Data Report workbook for sources of average emission factors).

To calculate Scope 1 CH$_4$ and N$_2$O emissions from the mobile combustion of fossil fuels, do the following:

1. Identify the vehicle type, fuel type, and technology type of all the vehicles
2. Determine the mileage by vehicle type
3. Determine the appropriate emission factors for fuel and vehicle type
4. Calculate CH$_4$ and N$_2$O emissions by vehicle type and convert them to MT
5. Determine the total annual MT CO$_2$e.

Step 1: Identify the vehicle type, fuel type, and technology type of all the vehicles

The agency Federal fleet manager is responsible for identifying all vehicles under operational control of the agency by vehicle type (passenger car, light-duty truck, heavy-duty truck, and/or motorcycle), fuel type (gasoline or diesel), and emission control technology (LEVs, moderate control technologies, etc.). See the EPA Center for Corporate Climate Leadership's Mobile Combustion Guidance for more detail on the tiered emission control technology.[79]

Step 2: Determine the mileage by vehicle type

For each vehicle type reported, the agency Federal fleet manager determines distance traveled for the reporting period.

Step 3: Determine the appropriate emission factors for fuel and vehicle type

The agency Federal fleet manager selects the appropriate factors. (See Annual GHG Data Report workbook for sources of emission factors by vehicle type and technology.) See the EPA's Mobile Combustion guidance for weighted assumptions by year. The weighted assumptions provide the estimated emission factor by type of vehicle and year. Additional tables in Appendix A of EPA Center for Corporate Climate Leadership's Mobile Combustion guidance present the percentage of vehicles by type in each year that was designed with the EPA's tiered designations, which can be used if the vehicle population by type of technology is not known but date of purchase is known. Agencies should establish the information available for their fleet and use the best estimates available.

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[79] EPA Center for Corporate Climate Leadership, *Direct Emissions from Mobile Combustion Sources*, Appendix A, May 2008. See https://www.epa.gov/climateleadership/center-corporate-climate-leadership-direct-emissions-mobile-combustion-sources.

Step 4: Calculate the CH₄ and N₂O emissions by vehicle type and convert them to MT

For each category of vehicle type, technology, and fuel, the agency Federal fleet manager will use Equation A-9 for CH_4 and N_2O emissions.

Equation A-9: Mobile Combustion CH_4 and N_2O Emissions (Fossil Fuels—Alternative)

CH_4 emissions [MT CH_4] =
Total miles traveled [mi] ● CH_4 emission factor [g/mi] ● 0.001 [kg/g] ● 0.001 [MT/kg]
N_2O emissions [MT N_2O] =
Total miles traveled [mi] ● N_2O emission factor [g/mi] ● 0.001 [kg/g] ● 0.001 [MT/kg]

Step 5: Determine the total annual MT CO_2e

To determine the total CO_2e emissions, the agency manager will multiply by the appropriate GWP value for each gas found in Appendix D, and sums.

Equation A-10: Mobile Combustion MT CO_2e Emissions (Fossil Fuels—Alternative)

CO_2e emissions [MT CO_2e] = MT CO_2 + (MT CH_4 ● CH_4 GWP) + (MT N_2O ● N_2O GWP)

Example A-4: Mobile Combustion (Fossil Fuels—Alternative Methodology)

> ➢ *CO_2 Calculation*

Step 1: Determine the total amount of fuel consumed by type
    A truck owned by the agency consumed 2,350 gallons of diesel fuel (Distillate Oil No. 2).

Step 2: Determine the appropriate CO_2 emission factors for each fuel

CO_2 emission factor [kg/gal]	= HHV [MMBtu/gal] ● Diesel emission factor [kg/MMBtu]
	= 0.138 [MMBtu/gal] ● 73.96 [kg/MMBtu]
	= 10.21 [kg/gal]

Step 3: Calculate the total CO_2 emissions and convert them to MT

Equation A-5: Mobile Combustion CO_2 Emissions (Fossil Fuels)

CO_2 emissions [MT]	= Vehicle fuel consumption [gal] ● CO_2 emission factor [kg/gal] ● 0.001[MT/kg]
	= 2,350 [gal] ● 10.21 [kg/gal] ● 0.001 [MT/kg]
	= 23.99 [MT CO_2]

> ➢ *CH_4 and N_2O Calculation*

Step 1: Identify the vehicle type, fuel type, and technology type of all the vehicles
    The 1993 truck's average mileage is 15 mpg. It uses moderate emissions control technology.

Step 2: Determine mileage by vehicle type

The truck used 2,340 gallons of diesel fuel and averaged 15 mpg, driving a total of 35,250 miles.

Step 3: Determine the appropriate emission factors for fuel and vehicle type

The CH_4 and N_2O emission factors for a diesel light truck with moderate emission control technology are 0.0009 g/mile and 0.0014 g/mile, respectively.

Step 4: Calculate CH_4 and N_2O emissions by vehicle type and convert them to MT

Equation A-9: Mobile Combustion CH_4 and N_2O Emissions (Fossil Fuels—Alternative)	
CH_4 emissions [MT]	= Total miles traveled [mi] ● CH_4 emission factor [g/mi] ● 0.001 [kg/g] ● 0.001 [MT/kg]
	= 35,250 miles ● 0.0009 [g/mi] ● 0.001 [kg/g] ● 0.001 [MT/kg]
	= 3.17×10^{-5} [MT CH_4]
N_2O emissions [MT]	= Total miles traveled [mi] ● N_2O emission factor [g/mi] ● 0.001 [kg/g] ● .001 [MT/kg]
	= 35,250 miles ● 0.0014 [g/mi] ● 0.001 [kg/g] ● 0.001 [MT/kg]
	= 4.94×10^{-5} [MT N_2O]

Step 5: Determine the total annual MT CO_2e

Equation A-10: Mobile Combustion MT CO_2e Emissions (Fossil Fuels—Alternative)	
CO_2e emissions [MT CO_2e]	= MT CO_2 + (MT CH_4 ● CH_4 GWP) + (MT N_2O ● N_2O GWP)
	= 23.99 [MT CO_2] + (3.17×10^{-5} [MT CH_4] ● 25) + (4.94×10^{-5} [MT N_2O] ● 298)
	= 23.99 [MT CO_2] + 6.66×10^{-4} [MT CO_2e] + 1.47×10^{-2} [MT CO_2e]
	= **24.01 [MT CO_2e]**

Note: Example has been provided for demonstration purposes only and has rounding imposed throughout each of the calculation steps above. Factors are for illustration. The most recent emission factors can be found in the Annual GHG Data Report workbook where their original sources will also be documented. As such results from this example may differ slightly from results generated using the Annual GHG Data Report workbook.**

Non-Highway Vehicles

Default emission factors for non-highway vehicles are available in the Annual GHG Data Report workbook (see fuels in Table A-6) to assist in calculating emissions for aircraft, boats and ships, agriculture equipment, and various other vehicle and fuel types. Estimating emissions from these non-highway vehicles also requires data on the quantity of fuel consumed by fuel types. The same general calculation methodology described for highway vehicles applies to non-highway vehicles. For non-highway vehicles recorded by hours traveled, agencies should use known vehicle efficiency data and report the resulting total fuel usage or mileage. Further information on the emission factors used in the Annual GHG Data Report workbook are available in Appendix B of EPA's *Greenhouse Gas Inventory Guidance Direct Emissions from Mobile Combustion Sources*, at www.epa.gov/sites/production/files/201603/documents/ mobileemissions_3_2016.pdf, while the source of updates to the factors is documented in Appendix D.

A.4. Mobile Combustion: Biofuels

Description

Biofuels combusted in vehicles, such as cars, trucks, airplanes, and water vessels, produce CO_2, CH_4, and N_2O emissions. Agencies should include CH_4 and N_2O emissions as Scope 1, and CO_2 emissions should be clearly identified and reported in Scope 1 as biogenic emissions. The CH_4 and N_2O calculations are the same as those outlined in Appendix A.3. Because the reporting separately addresses the biogenic and non-biogenic fractions of fuels separately within Scope 1, the calculation steps for the methodologies below distinguish between CO_2 emissions calculations and those from CH_4 and N_2O. To the greatest extent feasible, the Annual GHG Data Report workbook will automatically separate these emissions in the default methodology.

A.4.1 Default Methodology (to be Calculated by Annual Greenhouse Gas Data Report)

Data Sources

Use the FAST system and FEMP energy reporting data for fuel consumption totals from biofuel combusted by mobile sources (Table A-5).

Table A-7: Mobile Combustion – Biofuels Default Data Sources

Data Element	Preferred Source
Annual fuel consumption data by type	• FAST system and other FEMP data reporting sources
CH_4 and N_2O: annual fuel consumption data by type	• FAST system and other FEMP data reporting sources
Biobased fraction of fuel	• Calculated percentage of annual fuel consumption
Emission factor	• CO_2: see Appendix D by fuel type • CH_4 and N_2O: see Appendix D

Calculation Steps for CO_2 Emissions[80]

To calculate Scope 1 CO_2 emissions from mobile combustion of biofuels, agencies' vehicle fuel consumption data available in the FAST system will be imported automatically into the Annual GHG Data Report workbook (step 1).[81] In addition, non-fleet vehicle and equipment data is part of the FEMP energy reporting. To the greatest extent feasible, the Annual GHG Data Report workbook will automatically perform steps 2 through 4:

1. Determine the total amount of fuel consumed by type
2. Determine the biofuel and fossil fuel portions of each fuel type (blend)
3. Select the appropriate CO_2 emission factor for each fuel type
4. Calculate the CO_2 emissions by biofuel and fossil fuel type.

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[80] Primary Reference: EPA, *Greenhouse Gas Inventory Guidance Direct Emissions from Mobile Combustion Sources,* January 2016.
[81] Additional agency-specific analogous data systems may potentially be linked to the Annual GHG Data Report workbook.

Step 1: Determine the total amount of fuel consumed by type

In accordance with FAST reporting guidelines, data in FAST should be reviewed and approved by the agency prior to final submission to FEMP. Typically, Federal fleet managers enter fuel use in FAST. This includes petroleum and alternative fuels used for fleet applications. Some alternative fuels, such as biofuel blends and ethanol blends, are indicated in terms of the fraction of renewable fuel with petroleum. For example, B20 contains 20 percent biodiesel and 80 percent diesel. Likewise with ethanol blends, E85 contains 85 percent ethanol and 15 percent gasoline. Blends lower than B20 and E85 are not considered alternative fuels under the EPAct of 1992 and therefore only these blends are allowed to be entered into FAST and trigger GHG calculations if the fuel is used in fleets. Agencies using a custom blend of fossil and renewable fuels may enter a custom fuel in worksheet 3.3 Scope 1 FEMP VE Energy in the Annual GHG Data Report workbook with documented custom emission factors as long as the fuel is not reported in fleet use. E-10 which is a common blend, is not reported separately in the FAST system – the inventory will rely on FAST updates to emission factors and reporting and will not provide alternative methods for fleet GHG emissions. Currently E-10 is considered standard gasoline in FAST and the Annual GHG Data Report workbook.

When using the FAST system, agencies do not have to concern themselves with the conversion of natural gallons to GGE or distinguishing between blends (i.e., E85, B20). For example, an agency will enter the number of gallons of E85 in the corresponding field and the system, which has the conversion factors built in, will automatically convert to GGE. It also conducts separate calculations for each blend fraction (step 2). For those interested in seeing these conversion factors, refer to Appendix D.

Step 2: Determine the biofuel and fossil fuel portions of each fuel type (blend)

The fractional components of the biofuels have different carbon contents, requiring the CO_2 emissions for each fraction to be calculated separately. To the greatest extent feasible, the Annual GHG Data Report workbook will calculate the total amount of each fraction of fuel.

Step 3: Select the appropriate CO_2 emission factor for each fuel type

To the greatest extent feasible, the Annual GHG Data Report workbook will identify the appropriate emission factor for each type and fraction of fuel (see Table D-1 for fuel emission factors).

Step 4: Calculate the CO_2 emissions by biofuel and fossil fuel type

For each category of biofuel and fossil fuel type, the federal manager uses Equation A-11 to calculate their respective CO_2 emissions.

Equation A-11: Mobile Combustion CO$_2$ Emissions (Biofuels—Default)

Biofuel CO$_2$ emissions [MT] =   Total volume of biofuel in fuel consumed [gal] ● CO$_2$ emission factor [kg/gal] ● 0.001 [MT/kg]
Fossil fuel CO$_2$ emissions [MT] =   Total volume of fossil fuel in fuel consumed [gal] ● CO$_2$ emission factor [kg/gal] ● 0.001 [MT/kg]

The Annual GHG Data Report workbook will report CO$_2$ generated from the fossil fuel fraction as Scope 1; the quantity of CO$_2$ from the biofuel portion is calculated separately and reported in Scope 1 as biogenic.

Calculation Steps for CH$_4$ and N$_2$O Emissions

CH$_4$ and N$_2$O emissions are considered anthropogenic (not biogenic), and all emissions are attributed to Scope 1. However, there are slight differences in CH$_4$ and N$_2$O emission factors for mobile combustion. The Annual GHG Data Report workbook will attribute the emission factor for each fuel type to the fraction of the fuel it comprises. For example, the emission factor for E85 is the sum of 85 percent of the emission factor for ethanol (E100) and 15 percent of the emission factor for gasoline.

To calculate blend-specific CH$_4$ and N$_2$O emission factors for blends not available in the Annual GHG Data Report workbook, sum the product of the fuel percentage and fuel-specific emission factor.

Equation A-12: CH$_4$ and N$_2$O Emission Factors for Blended Fuels

Blended CH$_4$ emission factor [g/mile] =
 	
    (Total fraction of biofuel [%] ● CH$_4$ emission factor [g/mile])
 	
        + (Total fraction of fossil fuel [%] ● CH$_4$ emission factor [g/mile])

Blended N$_2$O emission factor [g/mile] =
 	
    (Total fraction of biofuel [%] ● N$_2$O emission factor [g/mile])
 	
        + (Total fraction of fossil fuel [%] ● N$_2$O emission factor [g/mile])

A.4.2. Alternative Methodology (User Calculated)

Data Sources

Data sources for calculating CO$_2$ emissions are the same as in the default method, and sources for calculating CH$_4$ and N$_2$O are the same as in Appendix A.3 with one additional step for determining the emission factor.

Calculation Steps for CO$_2$, CH$_4$, and N$_2$O Emissions

The alternative methodology for CO$_2$ is the same as the default. The CH$_4$ and N$_2$O alternative methodology is described in the alternative methodology for mobile combustion of fossil fuels (Appendix A.3.2). Report CH$_4$ and N$_2$O emissions for both fossil and biofuel components under

Scope 1. CH_4 and N_2O emissions from either fossil or biofuel mobile combustion are considered anthropogenic (not biogenic) and are included in agency reduction targets and inventories.

To calculate blend-specific CH_4 and N_2O emission factors, sum the product of the fuel percentage and fuel-specific emission factor.

Example A-5: Mobile Combustion (Biofuels—Alternative Methodology)

Step 1: Determine the total amount of fuel consumed by type

A light truck owned by an agency consumed 2,500 gallons of E85.

Step 2: Determine the biofuel and fossil fuel portions of each fuel type(blend)

This equates to 2,125 gallons of ethanol and 375 gallons of regular gasoline.

Step 3: Select the appropriate CO_2 emission factor for each fuel type

The ethanol emission factor is 5.75 kg CO_2/gal and the gasoline emission factor is 8.78 kg CO_2/gal.

Step 4: Calculate the CO_2 emissions by biofuel and fossil fuel type

Equation A-11: Mobile Combustion CO_2 Emissions (Biofuels—Default)

Ethanol CO_2 emissions [MT]	=	Total fraction of ethanol in fuel consumed [gal] ● CO_2 emission factor [kg/gal] ● 0.001 [MT/kg]
	=	2,125 [gal] ● 5.75 [kg/gal] ● 0.001 [MT/kg]
	=	12.22 [MT CO_2]

Gasoline CO_2 emissions [MT]	=	Total fraction of gasoline in fuel consumed [gal] ● CO_2 emission factor [kg/gal] ● 0.001 [MT/kg]
	=	375 [gal] ● 8.78 [kg/gal] ● 0.001 [MT/kg]
	=	3.29 [MT CO_2]

The Scope 1 gasoline CO_2 emissions are added to the total amount of CH_4 and N_2O emissions calculated using Equation A-5 below and reported as Scope 1 mobile emissions (see Equation A-7). The ethanol CO_2 emissions above are separately reported as biogenic in Scope 1 (see Example A-3 for more explanation). The truck has an average efficiency of 21 MPG and used 2,500 gallons; it traveled approximately 52,500 miles. The emission factors for the blend are calculated as follows, using E100 and motor gasoline:

Equation A-12: CH₄ and N₂O Emission Factors for Blended Fuels	
E85 CH₄ emission factor [g/mile]	= (Total fraction of biofuel [%] ● CH₄ emission factor [g/mile]) + (Total fraction of fossil fuel [%] ● CH₄ emission factor [g/mile]) = (.85 ● 0.055) + (.15 ● 0.0148) = 0.049 [g/mi]
E85 N₂O emission factor [g/mile]	= (Total fraction of biofuel [%] ● N₂O emission factor [g/mile]) + (Total fraction of fossil fuel [%] ● N₂O emission factor [g/mile]) = (.85 ● 0.067) + (.15 ● 0.0157) = 0.059 [g/mi]

➢ *CH₄ and N₂O Emissions Calculations:*

Equation A-9: Mobile Combustion CH₄ and N₂O emissions (Fossil Fuels—Alternative)	
CH₄ Emissions [MT]	= Total miles traveled [mi] ● CH₄ emission factor [g/mi] ● 0.001 [kg/g] ● 0.001 [MT/kg] = 52,500 miles ● 0.049 [g/mi] ● 0.001 [kg/g] ● 0.001 [MT/kg] = 0.0026 [MT CH₄]
N₂O Emissions [MT]	= Total miles traveled [mi] ● N₂O emission factor [g/mi] ● 0.001 [kg/g] ● 0.001 [MT/kg] = 52,500 miles ● 0.059 [g/mi] ● 0.001 [kg/g] ● 0.001 [MT/kg] = 0.0031 [MT N₂O]

➢ *Report as Scope 1:*

Equation A-10: Mobile Combustion MT CO₂e Emissions (Fossil Fuels—Alternative)	
CO₂e Emissions [MT CO₂e]	= MT CO₂ + (MT CH₄ ● CH₄ GWP) + (MT N₂O ● N₂O GWP) = 3.29 [MT CO₂] + (0.0026 [MT CH₄] ● 25) + (0.0031 [MT N₂O] ● 298) = 3.29 [MT CO₂] + 0.055 [MT CO₂e] + 0.961 [MT CO₂e] = **4.269 [MT CO₂e]**

➢ *Report as biogenic and Scope 1:*

CO₂e Emissions [MT CO₂e]	= MT CO₂ = 12.22 [MT CO₂]

Note: Example has been provided for demonstration purposes only and has rounding imposed throughout each of the calculation steps above. Factors are for illustration. The most recent emission factors can be found in the Annual GHG Data Report workbook where their original sources will also be documented. As such results from this example may differ slightly from results generated using the Annual GHG Data Report workbook.**

A.5. Fugitive Emissions: Refrigerants and Fluorinated Gases, Inputs to Fugitive F-Gases

Description

This section discusses default and alternative approaches for calculating Scope 1 fugitive GHG emissions from refrigerants and fluorinated gases which are combined with specific F-gas releases

to create total fugitive F-gas emissions. For purposes of inventory development, fugitive emissions are GHG emissions resulting from equipment operations or practices that do not pass through a stack, chimney, or other functionally equivalent opening (point source) and which are not captured or destroyed by an emissions control system. Alternatively, agencies may elect to inventory more GHGs than those covered under E.O. 13693. For example, they could consider inventorying high-GWP, ozone-depleting substances (e.g., CFCs) if they are prevalent due to manufacturing or other processes. Thus, it is recommended that agencies carefully track both refrigerant type and quantity to avoid reporting challenges with these commingled refrigerant gases.[82] Agencies should note that ozone depleting substances (CFCs and hydrochlorofluorocarbons [HCFCs]) are not included GHGs in the context of E.O. 13693 and other GHG accounting systems. Agencies that wish to report other fugitive gas emissions outside of the pre-populated lists may use the custom gas rows in the Annual GHG Data Report workbook where they can provide the chemical name and GWP of the custom entry.

F-gas fugitive emissions can occur during the manufacture, installation, use, service, and disposal of heating, ventilating, and air conditioning (HVAC) and refrigeration equipment; mobile source air-conditioning equipment; and electrical equipment in which SF_6 or PFCs are used as electrical insulators. Such electrical equipment includes gas-insulated circuit breakers, switch gears, substations, gas-insulated lines, and some transformers.

For purposes of the Annual GHG Data Report workbook, it is generally assumed that all agency emissions of F-gases are "fugitive." However, if an agency has F-gas emissions that are "non-fugitive" (pass through a stack or chimney, or are intentionally released during research), an agency should calculate these emissions and include them in their inventory as Scope 1 process emissions.

General Data Sources

In general, the information required to estimate F-gas emissions from HVAC, refrigeration, and electrical equipment consists of data on F-gas consumption and the net growth (or decline) of the total charge (nameplate capacity) of the equipment during the year. The net growth or decline of the total charge is tracked by the total quantities of equipment newly installed or retired. The total charge is also useful for its own sake in applying the screening analysis (discussed further below) or calculating emissions rates (such as kg HFC emitted per kg HFC charge).[83]

The ease and ability of obtaining the underlying activity data needed to calculate fugitive GHG emissions may be influenced by the size, mission, and maintenance capabilities of an agency. Larger organizations may operate agency-specific logistics and supply management systems at the facility level that track the requisition, purchase, receipt, storage, issue, shipment, disposition, and identification of equipment and supply materials and may maintain equipment in-house. If these systems are not centrally accessible at the agency headquarters level, formal data calls may be

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[82] CO_2, CH_4, and N_2O are not F-gases though there are also fugitive emissions of these GHGs. Fugitive emissions of these GHGs could stem from their use as specialty gases, waste water treatment, and solid waste facilities. See Appendices A-6 and A-7 on wastewater treatment and solid waste facilities, respectively.

[83] Mixed refrigerants will need to be calculated to their constituent compounds. The Annual GHG Data Report workbook has a calculator for this purpose that automatically populates the fugitive gas data entry module, but agencies are also welcome to use the EPA HFC Emission Accounting Tool for input into the Annual GHG Data Report workbook.

needed to obtain the necessary data from individual agency locations. Agencies are encouraged to use existing data, including purchase records, to estimate potential fugitive emissions.

Smaller organizations may not have the same logistics, data management, and equipment maintenance needs and/or may contract out such services. If F-gas purchase data are not available from local sources, best judgment estimates may be needed. Agencies may consider modifying facility support or service contracts to require contractors to provide these data for future inventories or utilizing existing data and documenting methodologies used for estimating fugitive emissions.

Specific data requirements will depend on the methodology applied, as described below.

Default and Alternative Methodologies[84]

Agencies can use these methods adapted to their own internal data or use the EPA HFC Emission Accounting Tool to translate their available data into the equivalent amounts of mixed refrigerants taken out of storage and returned to storage used in the GHG emissions calculations. The following table illustrates options and methodologies available to agencies for reporting refrigerant use and emissions. Agencies should indicate all the methodologies used for an inventory in the table provided in worksheet 3.6 of the Annual GHG Data Report workbook if different parts of the agency are using different methods whose results are then combined at the agency level.

Table A-8: Methodologies Used in EPA HFC Emission Accounting Tool

Methodology	Description
EPA Default Methodology	Amount of refrigerant purchased/issued from supply, amount of refrigerant returned to supply
EPA Material Balance	Quantity of refrigerant in storage at beginning of year, quantity of refrigerant in storage at end of year, refrigerant purchased/issued from supply, refrigerant returned to supply system, equipment capacity at beginning of year, equipment capacity at end of year
EPA Simplified Material Balance	Amount of refrigerant purchased to fill new equipment at installation, capacity of new equipment, refrigerant used to service equipment, capacity of retiring equipment, amount recovered from retiring equipment
EPA Simplified Screening 1	Based on equipment type, number of refrigerant-containing equipment by equipment type
EPA Simplified Screening 2	Estimate based on building type, total square footage
EPA Screening	Type of equipment, amount of refrigerant charged into new equipment, capacity of existing equipment, capacity of retired equipment

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[84] Primary Reference: EPA, *Greenhouse Gas Inventory Guidance Direct Fugitive Emissions from Refrigeration, Air Conditioning, Fire Suppression, and Industrial Gases*, February 2014. *EPA Technical Support Document for Emissions from Production of Fluorinated Gases: Final Fuel for Mandatory Report of Greenhouse Gases,* November 2010.

A.5.1 Default Methodology (to be Calculated by Annual GHG Data Report Workbook)

The Federal supply system transaction screening approach (default) is a much simplified version of the material balance approach used by Federal agencies in conjunction with the development of inventories of ozone depleting substances. It is also the default methodology in the EPA HFC Emission Accounting Tool. Central to this methodology is the assumption that subtracting the quantity of F-gas returned from the quantity an agency purchases or issues to maintain equipment can be used as a reasonable estimate of actual emissions. This assumption is reasonable when the total charge of a particular F-gas in the installed equipment is fairly constant from year to year. However, if the total charge is declining because more equipment containing the F-gas is being retired than installed, this assumption could lead to an underestimate of F-gas emissions.[85] If the agency knows that its total charge is declining significantly, it should consider using one of the other methodologies. This is the same basic approach as the default methodology found in the EPA HFC Emission Accounting Tool.

Furthermore, agencies with cyclical operations or events that use this default screening approach may find that a single reporting year is not representative of their Scope 1 F-gas fugitive emissions (HFCs, PFCs, and SF$_6$). As discussed in Chapter 5.5 of the Guidance, agencies may choose to calculate a 3-year rolling average base year value for their specific Scope 1 fluorinated fugitive emissions. The FY 2008 base year should consist of the average Scope 1 fluorinated gas fugitive emissions for FY 2006, FY 2007, and FY 2008. An agency may use a 3-year rolling average base year for fugitive emissions, if it continues to use a 3-year average for subsequent reporting years, and notes the use of this rolling average approach in the "Other Information" section of their qualitative statement. Agencies may not use the rolling average approach for their entire comprehensive inventory, but only for the F-gas fugitive emissions category.

Agencies may use a calendar year, fiscal year, or 3-year rolling average for amounts removed from supply and returned to supply. Agencies need to indicate which is used in the Annual GHG Data Report workbook in the input cell under "Enter Data Type".

Data Sources

Agencies will need to obtain purchase and supply requisition data on each F-gas from local or centralized sources. Chemical compounds are often listed by chemical name or trade name, which can lead to confusion when a single compound is referred to by multiple names. The Chemical Abstract Service (CAS) number is a unique numeric identifier for chemical compounds that should be used when searching a chemical inventory database to avoid such confusion.

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[85] Agencies should ensure there is no double counting or underreporting as they switch equipment (from R-22 to HFC-based refrigerants). If little or no new equipment is being installed, but significant amounts of old equipment are being retired, emissions can occur without resulting in demand for new gas. Specifically, emissions can occur between the final servicing of equipment and its retirement or during its retirement. These emissions could account for most or even all of the equipment charge. When at least some of the equipment charge is recovered and recycled, that charge can be used to service existing equipment (whose charge has leaked previously), offsetting demand for new gas that would have occurred if the gas from the retiring equipment were not available.

Table A-9: Fugitive Emissions – F-Gas Default Data Sources (Federal Supply System Transaction Screening Approach)

Data Element	Preferred Source	Alternate Source
Amount and type of each F-gas issued from procurement and storage [lb]	• GSA • Defense Logistics Agency • Agency logistics/supply organizations • Chemical inventory tracking system	• Local hazardous material management/ distribution centers • Purchase records • Maintenance records
Amount recovered from equipment and the amount returned to the supply system [lb]	• See above	• See above

Calculation Steps

To calculate Scope 1 emissions from fugitive F-gas emissions, do the following:

1. Collect transaction data
2. Find the difference in the amounts recovered and returned to estimate annual emissions
3. Convert annual emissions to MT CO_2e and sum emissions.

Step 1: Collect transaction data

The agency Federal facilities and/or fleet manager identifies the CAS numbers of the F-gases used and obtains supply system transactional data to determine the amount and type of each F-gas issued from storage. If F-gas purchase data are not available from local sources, the federal manager may need to make best judgment estimates. These data are entered by the agency manager into the Annual GHG Data Report workbook (see Table D-1 for sources of conversion factors).

Step 2: Find the difference in amount recovered and returned to estimate annual emissions

The Annual GHG Data Report workbook will subtract from the amount issued the amount recovered from equipment and the amount returned to the supply system. In some cases, the agency manager may need to first convert gas reported in units of volume to units of mass before estimating emissions.

Total mass of gas [lb]	= volume of gas [cu ft] ● conversion factor [cu m/cu ft] ● density of gas [lb/cu m]

Equation A-13 can be used once volume is known in pounds.

Equation A-13: Annual Fugitive Emissions (F-Gas—Default)

Annual Emissions [MT F-Gas] $= (I - R) \bullet 4.536 \times 10^{-4}$ [MT/lb]

Where:

I $\quad=\quad$ Amount of F-gas issued from supply system [lb]

R $\quad=\quad$ Amount of F-gas returned to supply system from equipment, which includes the amount recovered from equipment during maintenance and the unused amount originally issued from supply [lb]

Step 3: *Convert annual emissions to MT CO₂e and sum emissions*

The Annual GHG Data Report workbook will multiply the F-gas annual emissions [MT F-gas] by the GWP of each F-gas to calculate the CO₂e emissions (see Equation A-14). It will sum all F-gas emissions. (See Table D-1 for GWP values.)

Equation A-14: Conversion of F-Gas Emissions to CO₂e (Default)

CO₂e [MT F-gas] $=$ Annual Emissions [MT] $\bullet$ F-gas GWP

In Examples A-6 and A-7, the refrigerant HFC-23 (CAS number 75-46-7) is listed under two names: trifluoromethane and fluoroform, illustrating the importance of using CAS numbers when querying supply systems. The examples provide steps for applying the supply system transaction screening approach when the supply system provides information in both mass and volume units.

Example A-6: Fugitive Emissions (F-Gas—Default Methodology) When Supply Data Are Available in Mass-Based Units

Step 1: Collect transaction data

- Amount of HFC-23 issued from supply system = 220 lb
- Amount of HFC-23 returned to supply system from equipment = 55 lb

Step 2: Find the difference in the amounts recovered and returned to estimate annual emissions

Equation A-13: Annual Fugitive Emissions (F-Gas—Default)

$$\text{Annual Emissions [MT HFC-23]} = (I - R) \cdot 4.536 \times 10^{-4} \text{ [MT/lb]}$$
$$= (220 \text{ [lb]} - 55 \text{ [lb]}) \cdot 4.536 \times 10^{-4} \text{ [MT/lb]}$$
$$= 7.48 \times 10^{-2} \text{ [MT HFC-23]}$$

Where:

I = Amount of F-gas issued from supply system [lb]

R = Amount of F-gas returned to supply system from equipment, which includes the amount recovered from equipment during maintenance and the unused amount originally issued from supply [lb]

Step 3: Convert annual emissions to MT CO_2e and sum emissions

Equation A-14: Conversion of F-Gas Emissions to CO_2e (Default)

$$\text{CO}_2\text{e [MT F-gas]} = \text{Annual Emissions [MT]} \cdot \text{F-gas GWP}$$
$$= 7.48 \times 10^{-2} \text{ [MT]} \cdot 1{,}430$$
$$= \textbf{875.16 [MT CO}_2\textbf{e]}$$

Note: Example has been provided for demonstration purposes only and has rounding imposed throughout each of the calculation steps above. Factors are for illustration. The most recent emission factors can be found in the Annual GHG Data Report workbook where their original sources will also be documented. As such results from this example may differ slightly from results generated using the Annual GHG Data Report workbook.

Example A-7: Fugitive Emissions (F-Gas—Default Methodology) When Supply Data Are Available in Volume-Based Units

Step 1: *Collect transaction data*

Example calculation: The chemical inventory report shows that three canisters of HFC-23 have been issued and returned through the supply system over the past year. The amounts of gas are listed:

Canister number	Gas quantity	CAS Number	Chemical Name	Transaction
3778546	220 lb	75-46-7	Trifluoromethane	Issue
3645585	3 lb	75-46-7	Fluoroform	Issue
3654486	55 lb	75-46-7	Trifluoromethane	Return

Step 3: *Estimate annual emissions*

Equation A-13: Annual Fugitive Emissions (F-Gas—Default)

Annual Emissions [MT HFC-23]
$$= (I - R) \bullet 4.536 \times 10^{-4} \text{ [MT/lb]}$$
$$= ((220 \text{ [lb]} + 3 \text{ [lb]}) - 55 \text{ [lb]}) \bullet 4.536 \times 10^{-4} \text{ [MT/lb]}$$
$$= 7.57 \times 10^{-2} \text{ [MT HFC-23]}$$

Where:

I = Amount of F-gas issued from supply system [lb]

R = Amount of F-gas returned to supply system from equipment, which includes the amount recovered from equipment during maintenance and the unused amount originally issued from supply [lb]

Step 4: *Convert annual emissions to MT CO₂e and sum emissions*

Equation A-14: Conversion of F-Gas Emissions to CO₂e (Default)

CO₂e Emissions [MT F-gas]
$$= \text{Annual Emissions [MT]} \bullet \text{F-gas GWP}$$
$$= 7.57 \times 10^{-2} \text{ [MT HFC-23]} \bullet 11,700$$
$$= \mathbf{885.69 \text{ [MT CO}_2\text{e]}}$$

Note: Example has been provided for demonstration purposes only and has rounding imposed throughout each of the calculation steps above. Factors are for illustration. The most recent emission factors can be found in the Annual GHG Data Report workbook where their original sources will also be documented. As such results from this example may differ slightly from results generated using the Annual GHG Data Report workbook.

A.5.2. Alternative Methodologies (User Calculated)

There are three types of alternative methodologies that agencies may use to calculate fugitive emissions:

1. Material balance approach
2. Simplified material balance approach
3. Screening approaches.

Agencies using an alternative methodology may also want to consider the minimum charge size of equipment that will be inventoried. Conducting equipment inventories of many small sealed refrigerant systems, each containing only small quantities of HFCs, may not be an efficient use of resources, given the minor emissions likely to result from these systems. For example, an agency might consider excluding equipment that has installed charge sizes of less than five pounds such as household refrigeration/small appliances, stand-alone commercial-type refrigeration applications, smaller residential and commercial-type AC and heat-pumps, and small sealed electrical/electronic devices containing SF_6. This would have the advantage of harmonizing with the record keeping requirements under 40 Code of Federal Regulations (CFR) 82.166 (j) and (k).

Alternative Methodology 1: Material Balance Approach

A material balance approach is the most thorough method for determining fugitive F-gas emissions. The EPA HFC Emission Accounting Tool provides a full material balance methodology.

Data Sources

This methodology requires detailed information on the type of each F-gas used by your organization and each piece of F-gas-containing equipment operated at the facility level. It requires data on acquisitions, disbursements, inventory, and capacity (Table A-10).

Table A-10: Fugitive Emissions – F-Gas Alternative Data Sources (Material Balance Approach)

Data Element	Preferred Source
F-gas in inventory (storage not equipment) at the beginning of reporting period [lb]	
F-gas acquisitions during the reporting period [lb]	
Total capacity of F-gas in equipment at the beginning of the reporting period [lb]	• Purchase records • Maintenance records • Chemical inventory tracking system
F-gas in inventory (storage not equipment) at the end of reporting period [lb]	
F-gas disbursements during reporting period [lb]	
Total capacity of F-gas in equipment at the end of the reporting period [lb]	

Calculation Steps

To calculate Scope 1 emissions from fugitive F-gas emissions, do the following:

1. Determine the base inventory
2. Calculate changes to the base inventory
3. Calculate the annual emissions
4. Convert annual emissions to MT CO_2e and sum emissions for each facility.

Step 1: Determine the base inventory

For each F-gas in use at each facility, determine the quantity of F-gas in storage at the beginning of the year (does not include F-gas contained within equipment) and the quantity in storage at the end of the year.

Step 2: Calculate changes to the base inventory

For each F-gas, determine purchases and other acquisitions,[86] sales and other disbursements,[87] and net change of total equipment capacity for a given F-gas during the year.[88]

Step 3: Calculate the annual emissions

For each F-gas or refrigerant blend, use Equation A-15.

Equation A-15: Annual Fugitive Emissions (F-Gas—Material Balance Approach)

Annual Emissions [MT F-Gas] $= (I_B - I_E + P - S + C_B - C_E) \bullet 4.536 \times 10^{-4}$ [MT/lb]

Where:

I_B =   Quantity of F-gas in storage at beginning of inventory year [lb]

I_E =   Quantity of F-gas in storage at end of inventory year [lb]

P   =   Sum of all the F-gas acquisitions [lb]

S   =   Sum of all the F-gas disbursements [lb]

C_B =   Total capacity of F-gas in equipment at beginning of inventory year [lb]

C_E =   Total capacity of F-gas in equipment at end of inventory year [lb]

Step 4: Convert annual emissions to MT CO$_2$e and sum emissions for each facility

Use Equation A-16 to convert them to MT CO$_2$e. (See Appendix D for the GWP for each gas.) Sum the emissions from each F-gas type.

Equation A-16: Conversion of F-Gas Emissions to MT CO$_2$e (Alternative)

CO$_2$e [MT F-gas] = Annual Emissions [MT] $\bullet$ F-gas GWP

Example A-8: Fugitive Emissions (F-Gas—Material Balance)

Step 1: Determine the base inventory

- Beginning of year storage   =   1367 lb

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[86] Acquisitions are the sum of all individual F-gases purchased or otherwise acquired during the year, either in storage containers or in equipment. This includes F-gases purchased from producers or distributors, provided by manufacturers or inside equipment, added to equipment by contractors or other service personnel (unless that refrigerant is from the agency's inventory), and returned after off-site recycling or reclamation.

[87] Disbursements are the sum of all F-gases sold or otherwise dispersed during the year, either in storage containers or in equipment. This includes F-gases in containers or left in equipment that is sold, returned to suppliers, or sent off site for recycling, reclamation, or destruction.

[88] The net increase in total full charge of equipment refers to the full and proper charge of the equipment rather than to the actual charge, which may reflect leakage.

- End of year storage = 1323 lb
- Purchases of HFC-23 = 441 lb
- HFC-23 sold (i.e., disbursements) = 0.0 lb
- Total nameplate capacity of HFC-23 equipment retired during the inventory year = 44 lb
- Total nameplate capacity of new HFC-23 in equipment installed during the inventory year = 22 lb

Step 2: *Calculate changes to the base inventory*

Step 3: *Calculate the annual emissions*

Equation A-15: Annual Fugitive Emissions (F-Gas—Material Balance Approach)

$$\text{Annual Emissions [MT HFC]} = (I_B - I_E + P - S + C_B - C_E) \bullet 4.536 \times 10^{-4} \text{ [MT/lb]}$$
$$= (1367\ [lb] - 1323\ [lb] + 441\ [lb] + 0.0\ [lb] + 44\ [lb] - 22\ [lb]) \bullet 4.536 \times 10^{-4} \text{ [MT/lb]}$$
$$= 0.23 \text{ [MT HFC-23]}$$

Where:

I_B = Quantity of F-gas in storage at beginning of inventory year [lb]

I_E = Quantity of F-gas in storage at end of inventory year [lb]

P = Sum of all the F-gas acquisitions [lb]

S = Sum of all the F-gas disbursements [lb]

C_B = Total capacity of F-gas in equipment at beginning of inventory year [lb]

C_E = Total capacity of F-gas in equipment at end of inventory year [lb]

Step 4: *Convert annual emissions to MT CO$_2$e and sum emissions for each facility*

Equation A-16: Conversion of F-Gas Emissions to MT CO$_2$e (Alternative)

$$\text{CO}_2\text{e emissions [MT F-gas]} = \text{Annual Emissions [MT]} \bullet \text{F-gas GWP}$$
$$= 0.23 \text{ [MT]} \bullet 1{,}430$$
$$= \textbf{329 [MT]}$$

Note: Example has been provided for demonstration purposes only and has rounding imposed throughout each of the calculation steps above. Factors are for illustration. The most recent emission factors can be found in the Annual GHG Data Report workbook where their original sources will also be documented. As such results from this example may differ slightly from results generated using the Annual GHG Data Report workbook.**

Alternative Methodology 2: Simplified Material Balance Approach

Description

This methodology is a simplified version of the first alternative methodology, and corresponds with the EPA HFC Emission Accounting Tool Simplified Balance methodology.

Data Sources

Table A-11 shows the data by F-gas type agencies will need for this method.

Table A-11: Fugitive Emissions – F-Gas Alternative Data Sources (Simplified Material Balance Approach)

Data Element	Preferred Source
F-gas used to charge new equipment (omitted if the equipment has been precharged by the manufacturer) [lb]	• Purchase records • Maintenance records • Chemical inventory tracking system
Total full capacity of the new equipment (omitted if the equipment has been precharged by the manufacturer) [lb]	
Quantity of F-gas used to service equipment [lb]	
Total full capacity of retiring equipment [lb]	
F-gas recovered from retiring equipment [lb]	

Calculation Steps

To calculate Scope 1 emissions from fugitive F-gas emissions, do the following:

1. Determine the base inventory
2. Calculate the annual emissions
3. Convert annual emissions to MT CO_2e and sum emissions.

Step 1: Determine the base inventory

Determine the types and quantities of F-gas used at each facility by determining the quantity of F-gas used to charge new equipment and service existing equipment, including types and quantities recovered from retiring equipment. Also, determine the total full capacity of new and retiring equipment.

Step 2: Calculate the annual emissions

For each type of F-gas, determine any emissions from installation, operation, and disposal of equipment. If the reporting entity did not install or dispose of equipment during the reporting year, emissions from these activities should not be included. Using Equation A-17, add emissions from each piece of equipment to get the total emissions.

Equation A-17: Annual Fugitive Emissions (F-Gas—Simplified Material Balance Approach)

Annual Emissions [MT F-Gas] $= (P_N - C_N + P_S + C_D - R_D) \bullet 4.536 \times 10^{-4}$ [MT/lb]

Where:

P_N = Purchases of F-gas used to charge new equipment [lb]*

C_N = Total full capacity of the new equipment [lb]*

P_S = Quantity of F-gas used to service equipment [lb]

C_D = Total full capacity of retiring equipment [lb]

R_D = F-gas recovered from retiring equipment [lb]

* If no equipment was newly purchased or retired, variables can be omitted.

Step 3: Convert annual emissions to MT CO₂e and sum emissions

Use Equation A-16 to convert the emissions associated with each F-gas to MT CO₂e and total F-gas emissions at each facility.

Example A-9: Fugitive Emissions (F-Gas—Simplified Material Balance)

Step 1: Determine the base inventory

- Purchases of HFC-23   = 1543 lb
- Total full capacity of the new equipment   = 882 lb
- Quantity of HFC-23 used to service equipment = 441 lb
- Total full capacity of retiring equipment   = 794 lb
- HFC-23 recovered from retiring equipment   = 220 lb

Step 2: Calculate the annual emissions

Equation A-17: Annual Fugitive Emissions (F-Gas—Simplified Material Balance Approach)

$$
\begin{aligned}
\textbf{Annual Emissions [MT HFC-23]} &= (P_N - C_N + P_S + C_D - R_D) \bullet 4.536 \times 10^{-4} \ [\text{MT/lb}] \\
&= (1543\ [\text{lb}] - 882\ [\text{lb}] + 441\ [\text{lb}] + 794\ [\text{lb}] - 220\ [\text{lb}]) \bullet 4.536 \times 10^{-4}\ [\text{MT/lb}] \\
&= 0.76\ [\text{MT HFC-23}]
\end{aligned}
$$

P_N = Purchases of F-gas used to charge new equipment [lb]

C_N = Total full capacity of the new equipment [lb]

P_S = Quantity of F-gas used to service equipment [lb]

C_D = Total full capacity of retiring equipment [lb]

R_D = F-gas recovered from retiring equipment [lb]

Step 3: Convert annual emissions to MT CO_2e and sum emissions

Equation A-16: Conversion of F-Gas Emissions to MT CO₂e (Alternative)

$$
\begin{aligned}
\textbf{CO}_2\textbf{e emissions [MT F-gas]} &= \text{Annual Emissions [MT F-gas]} \bullet \text{F-gas GWP} \\
&= 0.76\ [\text{MT HFC-23}] \bullet 1{,}430 \\
&= \textbf{8{,}892 [MT CO}_2\textbf{e]}
\end{aligned}
$$

Note: Example has been provided for demonstration purposes only and has rounding imposed throughout each of the calculation steps above. Factors are for illustration. The most recent emission factors can be found in the Annual GHG Data Report workbook where their original sources will also be documented. As such results from this example may differ slightly from results generated using the Annual GHG Data Report.

Alternative Methodology 3: Screening Approach[89]

Data Sources

An agency may use this screening method when it has an inventory of equipment by quantity, equipment category, F-gas type, and total charge capacity (Table A-12). The EPA HFC Emission Accounting Tool offers two types of simplified screening, one based on type of equipment, charge in new equipment, capacity of existing equipment, and capacity of retired equipment. The other is

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[89] Although this enhanced screening approach would enhance the fidelity of estimates over the default methodology, the fugitive emissions estimates are still uncertain.

highly simplified and only requires building type and square footage. Agencies should use the more detailed screening approach if at all feasible.

Table A-12: Fugitive Emissions – F-Gas Alternative Data Sources (Screening Approach)

Data Element	Preferred Source
Inventory of equipment by number, equipment category, F-gas type, and total charge capacity [lb]	• Purchase records • Maintenance records • Chemical inventory tracking system
Amount of F-gas in the equipment [lb]	• Same as above
Emission Factor	• See Appendix D

Calculation Steps

To calculate Scope 1 emissions from fugitive F-gas emissions, do the following:

1. Determine the base inventory
2. Calculate the annual emissions
3. Convert annual emissions to MT CO_2e and sum emissions.

Step 1: Determine the base inventory

Determine the quantity and types of equipment by equipment category, the types of F-gas used, and the F-gas charge capacity of each piece of equipment.

Step 2: Calculate the annual emissions

For each type of F-gas, determine any emissions from installation, operation, or disposal of equipment. Equation A-18 combines these three sources, as follows:

Installation: ($C_N \bullet k$), where the emissions from installation equal the amount of refrigerant charged into new equipment (C_N) multiplied by assembly losses (k)

Operation: ($C \bullet x \bullet T$), where emissions from operation equal the charge capacity (C) multiplied by the annual leak rate (x) and time used (T)

Disposal: ($C_D \bullet y \bullet (1 - z)$), where disposal equals the charge capacity being disposed of (C_D) multiplied by the percent capacity remaining (y) and the percent refrigerant removed (1-z).

If the reporting entity did not install or dispose of equipment during the reporting year, emissions from these activities should not be included. Use default emission factors provided in Appendix D by equipment type. Estimate annual emissions of each F-gas type, using Equation A-18.

Equation A-18: Annual Fugitive Emissions (F-Gas—Screening Approach)

Annual Emissions [MT F-Gas] =

$((C_N \bullet k) + (C \bullet x \bullet T) + (C_D \bullet y \bullet (1 - z))) \bullet 4.536 \times 10^{-4}$ [MT/lb]

Where:

C_N	=	Quantity of F-gas charged into the new equipment [lb]*
C	=	Total full charge capacity of the equipment [lb]
T	=	Time equipment was in use (such as 0.5 if used only during half the year and then disposed) [yrs]
C_D	=	Total full charge capacity of equipment being disposed [lb]*
k	=	Installation emission factor [%]
x	=	Operation emission factor [%]
y	=	Refrigerant remaining at disposal [%]
z	=	Recovery efficiency [%]

* If no equipment was added or retired, variables can be omitted.

Step 3: Convert annual emissions to MT CO₂e and sum emissions

Use Equation A-16 to convert them to units of CO_2e and determine the total F-gas emissions. (See Appendix D for the sources for GWP for each gas.)

Example A-10: Fugitive Emissions (F-Gas—Screening)

Step 1: Determine the base inventory

Screening sample data for medium and large commercial refrigeration:

- Quantity of HFC-23 charged into the new equipment = 1,764 lb
- Total full charge of the new equipment = 882 lb
- Time equipment was in use = 1 yr
- Total full charge of equipment being disposed of = 441 lb
- Installation emission factor = 3% (0.03)
- Operating emission factor = 35% (0.35)
- Refrigerant remaining at disposal = 100% (1.00)
- Recovery efficiency = 70% (0.70)

Step 2: Calculate the annual emissions

Equation A-18: Annual Fugitive Emissions (F-Gas—Screening Approach)

HFC-23 Emissions [MT]
$= ((C_N \bullet k) + (C \bullet x \bullet T) + (C_D \bullet y \bullet (1 - z))) \bullet 4.536 \times 10^{-4} \text{ [MT/lb]}$
$= ((1764 \text{ [lb]} \bullet 0.03 + (882 \text{ [lb]} \bullet 0.35 \bullet 1) + (441 \text{ [lb]} \bullet 1.00 \bullet (1\text{-}0.70)) \bullet 4.536 \times 10^{-4} \text{ [MT/lb]}$
$= (52.92 \text{ [lb]} + 308.7 \text{ [lb]} + 132.3) \bullet 4.536 \times 10^{-4} \text{ [MT/lb]}$
$= 0.2240 \text{ [MT HFC-23]}$

Where:

C_N = Quantity of F-gas charged into the new equipment [lb]

C = Total full charge capacity of the equipment [lb]

T = Time equipment was in use
(such as 0.5 if used only during half the year and then disposed) [yrs]

C_D = Total full charge capacity of equipment being disposed [lb]

k = Installation emission factor [%]

x = Operation emission factor [%]

y = Refrigerant remaining at disposal [%]

z = Recovery efficiency [%]

Step 3: Convert annual emissions to MT CO$_2$e and sum emissions

Equation A-16: Conversion of F-Gas Emissions to MT CO$_2$e (Alternative)

CO$_2$e emissions [MT F-gas]
$= \text{Annual Emissions [MT F-gas]} \bullet \text{F-gas GWP}$
$= 0.2240 \text{ [MT HFC-23]} \bullet 1,430$
$= \textbf{320.32 [MT CO2e]}$

Note: Example has been provided for demonstration purposes only and has rounding imposed throughout each of the calculation steps above. Factors are for illustration. The most recent emission factors can be found in the Annual GHG Data Report workbook where their original sources will also be documented. As such results from this example may differ slightly from results generated using the Annual GHG Data Report.

A.6. Fugitive Emissions: Wastewater Treatment

Description

This category includes emissions from treatment of wastewater generated as a result of operations, with the treatment plant falling within the agency's organizational boundary. The category includes anaerobic reactors, anaerobic lagoons, and anaerobic sludge digesters.[90] Wastewater from domestic (municipal sewage) and industrial sources is treated to remove soluble organic matter, suspended solids, pathogenic organisms, and chemical contaminants. WWTP processes can produce anthropogenic CH_4 and N_2O emissions.

This section focuses solely on calculating the CH_4 and N_2O emissions created by on site wastewater treatment and septic systems. GHG emissions from other activities related to wastewater treatment are currently not included in the Guidance.

The default methodology requires only data on the population served by each type of agency owned or operated WWTP. Where one treatment process feeds into another, agencies should enter the population served into each process calculation. The default methodology uses national averages to determine the treatment processes and operating variables. However, this is not as accurate as the alternative methodology approach, which uses facility-specific wastewater treatment processes and operating variables.[91] Agencies can pursue the alternative method when flow data are known.

A.6.1. Default Methodology (to be Calculated by Annual GHG Data Report Workbook)

Data Sources

The default methodology (Table A-13) applies population-based calculations that use national average defaults. The population served should include the population actually served by the plant, regardless of employer (Federal, contractor, sub-contractor). For example, if construction workers bring their own outhouses, they would not be counted. If the site includes a visitors' center or a prison, those visitor or prisoner populations should be included. If the number fluctuates throughout the year, agencies should provide an annual average of the population contributing to the system. The Annual GHG Data Report workbook will allow for customization in the number of hours the population is using the system (default is 12 hours).

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[90] An *anaerobic reactor* is an enclosed vessel used for anaerobic wastewater treatment (*e.g.,* upflow anaerobic sludge blanket, fixed film). An *anaerobic sludge digester* is an enclosed vessel in which wastewater treatment sludge is degraded anaerobically. An *anaerobic lagoon* is a lined or unlined earthen basin used for wastewater treatment, in which oxygen is absent throughout the depth of the basin, except for a shallow surface zone. Anaerobic lagoons are not equipped with surface aerators. Anaerobic lagoons are classified as deep (depth more than 2 meters) or shallow (depth less than 2 meters).

[91] Both the minimum and alternative methodologies are based on EPA*, Inventory of U.S. Greenhouse Gas Emissions and Sinks* and *LGO Protocol*, Chapter 10. Agencies should be aware that there are a limited number of widely accepted methodologies for calculating emissions associated with wastewater treatment at an organizational scale and the *LGO Protocol* is not from a federal source. See https://www.theclimateregistry.org/ tools-resources/reporting-protocols/local-goverment-operations-protocol/. for the *LGO Protocol*.

Table A-13: Fugitive Emissions – Wastewater Treatment Default Data Sources

Data Element	Preferred Source	Alternate Source
Type of WWTP	• Default provided	• Wastewater operations division
Population served (includes employees, on-site contractors, and visitors)[92]	• Agency records	• Agency records

The default methodology divides sources of CH_4 and N_2O emissions into six categories (Table A-14). Agencies may use more than one of these processes.

Table A-14: Fugitive Emissions – Summary of Wastewater Treatment Default Emissions Sources

GHG Source	GHG Type	Data Required	Equation
On-site centralized WWTP with anaerobic digestion	Stationary CH_4 emissions	Population served	A-19
On-site centralized WWTP with nitrification/denitrification	N_2O emissions	Population served	A-20
On-site centralized WWTP without nitrification/denitrification	N_2O emissions	Population served	A-21
On-site effluent discharge to rivers and estuaries with and without nitrification/denitrification	N_2O emissions	Population served	A-22
On-site wastewater treatment lagoons	CH_4 emissions	Population served	A-23
On-site septic systems	CH_4 emissions	Population served	A-24

Calculation Steps

1. Determine which wastewater treatment processes are used and the number of personnel served by each
2. Calculate emissions from each wastewater treatment process used
3. Sum emissions from all processes

Step 1: Determine which wastewater treatment processes are used and the number of personnel served by each

The emissions from WWTPs depend on the wastewater treatment processes used. Agencies should coordinate with their wastewater operations division to determine which of the processes outlined in Table A-14 are part of their agency's wastewater treatment operations.

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[92] Given that an agency maintains operational control over the on-site WWTP facilities and process, the number of Federal employees, on-site contractors and visitors is used as a proxy for estimating biological oxygen demand (BOD_5) input for the WWTP facility's treatment stream emissions calculations. If industrial BOD_5 or significant numbers of visitors increase this treatment load, this additional BOD_5 should be converted to full-time equivalent personnel served and added to the overall personnel served number. However, if BOD_5 monitoring data are available, these should be used and converted to full-time equivalent population served as an alternative methodology.

Agency calculations of the number of personnel served by the WWTP are not performed by the Annual GHG Data Report workbook. To calculate employee and on-site contractor population served by the system, use the equation below. Estimate the percentage of time that part-time employees/contractors (PT) spend on site compared with full-time employees/contractors (FT).

Employee and on-site contractor population served by system = the number of FT + (the number of PT x percent of time spent on site)

Methods to estimate visitor population served by the on-site wastewater treatment system are specific to facility type. For office buildings, laboratories, and other similar facilities, agencies may assume that visitor wastewater treatment inputs are netted out by off-site visits made by employees. Therefore, agencies can input only the number of employees and on-site contractors.

For national parks/federal lands, and other visitor-focused sites, where available, use visitor data.

Where data are unavailable, agencies may develop a method to estimate visitors, such as developing a factor to be applied to the number of employees at the site (e.g., 10 visitors for every employee) to estimate visitors. Alternatively, in the Annual GHG Data Report workbook, the default number of workdays per year may be adjusted to reflect the number of visitors or that the visitors do not remain on site for the duration of a workday. It is recommended that agencies clearly document assumptions behind visitor numbers and length of stay. Note that agencies may have to calculate a composite value when changing default values if the entry combines calculations for sites with very different user patterns and employee numbers.

The agency enters the population served by each type of process. Where treatment processes occur in series, the population served should be entered into each treatment process calculation. For example, centralized wastewater treatment and on-site effluent discharged to rivers and estuaries are not mutually exclusive since a site may have both centralized treatment and effluent discharges. "Centralized waste water treatment" refers to on-site wastewater treatment processes that generate emissions prior to discharge into a river. These emissions include CH_4 from bacterial activity in the anaerobic digesters of the treatment plant. "On-site effluent discharged to rivers and estuaries" refers to a WWTP direct discharge of treated wastewater to a river. This wastewater contains nutrients that cause additional biological activity in the river or estuary. GHG emissions are generated in the river downstream due to this increased biological activity as bacteria process these added nutrients.

Agencies are given a number of options to calculate wastewater flow to the various treatment processes or series of processes:

1. Attribute a share of personnel to each wastewater treatment system based on the amount of wastewater processed in each system when that data is available or when an estimate can be made
2. Attribute a share of personnel to each wastewater treatment system based on the capacity of each system
3. Assume all wastewater goes to the treatment system that would create highest amount of GHG
4. Assume all wastewater goes to the largest treatment system.

Agencies may need to adjust the population served for some wastewater treatment processes if there are significant industrial contributions to the system. Examples of sources of potential significant contribution of nitrogen and/or biological oxygen demand (BOD) include food processing, ethanol production, and pulp and paper processing. The contribution factor from industry is calculated by estimating the total nitrogen and BOD contribution of the industrial process and dividing units of nitrogen or BOD per day by a population equivalent, identified by process in Table A-15. This factor is added to the population served. Processes not listed do not need to adjust the population served.

Table A-15: Fugitive Emissions – Industrial Contribution Equivalents for GHG Sources

GHG Source	Industrial Contribution Equivalent	Equation
On-site centralized WWTP with and without nitrification/denitrification	= kg total nitrogen from industrial sources per day ÷ 0.026 [kg N/person/day]	A-20,21
On-site effluent discharge to rivers and estuaries with and without nitrification/denitrification	= kg total nitrogen from industrial sources per day ÷ 0.026 [kg N/person/day]	A-22
On-site wastewater treatment lagoons	= kg total BOD_5 from industrial sources per day ÷ 0.090 [kg BOD_5/person/day]	A-23

Step 2: Calculate emissions from each wastewater treatment process used

The Annual GHG Data Report workbook will automatically calculate emissions associated with each process on the basis of population information provided using default national averages. Agencies may choose to alter certain criteria, such as the number of workdays per year and fraction of time allocated to the facility (the default is 50 percent, or 12 hours). Note that if data is combined from a number of facilities with different time allocations and personnel these changes will have to be adjusted to represent the entire portfolio of sites using each process.

This step is subdivided into the six processes outlined in Table A-14. Each subsection below briefly describes the process and associated calculations that will be performed by the Annual GHG Data Report workbook.

On-Site Centralized WWTP with Anaerobic Digestion

Many agencies use anaerobic digesters to treat excess biosolids produced by the wastewater treatment processes. The process of anaerobic digestion creates CH_4, which is then combusted as a flare. However, this combustion is also a source of CH_4 and N_2O emissions. Equation A-19 describes the default methodology to be used in the Annual GHG Data Report workbook. The Annual GHG Data Report workbook will also calculate the stationary combustion emissions from flaring. This will be calculated according to the methodology in Section A.1 and will not require any additional agency input.

Equation A-19: Fugitive CH$_4$ Emissions from On-Site Centralized WWTP with Anaerobic Digestion (Default)

Annual CH$_4$ emissions [MT] = (P_{total} ● 230 ● 0.5) ● Digester Gas ● F CH$_4$ ● ρ(CH$_4$)		

Where:

P_{total}	=	Population serviced by the WWTP with anaerobic digesters
230.00	=	Conversion factor [workdays/year]
0.5	=	Fraction of time allocated to facility (12 hrs)
Digester Gas	=	Measured standard cubic feet of digester gas produced per capita per day [cu ft/day], default value of 1.0
F CH$_4$	=	Fraction of CH$_4$ in biogas, default value of 0.65
ρ(CH$_4$)	=	Density of CH$_4$ at standard conditions [kg/cu ft], default value of 0.019
0.001		Conversion from kg to MT [MT/kg]

Source: EPA, *Inventory of US Greenhouse Gas Emissions and Sinks: 1990 – 2008,* Chapter 8 (2010) and *LGO Protocol*. See www.theclimateregistry.org/resources/protocols/local-government-operations-protocol/.

On-Site Centralized WWTP with or without Nitrification/Denitrification

This section provides equations for calculating N$_2$O emissions from a centralized WWTP. Agencies with large Federal facilities may maintain and operate such WWTP facilities on site. At the treatment facility, the wastewater is treated to standards that allow for surface water discharge. Some centralized systems have nitrification/denitrification treatment processes, and some do not.[93]

If significant industrial contributions of nitrogen are discharged to the municipal treatment system, the agency should modify the population served value. The contribution factor from industry is calculated by dividing the total nitrogen discharged by industry to the municipal treatment system [kg of total nitrogen per day] by the nitrogen population equivalent of 0.026 kg N/person/day.

This industrial contribution is adjusted for using an equivalent population proxy value that should be added to the domestic populations served by the centralized wastewater treatment system. As much as possible, this adjusted population served number (domestic plus industrial equivalent) is the value agencies should use in the Annual GHG Data Report workbook.

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[93] Equations in this section are adapted for use by agencies from Section 6.3 of the 2006 IPCC Guidelines and Section 8.2 of the EPA *Inventory of U.S. Greenhouse Gas Emissions and Sinks (1990–2008).*

Equation A-20: Fugitive N$_2$O Emissions from WWTP with Nitrification/Denitrification (Default)

Annual N$_2$O emissions [MT] = (P$_{total}$ ● 230.00 ● 0.5) ● EF nit/denit ● 10^{-6}		

Where:

P$_{total}$	=	Total population served by the centralized WWTP adjusted for industrial discharge, if applicable [person]
230.00	=	Conversion factor [workdays/year]
0.5	=	Fraction of time allocated to facility (12 hrs)
EF nit/denit	=	Emission factor for a WWTP with nitrification/denitrification [g N$_2$O/person/day], default value of 0.019
10^{-6}	=	Conversion from g to MT [MT/g]

Equation A-21: Fugitive N$_2$O Emissions from WWTP without Nitrification/Denitrification (Default)

Annual N$_2$O emissions [MT] = (P$_{total}$ ● 230.00 ● 0.5) ● EF w/o nitrification/denitrification ● 10^{-6}		

Where:

P$_{total}$	=	Total population served by the centralized WWTP adjusted for industrial discharge, if applicable [person]
230.00	=	Conversion factor [workdays/year]
0.5	=	Fraction of time allocated to facility (12 hrs)
EF w/o nit/denit	=	Emission factor for a WWTP without nitrification/denitrification [g N$_2$O/person/day], default value of 0.009
10^{-6}	=	Conversion from g to MT [MT/g]

Effluent Discharge to Rivers and Estuaries for WWTP with and without Nitrification/Denitrification

If site-specific data are not available, Equation A-18 is used to estimate fugitive N$_2$O emissions from effluent discharge with or without nitrification/denitrification. The only difference in either calculation is the default value of the plant nitrification/denitrification factor. The Annual GHG Data Report workbook will automatically calculate each type per the population served. Agencies should adjust population for industrial contributions for this source. The Annual GHG Data Report workbook will assume the system is aerobic.

Equation A-22: Fugitive N$_2$O Emissions from Effluent Discharge (Default)

Annual N$_2$O emissions [MT] =

   (P$_{total}$ ● 230 ● 0.5) ● (NLoad – Nuptake ● BOD$_5$ load) ● Effluent ● 44/28 ● (1 – Fplant nit/denit) ● 0.001

Where:

P$_{total}$	=	Total population served by the centralized WWTP adjusted for industrial discharge, if applicable [person]
230.00	=	Conversion factor [workdays/year]
0.5	=	Fraction of time allocated to facility (12 hrs)
NLoad[94]	=	Per capita nitrogen load [kg N/person/day], default value of 0.026
Nuptake[95]	=	Nitrogen uptake for cell growth in aerobic system/anaerobic system [kg N/kg BOD$_5$], default values of 0.05* for aerobic and 0.005* for anaerobic
BOD$_5$ load	=	Per capita BOD$_5$ produced per day [kg BOD$_5$/person/day], default value of 0.090
EFeffluent	=	Effluent emission factor [kg N$_2$O-N/kg sewage-N produced], default value of 0.005
44/28	=	Molecular weight ratio of N$_2$O to N$_2$
Fplant nit/denit	=	Fraction of nitrogen removed for the centralized WWTP with nit/denit, default value of 0.7* or, fraction of nitrogen removed for the centralized WWTP w/o nit/denit, default value of 0.0[1]
0.001	=	Conversion from kg to MT [MT/kg]

* C. P. L. Grady Jr., G. T. Daigger, and H. C. Lim, *Biological Wastewater Treatment*, p. 108–109, 644 2nd edition (1999).

On-Site Wastewater Treatment Lagoons

Treatment lagoons are pond-like bodies of water used to receive, hold, and treat wastewater for a predetermined period. Wastewater is treated aerobically and anaerobically, and the latter generates quantities of CH$_4$ emissions. Equation A-23 details the process to estimate fugitive CH$_4$ emissions from wastewater treatment lagoons. If significant industrial contributions of wastewater are discharged, the agency should modify the population served value. The contribution factor from industry is calculated by dividing the total BOD$_5$ discharged by industry to the municipal treatment system, expressed in kg of total BOD$_5$ per day by the BOD$_5$ population equivalent of 0.090 kg BOD$_5$/person/day.

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[94] The default total nitrogen load value is derived on the basis of the following default values from EPA *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2008*, Chapter 8 and Table 8.13: Average U.S. protein intake (41.9 kg/person-year) x default fraction of N in protein (0.16 kg N/kg protein) x factor for non-consumed protein added to water (1.4)/days per year (365.25) = 0.026 kg N/person/day.

[95] Some of the influent nitrogen is required for microbial growth inherent in aerobic or anaerobic treatment processes. Nitrogen is assimilated by bacteria, which grow and are further managed as biosolids. This assimilation results in lower nitrogen levels in the discharged effluent.

The industrial-equivalent population is then added to the domestic population served by the centralized wastewater treatment system, and the total population (domestic plus industrial-equivalent) is the value agencies should use in the Annual GHG Data Report workbook.

Equation A-23: Fugitive CH₄ Emissions from Wastewater Treatment Lagoons (Default)

Annual CH₄ emissions [MT] =
$(P_{total} \bullet 230 \bullet 0.5) \bullet BOD_5 \text{ load} \bullet (1-F_P) \bullet Bo \bullet MCF_{anaerobic} \bullet F_{removed} \bullet 0.001$

Where:

P_{total}	=	Population served by lagoons adjusted for industrial discharge, if applicable [person]
230.00	=	Conversion factor [workdays/year]
0.5	=	Fraction of time allocated to facility (12 hrs)
BOD_5 load	=	Per capita BOD_5 produced per day (influent to wastewater treatment process) [kg BOD_5/person/day], default value of 0.090
F_P	=	Fraction of BOD_5 removed in primary treatment, if present, default value of 0.325
Bo	=	Maximum CH₄-producing capacity for domestic wastewater [kg CH₄/kg BOD_5 removed], default value of 0.6
$MCF_{anaerobic}$	=	CH₄ correction factor for anaerobic systems, default value of 0.8
$F_{removed}$	=	Fraction of lagoon BOD_5 removal performance, default value of 1.0
0.001	=	Conversion from kg to metric ton [metric ton/kg]

On-Site Septic Systems

Septic tanks are usually small-scale treatment systems where wastewater is held in a tank or receptacle while it is being treated. Anaerobic bacteria treat the waste and release CH₄ in the process. If an agency has operational control of septic systems, fugitive CH₄ emissions should be estimated. If site-specific data are not available, emissions from septic systems will be calculated in the Annual GHG Data Report workbook using Equation A-24.

Equation A-24: Fugitive CH₄ Emissions from Septic Systems (Default)

Annual CH₄ emissions [MT] = $(P_{total} \bullet 230 \bullet 0.5) \bullet BOD_5 \text{ load} \bullet Bo \bullet MCF_{septic} \bullet 0.001$

Where:

P_{total}	=	Population served by septic systems [person]
230.00	=	Conversion factor [workdays/year]
0.5	=	Fraction of time allocated to facility (12 hrs)
BOD_5 load	=	Per capita BOD_5 produced per day [kg BOD_5/person/day], default value of 0.090
Bo	=	Maximum CH₄-producing capacity for domestic wastewater [kg CH₄/kg BOD_5 removed], default value of 0.6
MCF_{septic}	=	CH₄ correction factor for septic systems, default value of 0.5
0.001	=	Conversion from kg to MT [MT/kg]

Step 3: Sum emissions from all processes

In this final step, the Annual GHG Data Report workbook will sum the emissions from all processes and apply the appropriate GWP values to calculate total emissions from wastewater treatment in units of CO_2e.

Equation A-25: Fugitive Wastewater Treatment MT CO_2e Emissions (Default)

CO_2e **Emissions [MT CO_2e]** = (MT CH_4 ● CH_4 GWP) + (MT N_2O ● N_2O GWP)

Example A-11: Fugitive Emissions (Wastewater Treatment—Default)

An agency's wastewater treatment facility combusts digester gas and has a nitrification/denitrification process. The facility serves 10,000 people, and the agency does not have any site-specific data on the facility. The site has industrial contributions for N_2O, a total of 10 kg of N, which requires an increase in population of 385.

Industrial Contribution: = kg total nitrogen from industrial sources per day ÷ 0.026 [kg N/person/day]
= 10 [N] ÷ 0.026 [kg N/person/day]
= 384.62 industrial population equivalent

The following equations do not include the stationary process of flaring, leading to very different results, which will be addressed in one step in the Annual GHG Data Report workbook.

Step 1: Determine which wastewater treatment processes are used

The WWTP uses incomplete combustion of digester gas and nitrification/denitrification.

Step 2: Calculate emissions from each wastewater treatment process used

Equation A-20: Fugitive CH_4 Emissions from On-Site Centralized WWTP with Anaerobic Digestion (Default)

Annual CH_4 emissions [MT]	= (P ● 230 ● 0.5) ● Digester Gas ● F CH_4 ● ρ(CH_4) ● 0.001
	= (10,000 ● 230 ● 0.5) ● 1.0 ● 0.65 ● 0.019 ● 0.001
	= 14.20 [MT CH_4]

Where:

P	=	Population serviced by the WWTP with anaerobic digesters
230.00	=	Conversion factor [workdays/year]
0.5	=	Fraction of time allocated to facility (12 hrs)
Digester Gas	=	Measured standard cubic feet of digester gas produced per capita per day [cu ft/day], default value of 1.0
F CH_4	=	Fraction of CH_4 in biogas, default value of 0.65
ρ(CH_4)	=	Density of CH_4 at standard conditions [kg/cu ft], default value of 0.019
0.001	=	Conversion from kg to MT [MT/kg]

Equation A-21: Fugitive N_2O Emissions from WWTP with Nitrification/Denitrification (Default)

Annual	=	$(P_{total} \bullet 230 \bullet 0.5) \bullet EF\ nit/denit \bullet 10^{-6}$
N₂O	=	$(10{,}385 \bullet 230 \bullet 0.5) \bullet 0.019 \bullet 10^{-6}$
emissions	=	$0.02269\ [MT\ N_2O]$
[MT]		

Where:

P_{total}	=	Total population served by the centralized WWTP adjusted for industrial discharge, if applicable [person]
230.00	=	Conversion factor [workdays/year]
0.5	=	Fraction of time allocated to facility (12 hrs)
EF nit/denit	=	Emission factor for a WWTP with nitrification/denitrification [g N₂O/person/day], default value of 0.019
10^{-6}	=	Conversion from g to MT[MT/g]

Step 3: Sum emissions from all processes

Equation A-26: Fugitive Wastewater Treatment MT CO₂e Emissions (Default)

CO₂e	=	$(MT\ CH_4 \bullet CH_4\ GWP) + (MT\ N_2O \bullet N_2O\ GWP)$
emissions	=	$(14.20 \bullet 25) + (0.02185 \bullet 310)$
[MT CO₂e]	=	**304.97 [MT CO₂e]**

Note: Example has been provided for demonstration purposes only and has rounding imposed throughout each of the calculation steps above. As such results from this example may differ slightly from results generated using the Annual GHG Data Report workbook.**

A.6.2. Alternative Methodology (User Calculated)

Data Sources

The alternative methodology requires the data shown in Table A-13 for each WWTP over which the agency has operational control.

Table A-16: Fugitive Emissions – Wastewater Treatment Alternative Data Sources

Data Element	Preferred Source
Population served	• Agency records
Wastewater treatment processes used	• Wastewater operations division
Digester gas [cu ft/day]	• Wastewater operations division
Fraction of CH₄ in biogas	• Wastewater operations division
BOD₅ load [kg BOD₅/day]	• Wastewater operations division
Fraction of overall BOD₅ removal performance	• Wastewater operations division
N load	• Wastewater operations division

As in the default methodology, sources of CH₄ and N₂O emissions are divided into six categories. Table A-17 shows the sources of CH₄ and N₂O emissions and references the detailed equations agencies should use to calculate emission from each applicable source.

Table A-17: Fugitive Emissions – Summary of Wastewater Treatment Alternative Emissions Sources

GHG Source	GHG Type	Data Required	Equation
On-site centralized WWTP with anaerobic digestion	Stationary CH_4 emissions	• Digester gas [cu ft/day] • Fraction of CH_4 in biogas	A-26
On-site centralized WWTP with nitrification/denitrification	Fugitive N_2O emissions	• Population served	A-27
On-site centralized WWTP without nitrification/denitrification	Fugitive N_2O emissions	• Population served	A-28
On-site effluent discharge to receiving aquatic environments	Fugitive N_2O emissions	• N load [kg N/day]	A-29
On-site wastewater treatment lagoons	Fugitive CH_4 emissions	• BOD_5 load [kg BOD_5/day] • Fraction of overall BOD_5 removal performance	A-30
On-site septic systems	Fugitive CH_4 emissions	• BOD_5 load [kg BOD_5/person/day]	A-31

Calculation Steps

To calculate Scope 1 emissions from wastewater treatment, do the following:

1. Determine which wastewater treatment processes are used *and the number of personnel served by each*
2. Calculate emissions from each wastewater treatment process used
3. Sum emissions from all processes.

Step 1: Determine which wastewater treatment processes are used and the number of personnel served by each

The emissions from WWTPs depend on the wastewater treatment processes used. Agencies should work with their wastewater operations division to determine which of the processes outlined in Table A-14 are relevant to the agency.

If the number of employees using specific types of wastewater treatment systems is unknown, and the capacities of the systems are known, attribute a share of personnel to each wastewater treatment system based on the capacity of each system.

Step 2: Calculate emissions from each wastewater treatment process used

Once an agency has identified the wastewater treatment processes it uses, it should calculate emissions associated with each process using the equations referenced in Table A-14. See the default methodology for more detail on each source.

On-Site Centralized WWTP with Anaerobic Digestion

Equation A-26 should be used by agencies that collect measurements of the volume of digester gas (biogas) produced and the fraction of CH$_4$ in their biogas in accordance with local, state, and Federal regulations or permits or published industry standardized sampling and testing methodologies, such as 40 CFR 136, NSPS, APHA, AWWA, WEF, ASTM, and EPA. The conversion factor from day to year can be modified to reflect the agency's usage of the facility. Equation A-26 does not include the stationary combustion from flaring (which is addressed in Appendix A.1), so the calculations below, which illustrate this methodology, will not match those produced in the Annual GHG Data Report workbook.

Equation A-26: Fugitive CH$_4$ Emissions from On-Site Centralized WWTP with Anaerobic Digestion (Alternative)

Annual CH$_4$ emissions [MT] = Digester Gas ● FCH$_4$ ● ρ(CH$_4$) ● 365.25 ● 0.001

Where:

Digester Gas	=	Measured standard cubic feet of digester gas produced per day [cu ft/day]
F CH$_4$	=	Measured fraction of CH$_4$ in biogas
P(CH$_4$)	=	Density of methane at standard conditions [kg/cu ft], default value of 0.019
365.25	=	Conversion factor [day/year]
0.001	=	Conversion from kg to MT [MT/kg]

Source: EPA *Inventory of US Greenhouse Gas Emissions and Sinks: 1990 – 2008,* Chapter 8 (2010) and *LGO Protocol*. See www.theclimateregistry.org/resources/protocols/local-government-operations-protocol/.

On-Site Centralized WWTP with or without Nitrification/Denitrification

This section provides equations for calculating N$_2$O emissions from a centralized WWTP. Agencies with large Federal facilities may maintain and operate such WWTP facilities on site. At the treatment facility, the wastewater is treated to standards that allow for surface water discharge. Some centralized systems have nitrification/denitrification treatment processes, and some do not.[96]

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[96] Equations in this section are adapted for use by agencies from Chapter 6.3 of the 2006 IPCC Guidelines and Chapter 8.2 of the EPA *Inventory of U.S. Greenhouse Gas Emissions and Sinks (1990–2008).*

Equation A-27: Fugitive N$_2$O Emissions from WWTP with Nitrification/Denitrification (Alternative)

Annual N$_2$O emissions [MT] = P$_{total}$ ● EF nit/denit ● 10^{-6}

Where:

P$_{total}$	=	Total population served by the centralized WWTP adjusted for industrial discharge, if applicable [person]
EF nit/denit	=	Emission factor for a WWTP with nitrification/denitrification [g N$_2$O/person/year], default value of 7.0
10^{-6}	=	Conversion from g to MT [MT/g]

Equation A-28: Fugitive N$_2$O Emissions from WWTP without Nitrification/ Denitrification (Alternative)

Annual N$_2$O emissions [MT] = P$_{total}$ ● EF w/o nit/denit ● 10^{-6}

Where:

P$_{total}$	=	Total population served by the centralized WWTP adjusted for industrial discharge, if applicable [person]
EF w/o nit/denit	=	Emission factor for a WWTP without nitrification/denitrification [g N$_2$O/person/ year], default value of 3.2
10^{-6}	=	Conversion from g to MT [MT/g]

Effluent Discharge to Rivers and Estuaries

If significant industrial contributions of nitrogen are discharged to the treatment system used by an agency, the agency should use Equation A-29.

Equation A-29 requires wastewater operators to collect measurements of the average total nitrogen discharged in accordance with local, state and Federal regulations or permits or published industry standardized sampling and testing methodologies (such as 40 CFR 136, NSPS, APHA, AWWA, WEF, ASTM, and EPA).

Equation A-29: Fugitive N$_2$O Emissions from Effluent Discharge (Alternative)

Annual N$_2$O emissions [MT] = N Load ● EF effluent ● 44/28 ● 365.25 ● 0.001

Where:

N Load	=	Measured average total nitrogen discharge [kg N/day]
EF effluent	=	Emission factor [kg N$_2$O-N/kg sewage-N produced], default value of 0.005
44/28	=	Molecular weight ratio of N$_2$O to N$_2$
365.25	=	Conversion factor [day/year]
0.001	=	Conversion from kg to MT [MT/kg]

On-Site Wastewater Treatment Lagoons

If significant industrial contributions of BOD_5 are discharged to the treatment lagoons, agencies should use Equation A-30. Equation A-30 requires agencies to collect measurements of the average BOD_5 load, BOD_5 removal in primary treatment upstream of the lagoon (if primary treatment is present), and the fraction of overall lagoon removal performance in accordance with local, state and Federal regulations or permits or published industry standardized sampling and testing methodologies (such as 40 CFR 136, NSPS, APHA, AWWA, WEF, ASTM, and EPA).

Equation A-30: Fugitive CH₄ Emissions from Wastewater Treatment Lagoons (Alternative)

Annual CH₄ emissions [MT] =
  BOD_5 load ● (1-F_P) ● Bo ● MCF $_{anaerobic}$ ● F $_{removed}$ ● 365.25 ● 0.001

Where:

BOD_5 load	=	Amount of BOD_5 produced per day (influent to wastewater treatment process) [kg BOD_5/day]
F_P	=	Fraction of BOD_5 removed in primary treatment, if present
Bo	=	Maximum CH₄-producing capacity for domestic wastewater [kg CH₄/kg BOD_5 removed], default value of 0.6
$MCF_{anaerobic}$	=	CH₄ correction factor for anaerobic systems, default value of 0.8
$F_{removed}$	=	Fraction of overall lagoon BOD_5 removal performance
0.001	=	Conversion from kg to MT [MT/kg]

On-Site Septic Systems

Equation A-31 should be used when measurements of the average BOD_5 load are collected in accordance with local, state, and Federal regulations or permits or published industry standardized sampling and testing methodologies (such as 40 CFR 136, NSPS, APHA, AWWA, WEF, ASTM, and EPA).

Equation A-31: Fugitive CH₄ Emissions from Septic Systems (Alternative)

Annual CH₄ emissions [MT] = BOD_5 load ● Bo ● MCF_{septic} ● 365.25 ● 0.001

Where:

BOD_5 load	=	Amount of BOD_5 produced per day [kg BOD_5/day]
Bo	=	Maximum CH₄-producing capacity for domestic wastewater [kg CH₄/kg BOD_5 removed], default value of 0.6
MCF_{septic}	=	CH₄ correction factor for anaerobic systems, default value of 0.5
365.25	=	Conversion factor [day/year]
0.001	=	Conversion from kg to MT [MT/kg]

<u>*Step 3*</u>: *Sum emissions from all processes*

Agencies should sum the emissions from all processes and apply the appropriate GWP values to calculate total emissions from wastewater treatment in units of CO_2e.

Equation A-32: Fugitive Wastewater Treatment MT CO_2e Emissions (Alternative)

CO_2e Emissions [MT CO_2e] = (MT CH_4 ● CH_4 GWP) + (MT N_2O ● N_2O GWP)

A.7. Fugitive Emissions: Landfills and Solid Waste Facilities

Description

This category includes emissions from the disposal and treatment of MSW generated as a result of agency operations and treated at on-site landfills that accepted waste on or after January 1, 1980.[97] This category also includes any on-site industrial landfill with a design capacity greater than or equal to 300,000 MT that does not accept only inert wastes. This category does not include construction and demolition wastes or waste piles.[98]

There is no *de minimis* accounting and reporting threshold for small on-site or closed landfills. Small on-site or closed landfills are within the agency's Scope 1 operational boundaries and should be included in the agency's GHG inventory, with the exception of closed landfills that did not accept waste on or after January 1, 1980. In the absence of necessary data, these small or closed landfills should, at a minimum, be noted as an emissions source in the agency's qualitative statement.

Disposal of waste may result in potentially significant GHG emissions. Landfilling organic waste causes anaerobic decomposition and CH_4 generation. If this landfill gas (LFG) is subsequently combusted, the combustion constitutes disposal and releases CO_2 biogenic emissions.

The default approach for calculating solid waste emissions is based on both the EPA's Landfill Gas Emission Model (LandGEM)[99] and the calculations behind the EPA Center for Corporate Climate Leadership's Offset Project Methodology.

The agency can choose to use site-specific data from its waste operations division in the alternative method. If an agency has an industrial landfill with a design capacity greater than or equal to 300,000 MT, and does not accept only inert wastes, it is to use a first order decay model such as that found in LandGEM or as defined in Subpart TT of the GHGRP.[100]

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[97] Landfills are defined as an area of land or an excavation in which wastes are placed for permanent disposal and that is not a land application unit, surface impoundment, injection well, or waste pile as those terms are defined under 40 CFR 257.2.

[98] Waste Piles are non-containerized piles of solid, non-liquid hazardous waste that are used for temporary storage or treatment. www.epa.gov/osw/hazard/tsd/td/ldu/.

[99] See www.epa.gov/ttn/catc/dir1/landgem-v302.xls for the EPA LandGEM model. See www.epa.gov/ttncatc1/dir1/landgem-v302-guide.pdf for the LandGEM user guide.

[100] Estimates resulting from application of Subpart TT of the GHGRP for GHG reporting purposes may be used for reporting in the Annual GHG Data Report workbook.

For some agencies, data on total waste disposal are available, but there are no data available for disposal off site versus on site. To develop separate Scope 1 and Scope 3 estimates, agencies can either monitor the amount of waste sent off site versus on site annually, or can develop a one-time estimate of the percent of wastes disposed on site versus off site and apply that percentage every year.

A.7.1. Default Methodology (User Calculated by LandGEM)

Data Sources

The EPA's LandGEM model is a well-established tool for regulatory reporting purposes.[101] Agencies may find that their facilities have already calculated their respective CH_4 emissions. The Microsoft Excel–based LandGEM requires agencies to enter the requisite data and automatically estimates the emission rates for total landfill gas, CH_4, CO_2 (biogenic), non-methane organic compounds, and individual air pollutants from MSW landfills. However, this model does not consider emissions reductions from LFG capture.

The Annual GHG Data Report workbook will assume 50 percent of landfills include LFG collection systems. The user calculates the mass of CH_4 and biogenic CO_2 using LandGEM. The agency will need data on the mass of solid waste disposed of for all years of landfill operation, and landfill open year and close year for LandGEM. Table A-15 shows the data sources.

Many agencies may not have all of the necessary historical landfill disposal data. Landfills without this data should use one of the methods listed below to estimate historical waste quantities. These calculations are not conducted by the Annual GHG Data Report workbook, and are to be completed separately by the reporting agency. Historical waste disposal quantities should only be determined once, and the same values should be used for all subsequent annual reports, supplemented by the next year's data on new waste disposal.

1. Assume all prior year's waste disposal quantities are the same as the waste quantity in the first year for which waste quantities are available, or an average based on multiple years of data.

2. Using data from the first year for which waste quantities are available, develop a per capita or per unit of activity/product amount of waste disposal. Use historical data on population or activity/production to estimate previous disposal for previous years.

3. Use a constant average waste disposal quantity calculated using Equation A-33 for each year the landfill was in operation (i.e., from the first year accepting waste until the last year for which waste disposal data is unavailable, inclusive).

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[101] LandGEM is a first order decay model and estimates landfill methane emissions generated from the anaerobic decay of municipal solid waste. This approach is different from the mass-balance approaches used in the Scope 3 targeting tool and the Scope 3 Contracted Waste Disposal methodology presented in Appendix C.

Table A-18: Fugitive Emissions – Landfills/MSW Default Data Sources

Data Element		Preferred Source
Mass of solid waste disposed of in landfills		• Reporting to Office of Federal Sustainability (OFS) under E.O. 13693, Sec. 3(j)
Landfill open year and close year		• Solid waste operations division
Mass of biogenic CO_2 and CH_4 [MT (Mg)]*		• Calculated by LandGEM or supplemented from Title V permit and annual emissions reporting data
CH_4 concentration rate, k		• Default provided by Annual GHG Data Report workbook
Potential methane generation capacity, Lo		• Default provided by Annual GHG Data Report workbook
Non-CH_4 Organic Compounds (NMOC) concentration, ppmv		• Default provided by Annual GHG Data Report workbook
CH_4 content of LFG, % by volume		• Default provided by Annual GHG Data Report workbook
Does the landfill have a LFG collection system?		• Annual GHG Data Report workbook assumes 50% include LFG collection system
If LFG collection system	Efficiency of LFG collection system	• Default provided by Annual GHG Data Report workbook
	Oxidation factor	• Default provided by Annual GHG Data Report workbook

* 1 MT = 1 Mg (megagram)

Calculation Steps[102]

Landfill fugitive emissions can be calculated using the following steps:

1. Determine historical waste disposal quantity

2. Use EPA's LandGEM to calculate the CO_2 and CH_4 generation and input into Annual GHG Data Report workbook

3. Calculate emissions from MSW landfills.

Step 1: Determine historical waste disposal quantity

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[102] Primary Reference: EPA Center for Corporate Climate Leadership, *Direct Emissions from Municipal Solid Waste Landfilling*, October 2004, and EPA Technical Support Document for the Landfill Sector: Proposed Rule for Mandatory Reporting of Greenhouse Gases, February 2009.

Equation A-33: Landfill Waste Quantity (Default)

W_x **[MT]** = LFC / (YrData – YrOpen + 1)

Where:

W_x	=	Quantity of waste placed in the landfill in year x [MT, wet basis], the amount reported should be the same as the amount of waste diverted to the agency landfill(s) agencies report under separate guidance on waste diversion and disposal, currently pending from CEQ.
LFC	=	Landfill capacity or, for operating landfills, capacity of the landfill used (or the total quantity of waste-in-place) at the end of the year prior to the year when waste disposal data are available from design drawings or engineering estimates [MT]
YrData	=	Year in which the landfill last received waste or, for operating landfills, the year prior to the first reporting year when waste disposal data is first available from company records, or best available data
YrOpen	=	Year in which the landfill first received waste from company records or best available data. If no data are available for estimating for a closed landfill, use 30 years as the default operating life of the landfill

Step 2: Use EPA's LandGEM to calculate the CO_2 and CH_4 generation and input into Annual GHG Data Report workbook

LandGEM calculates the annual quantity of biogenic CO_2 and anthropogenic CH_4 that a landfill will generate based upon past and current disposal of MSW. LandGEM's most accurate estimates are calculated when past and current year quantities of MSW are entered.[103] While disposed solid waste generates GHGs for several years, agencies' Scope 1 GHG inventories will account for the facility's annual emissions for Scope 1 for that fiscal year's GHG inventory only. This is consistent with methods used for compliance with CAA Title V reporting, which agencies also leverage to obtain, aggregate, and input the required data.

The agency should select the "Inventory Conventional" values, input the mass of solid waste disposed,[104] landfill open and close date, and then enter the mass of CH_4 and CO_2 determined by LandGEM into the Annual GHG Data Report workbook.

Step 3: Calculate emissions from MSW landfills

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[103] To the extent possible, agencies should leverage historical landfill data and LandGEM calculations from existing CAA Title V reporting. Where historic data is not available, LandGEM can be used to calculate biogenic CO_2 and anthropogenic emissions using annual municipal solid waste disposal quantities. However, this data-limited approach will result in an underestimation of landfill emissions.

[104] The LandGEM model will require an agency to input the mass of waste disposed in each past year, as well as in the current year, consistent with the use of LandGEM for CAA Title V reporting. Without inclusion of past waste data, agencies should note that LandGEM would underestimate emissions of anthropogenic CH_4 and biogenic CO_2 for the current reporting year.

The Annual GHG Data Report workbook will apply LFG collection (defaults to 50 percent national average), LFG collection efficiency (assumes 75 percent default), and the methotropic bacteria oxidation factor (assumes 10 percent default).

Equation A-34 does not take into account emissions from landfill gas flaring, which is a stationary combustion emissions source. Flaring emissions are calculated by the same methodology described in Appendix A.1 and would complete the mass balance of the global estimation approach. The Annual GHG Data Report workbook will calculate landfill gas flaring in the same location as fugitive landfill emissions to reduce data input. Equation A-34 applies national average factors based upon information in the EPA Center for Corporate Climate Leadership's "Greenhouse Gas Inventory Protocol Offset Project Methodology" and covers all operations of the approach, with the exception of flare combustion and venting (1-percent non-combustion stack loss).

Equation A-34: Fugitive Emissions from Solid Waste Facilities (Default)

CO_2e Emissions [MT] =
$((CH_{4gen} \bullet CH_{4release} \bullet (1 - OX_B)) + (CH_{4gen} \bullet (1 - CH_{4release}) \bullet (1 - \eta_{LFGsystem}) \bullet (1 - OX_B))) \bullet GWP$

Where:

CH_{4gen}	=	CH_4 generated by landfill, calculated in LandGEM [MT]
$CH_{4release}$	=	Percentage of uncontrolled release of CH_4, default national average value of 0.5
OX_B	=	Methotropic Bacteria Oxidation Factor, default value of 0.10
$\eta_{LFGsystem}$	=	Efficiency of LFG collection system, default value of 0.75
GWP	=	Global Warming Potential of CH_4, 25

Source: EPA Center for Corporate Climate Leadership, Greenhouse Gas Inventory Protocol, Direct Emissions From Municipal Solid Waste Landfilling Methodology and Offset Project Methodology. See both at: www.epa.gov/climateleaders/resources/index.html.

Example A-12: Fugitive Emissions (Solid Waste Management—Default)

An agency does not know whether its solid waste facility has an LFG collection system. For brevity, this example assumes output from LandGEM, and begins at Step 2.

Step 2: Use EPA's LandGEM to calculate the CO_2 and CH_4 generation and input into the Annual GHG Data Report workbook

The agency inputs the mass of solid waste they dispose of annually, the facility's open/close dates, and other known factors into LandGEM. LandGEM outputs that the waste generates 1,000 MT of CO_2 and 1,000 MT of CH_4. As no site-specific data are available, the agency uses available default values.

➢ ***Reported as biogenic emissions in Scope 1*** = 1,000 MT CO_2

Step 3: *Calculate emissions from landfills and solid waste facilities*

Equation A-34: Fugitive Emissions from Solid Waste Facilities (Default)

➢ ***Reported as Scope 1 emissions***

$$
\begin{aligned}
\textbf{CO}_2\textbf{e emissions [MT]} &= ((CH_{4gen} \bullet CH_{4release} \bullet (1 - OX_B)) + (CH_{4gen} \bullet (1 - CH_{4release}) \bullet (1 - \eta_{LFGsystem}) \bullet (1 - OX_B))) \bullet GWP \\
&= ((1{,}000 \bullet 0.5 \bullet (1 - 0.10)) + (1{,}000 \bullet (1 - 0.5) \bullet (1 - 0.75) \bullet (1 - 0.10))) \bullet 25 \\
&= ((1{,}000 \bullet 0.5 \bullet 0.9) + (1{,}000 \bullet 0.5 \bullet 0.25 \bullet 0.9)) \bullet 25 \\
&= (450 + 112.5) \bullet 25 \\
&= \textbf{11,812.5 MT CO}_2\textbf{e}
\end{aligned}
$$

Where:

CH_{4gen}	=	CH_4 generated by landfill, calculated in LandGEM [MT]
$CH_{4release}$	=	Percentage of uncontrolled release of CH_4, default national average value of 0.5
OX_B	=	Methotropic Bacteria Oxidation Factor, default value of 0.10
$\eta_{LFGsystem}$	=	Efficiency of LFG collection system, default t value of 0.75
GWP	=	Global Warming Potential of CH_4, 25

****Note**: Example has been provided for demonstration purposes only and has rounding imposed throughout each of the calculation steps above. Factors are for illustration. The most recent emission factors can be found in the Annual GHG Data Report workbook where their original sources will also be documented. As such results from this example may differ slightly from results generated using the Annual GHG Data Report workbook.**

A.7.2. Alternative Methodology (User Calculated by LandGEM)

Data Sources

The alternative methodology also uses LandGEM. For the alternative methodology, the agency should also have data on site-specific methane concentrations, generation capacity, and system efficiency. If the agency is already reporting under the GHGRP, use this output.

Before performing the calculations, it is necessary to determine whether the landfills in its operational control have LFG collection systems. If they do not, agencies need only apply the methodology approach outlined in Step 1 in the next section. However, if one or more of the agency's landfills have an LFG collection system, they should apply both steps 1 and 2 to the

respective landfills. If agencies are unsure whether their landfill has an LFG collection system, step 2 enables the agency to apply a national average factor until more detailed information is available. Table A-19 shows the data sources.

Table A-19: Fugitive Emissions – Landfills/MSW Alternative Data Sources

Data Element		Preferred Source
Does the landfill have a LFG collection system?		• Waste operations division
Mass of solid waste disposed of in landfills		• Reporting to Office of Federal Sustainability (OFS) under E.O. 13693, Sec. 3(j)
Landfill open year and close year		• Waste operations division
Mass of biogenic CO_2 and CH_4 [MT (Mg)]*		• Calculated by LandGEM or supplemented from Title 5 permit data
CH_4 concentration rate, k		• Waste operations division
Potential CH_4 generation capacity, Lo		• Waste operations division
NMOC concentration, ppmv		• Waste operations division
CH_4 content of LFG, % by volume		• Waste operations division
If LFG collection system	Efficiency of LFG collection system	• Waste operations division
	Oxidation factor	• Waste operations division

* 1 MT = 1 Mg (megagram)

Calculation Steps

Landfill fugitive emissions can be calculated using the following steps:

1. Use EPA's LandGEM or other method to calculate the CH_4 and biogenic CO_2 generation
2. Calculate emissions reductions from capture and combustion of LFG.

The calculation steps for the alternative methodology are the similar to the default, except for substituting site-specific information about the landfills.

Equation A-35: Fugitive Emissions from Solid Waste Facilities (Alternative)

CO_2e **Emissions [MT] =**

$((CH_{4gen} \bullet CH_{4release} \bullet (1 - OX_B)) + (CH_{4gen} \bullet (1 - CH_{4release}) \bullet (1 - \eta_{LFGsystem}) \bullet (1 - OX_B))) \bullet GWP$

Where:

CH_{4gen}	=	CH_4 generated by landfill, calculated in LandGEM [MT]
$CH_{4release}$	=	Percentage of uncontrolled release of CH_4 (either 1.0 or 0 depending on presence of LFG-collection system)
$\eta_{LFGsystem}$	=	Efficiency of LFG collection system, default value of 0.75
OX_B	=	Methotropic Bacteria Oxidation Factor, default value of 0.10
GWP	=	Global Warming Potential of CH_4, 25

Source: EPA Center for Corporate Climate Leadership, Greenhouse Gas Inventory Protocol, Direct Emissions From Municipal Solid Waste Landfilling and Offset Project Methodology.

A.8. Industrial Process Emissions

Most agencies will not likely have applicable fugitive emissions beyond those detailed above. If the agency owns and/or operates industrial sources of GHG emissions, the following guidelines can be used to calculate associated process emissions. All references to the IPCC 2006 Guidelines are to Volume 3 of those Guidelines, *Industrial Processes and Product Use*.

- Adipic acid production (process N_2O emissions)
  - EPA GHGRP Technical Support Document: 40 CFR 98, Subpart E
  - IPCC 2006 Guidelines, Volume 3, Chapter 3, Equation 3.8
  - World Resources Institute (WRI)/World Business Council for Sustainable Development (WBCSD), Calculating N_2O Emissions from the Production of Adipic Acid, 2001
- Aluminum production (process CO_2 and PFC emissions)
  - EPA GHGRP Technical Support Document: 40 CFR 98, Subpart F
  - CO_2: IPCC 2006 Guidelines, Volume 3, Chapter 4, Equations 4.21–4.24
  - PFCs: IPCC 2006 Guidelines, Volume 3, Chapter 4, Equations 4.25–4.27
- Ammonia production (process CO_2 emissions)
  - EPA GHGRP Technical Support Document: 40 CFR 98, Subpart G
  - IPCC 2006 Guidelines, Volume 3, Chapter 3, Equation 3.3
- Cement production (process CO_2 emissions)
  - EPA GHGRP Technical Support Document: 40 CFR 98, Subpart H
  - California Air Resources Board, Draft Regulation for the Mandatory Reporting of Greenhouse Gas Emissions, 2008
  - California Climate Action Registry Cement Reporting Protocol, 2005
  - Cement Sustainability Initiative, The Cement CO_2 Protocol: CO_2 Accounting and Reporting Standard for the Cement Industry (2005) Version 2.0
- HCFC-22 production (process HFC-23 emissions)

- o EPA GHGRP Technical Support Document: 40 CFR 98, Subpart O
- o IPCC 2006 Guidelines, Volume 3, Chapter 3, Equations 3.31–3.33
- o WRI/WBCSD, Calculating HFC-23 Emissions from the Production of HCFC-22, 2001
- Iron and steel production (process CO_2 emissions)
  - o EPA GHGRP Technical Support Document: 40 CFR 98, Subpart Q
  - o IPCC 2006 Guidelines, Volume 3, Chapter 4, Equations 4.9–4.11.
- Lime production (process CO_2 emissions)
  - o EPA GHGRP Technical Support Document: 40 CFR 98, Subpart S
  - o IPCC 2006 Guidelines, Volume 3, Chapter 2, Equation 2.5–2.7
- Nitric acid production (process N_2O emissions)
  - o EPA GHGRP Technical Support Document: 40 CFR 98, Subpart V
  - o IPCC 2006 Guidelines, Volume 3, Chapter 3, Equation 3.6
  - o WRI/WBCSD, Calculating N_2O Emissions from the Production of Nitric Acid, 2001
- Particle accelerators (SF_6 emissions)
  - o IPCC 2006 Guidelines, Volume 3, Chapter 8, Equation 8.17
- Pulp and paper production (process CO_2 emissions)
  - o EPA GHGRP Technical Support Document: 40 CFR 98, Subpart AA
  - o IPCC 2006 Guidelines, Volume 3, Chapter 2, Chapter 2.5
  - o International Council of Forest and Paper Associations, Calculation Tools for Estimating Greenhouse Gas Emissions from Pulp and Paper Mills, Version 1.1, 2005
- Refrigeration and air conditioning equipment manufacturing (process HFC and PFC emissions)
  - o EPA Center for Corporate Climate Leadership, Direct HFC and PFC Emissions from Manufacturing Refrigeration and Air Conditioning Units, 2003
  - o WRI/WBCSD, Calculating HFC and PFC Emissions from the Manufacturing, Installation, Operation and Disposal of Refrigeration & Air-conditioning Equipment (Version 1.0) 2005
- Semiconductor manufacturing (process PFC and SF_6 emissions)
  - o IPCC 2006 Guidelines, Equations 6.7–6.11

Appendix B. Calculating Scope 2 Emissions

Scope 2 emissions are indirect GHG emissions associated with the consumption of purchased or acquired electricity, steam, heating, or cooling. They are a consequence of activities occurring within the agency's boundaries, but are emitted at sources owned or controlled by another entity.

This section provides calculation methodologies for the following:

- Purchased electricity

- Purchased steam or hot water

- Purchased chilled water

- Electricity, steam, or hot water purchases from a combined heat and power (CHP) facility[105]

- Steam purchases from a MSW waste-to-energy (WTE) facility

B.1   Purchased Electricity

Description

Purchased electricity is defined as electricity purchased or otherwise brought into the organizational boundary of the agency. Appendix B.1.1 describes the default methodology for calculated emissions from purchased electricity to be calculated by the Annual GHG Data Report workbook. This GHG emissions calculation methodology is the only acceptable one for purchased electricity. Appendix B.1.2 describes the alternative data estimation methods for purchased electricity if these activity data are not available.

B.1.1. Default Methodology (to be Calculated by Annual GHG Data Report Workbook)

Data Sources

The default methodology uses purchased electricity data, ideally based on metered electricity consumption. Table B-1 shows the required data elements and sources**.**

Table B-1: Purchased Electricity Default Data Sources

Data Element	Preferred Source
Purchased Electricity [MWh]	• Purchasing records by zip code or eGRID subregion
Emission Factor [kg/MWh] or kilograms per gigawatt hour [kg/GWh]	• Standardized emission factors from sources in Table D-1

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[105] CHP methodology can be used as an alternative methodology for estimating the emissions associated with the purchased electricity generated at a waste-to-energy facility.

Calculation Steps

The Annual GHG Data Report workbook will automatically calculate Scope 2 emissions from use of purchased electricity based on the activity data provided. To provide the data:

1. Determine annual use of purchased electricity from all facilities within the agency's operational control by eGRID subregion
2. Select the appropriate eGRID subregion output emission rate factors that apply to the electricity used
3. Calculate total CO_2, CH_4, and N_2O emissions, and convert them to MT
4. Convert to MT CO_2e and calculate total emissions.

Step 1: Determine annual use of purchased electricity from all facilities within the agency's operational control

Include purchased electricity data for all facilities that fit with the definition of operational control under Scope 2 provided in Chapter 2 of the main Guidance document. Report electricity use by the corresponding eGRID subregion and, if applicable, U.S. Territory and Country if the agency chooses to include international emissions.[106]

Step 2: Select the appropriate eGRID subregion output emission rate factors that apply to the electricity used

Electricity emission factors represent the amount of GHGs emitted per unit of electricity consumed. They are usually reported in GHG [lb] per MWh or gigawatt hour (GWh).

The Annual GHG Data Report workbook will choose the appropriate eGRID subregion output emission rate factors (see Table D-1). These are included in this document to provide a consistent, verifiable basis for emissions calculations. Because emission factors vary by location, agencies should be sure to use the appropriate subregion-specific factors for each facility. Because eGRID is updated periodically, the Annual GHG Data Report workbook will use emission rates from the eGRID edition that is closest to the year of their inventory activity data.[107] Agencies are not expected to retroactively update their inventories with new eGRID output emission rate factors once the inventory has been submitted to CEQ.

Step 3: Calculate total CO_2, CH_4, and N_2O emissions, and convert them to MT

To determine annual emissions, the Annual GHG Data Report workbook will multiply annual electricity use in MWh (Step 1) by the emission factors for CO_2, CH_4, and N_2O in kg/MWh (Step 2), and convert them to MT.

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[106] When reporting emissions for U.S. Territories and/or choosing to report facilities in foreign nations, use emission factors from sources in Appendix D.

[107] eGRID publishes data regularly but reflects the operational data from power plants from 2–3 years prior. For example, eGRID 2007 has year 2005 operational data but is configured to company ownerships and industry structures as of year 2007.

Equation B-1: Purchased Electricity GHG Emissions

CO_2 Emissions [MT] = Electricity use [MWh] ● CO_2 emission factor [kg CO_2/MWh] ● 0.001 [MT/kg]
CH_4 Emissions [MT] = Electricity use [MWh] ● CH_4 emission factor [kg CH_4/GWh] ● 0.001 [MT/kg] ● 0.001[GWh/MWh]
N_2O Emissions [MT] = Electricity use [MWh] ● N_2O emission factor [kg N_2O/GWh] ● 0.001 [MT/kg] ● 0.001[GWh/MWh]

Step 4: Convert to MT CO_2e and calculate total emissions

The Annual GHG Data Report workbook will convert CH_4 and N_2O into units of CO_2e using the emissions [MT] and the GWP values provided in Appendix D. It will sum the CO_2e emissions of each of the three gases to determine total GHG emissions for Scope 2 purchased electricity.

Equation B-2: Purchased Electricity MT CO_2e Emissions

CO_2e emissions [MT CO_2e] = MT CO_2 + (MT CH_4 ● CH_4 GWP) + (MT N_2O ● N_2O GWP)

Transmission and Distribution (T&D) Losses

If the agency purchases (rather than generates) electricity and transports it through a T&D system that it owns or controls, it should report the emissions associated with T&D losses under Scope 2. End consumers of purchased electricity do not report indirect emissions associated with T&D losses in Scope 2 if they do not own or control the T&D operation where the electricity is consumed. If the agency does not own or control the T&D operation, these emissions are estimated as Scope 3 (see Appendix C.2).

Example B-1: Purchased Electricity (Default)

An agency with operations in the eGRID subregion SRVC (see eGrid map in Figure D-1) has all the monthly energy statements for the reporting year. The annual electricity use is 30,000 MWh for the facility, based on monthly energy statements.

Step 1: Determine annual use of purchased electricity from all facilities within the agency's operational control

The electricity use for this facility is 30,000 MWh.

Step 2: Select the appropriate eGRID subregion output emission rate factors that apply to the electricity used

The SRVC subregion output emission rate factors from eGRID are shown below:
- CO_2 emission factor = 507.30 [kg/MWh]
- CH_4 emission factor = 10.10 [kg/GWh]
- N_2O emission factor = 8.65 [kg/GWh

Step 3: Calculate total CO_2, CH_4, and N_2O emissions, and convert them to MT

Equation B- 1: Purchased Electricity GHG Emissions	
CO_2 Emissions [MT]	= Electricity use [MWh] ● CO_2 emission factor [kg CO_2/MWh] ● 0.001 [MT/kg] = 30,000 [MWh] ● 507.30 [kg CO_2/MWh] ● 0.001 [MT/kg] = 15,219 [MT CO_2]
CH_4 Emissions [MT]	= Electricity use [MWh] ● CH_4 emission factor [kg CH_4/MWh] ● 0.001 [MT/kg] ● 0.001 [GWh/MWh] = 30,000 [MWh] ● 8.65 [kg CH_4/GWh] ● 0.001 [MT/kg] ● 0.001 [GWh/MWh] = 0.260 [MT CH_4]
N_2O Emissions [MT]	= Electricity use [MWh] ● N_2O emission factor [kg N_2O/MWh] ● 0.001 [MT/kg] ● 0.001 [GWh/MWh] = 30,000 [MWh] ● 10.10 [kg CH_4/GWh] ● 0.001 [MT/kg] ● 0.001 [GWh/MWh] = 0.303 [MT N_2O]

Step 4: Convert to MT CO_2e and calculate total emissions

Equation B-2: Purchased Electricity MT CO_2e Emissions	
Total Emissions [MT CO_2e]	= MT CO_2 + (MT CH_4 ● CH_4 GWP) + (MT N_2O ● N_2O GWP) = 15,219 [MT CO_2] + (0.260 [MT CH_4] ●25) + (0.303 [MT N_2O] ● 310) = **15,318.39 [MT CO_2e]**

Note: Example has been provided for demonstration purposes only and has rounding imposed throughout each of the calculation steps above. Factors are for illustration. The most recent emission factors can be found in the Annual GHG Data Report workbook where their original sources will also be documented. As such results from this example may differ slightly from results generated using the Annual GHG Data Report workbook.**

B.1.2. Alternative Data Estimation Methods (User Calculated)[108]

For Scope 2 purchased electricity, this section shows alternative methods for calculating the amount of electricity consumed by a Federal agency. The agency can use these alternative data

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[108] The Climate Registry, *Local Government Operations Protocol*, Version 1.0, September 2008.

estimation methods if it is unable to determine annual electricity use from preferred sources of electricity use data (see Appendix B.1.1, Step 1). The data values for electricity use calculated through these alternative methods should be input into the Annual GHG Data Report workbook by the user only if electricity use cannot otherwise be obtained. The Annual GHG Data Report workbook will use these values to continue the default methodology (Appendix B.1.1, Steps 2 through 4).

These alternative ways of calculating electricity use data are based on estimates and are less accurate than the metered data requirements for FEMP energy reporting. If metered electricity data are unavailable for an agency's buildings or facilities, there are two alternative approaches for estimating electricity use in order to calculate Scope 2 purchased electricity emissions:

1. Estimate electricity use based on proxy year data, or
2. Estimate electricity use based on known electricity use at comparable facilities.

Alternative Data Estimation Method 1: Proxy Year Data

If purchase records, electricity bills, or meter readings are not available, the agency can estimate electricity use for a facility on the basis of electricity consumed at the building or facility in another year. Typically, this approach is used when data are unavailable for one or a few minor facilities. Generally, it should not be used as a substitute for a significant group of facilities. Agencies should disclose the use of any proxy years in reporting as part of their qualitative statement disclosure (see Chapter 2.1).

Data Sources

Table B-2 shows the data elements and sources.

Table B-2: Purchased Electricity Proxy Year Alternative Data Sources

Data Element	Preferred Source
Electricity use from prior years [kWh]	• Prior Annual GHG Data Report workbooks • Electricity purchasing records
Heating and cooling degree days	• National Climate Data Center

Description

The following steps can be taken to estimate the annual electricity use at a facility using proxy year data:

1. Determine the electricity used in each facility in the proxy year
2. Normalize for heating and cooling degree days.

Step 1: Determine the electricity used in each facility in the proxy year

The proxy year can be either another calendar year or a fiscal year.

Step 2: _Normalize for heating and cooling degree days_

Estimate the proportion of electricity used in a year for heating as a percentage of the total electricity consumed and the proportion of annual electricity used in a year for cooling as a percentage of the electricity consumed. This should be based on the increased electricity consumed during winter months and summer months, respectively. Where monthly data are not available, the best recommendation of the facility manager may be used. Then determine annual heating and cooling degree days in the region in the year being estimated and the proxy year. The National Climate Data Center website provides information on the heating and cooling degree days by month and by state.[109]

Normalize for heating and cooling degree days using Equation B-3.

Equation B-3: Normalization for Heating and Cooling Degree Days

Estimated Energy Consumed in Inventory Year [kWh] =
$$[((EP \bullet Eh)/DHP) \bullet (DHI/1)] + [((EP \bullet EC)/DCP) \bullet (DCI/1)] + [(1 - Eh - EC) \bullet EP]$$

Where:

EP	=	Electricity used in proxy year [kWh]
Eh	=	Percentage of electricity used for heating [%]
DHP	=	Heating degree days in the proxy year
DHI	=	Heating degree days in inventory year
EC	=	Percentage of electricity used for cooling [%]
DCP	=	Cooling degree days in the proxy year
DCI	=	Cooling degree days in inventory year

Source: Local Government Operations Protocol (LGO Protocol). See
www.theclimateregistry.org/resources/protocols/local-government-operations-protocol.

Agencies should input the estimated electricity use calculated from Equation B-3 into the Annual GHG Data Report workbook, which will follow the default methodology to estimate CO_2, CH_4, and N_2O Scope 2 emissions from the facility (see Appendix B.1.1).

Alternative Data Estimation Method 2: Comparable Facilities and Square Footage

If total annual electricity consumption data are not available for the current reporting year or previous years, agencies can estimate electricity use on the basis of the size and function of the facility.

Typically, this approach is used when data are unavailable for one or a few minor facilities. It should not be used as a substitute for a significant group of facilities. When reporting, agencies should note the use of any comparable facilities data to ensure full disclosure in the agency's qualitative statement (see Chapter 2.1).

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[109] National Climate Data Center. See: www7.ncdc.noaa.gov/CDO/CDODivisionalSelect.jsp#.

Data Sources

Table B-3 shows the data elements and sources.

Table B-3: Purchased Electricity Comparable Facilities and Square Footage Alternative Data Sources

Data Element	Preferred Source
Size of the facility [sq ft]	• Building Manager
Size [sq ft] and annual electricity use [MWh] of comparable facilities	• Buildings Manager of comparable facilities

Calculation Steps

Use the following steps to estimate the electricity use at the facility:

1. Determine the size of the facility measured in floor area [sq ft]
2. Identify comparable facilities with known annual electricity use and square footage
3. Determine the electricity used per square foot at a comparable facility and estimate the electricity used at the facility.

Step 1: Determine the size of the facility measured in floor area [sq ft]

Agencies can obtain this information from the respective building manager or from the agency's Federal Real Property Profile database, as appropriate.

Step 2: Identify comparable facilities with known annual electricity use rates and square footage

If possible, these facilities should be owned or operated by the same agency. The determination of comparability should include consideration of the primary function of the facility (such as office or hospital) and the primary uses of electricity at each facility (such as heating or cooling). Facility age, hours of operation, number of occupants, and the type of heating and cooling systems employed should also be considered.

If electricity consumption for another comparable facility owned or operated by the same agency is not available, consult EIA's Commercial Building Energy Consumption Survey for average energy use by facility type and region of the country (www.eia.doe.gov/emeu/cbecs).

Step 3: Determine the electricity used per square foot at a comparable facility and estimate the electricity used at the facility

Divide the annual electricity use at the comparable facility by its square footage to obtain a kWh/sq ft coefficient. Then multiply this energy intensity by the area of the facility for which electricity use is being estimated.

Equation B-4: Estimated Annual Electricity Use (Square Footage)

Energy Intensity [kWh/sq ft] =
Annual electricity use at comparable facility [kWh] ÷ size of comparable facility [sq ft]
Estimated Electricity Use [kWh] =
Coefficient [kWh/sq ft] ● size of facility being estimated [sq ft]

Agencies should input the estimated electricity use from Equation B-4 into the Annual GHG Data Report workbook, which will follow the default approach to estimate CO_2, CH_4, and N_2O Scope 2 emissions and total CO_2e from the facility (see Appendix B.1.1).

B.2   Purchased Steam or Hot Water

Many agencies purchase steam or district heating to provide space heating in the buildings or process heating for industrial needs. Emissions associated with these sources are considered to be indirect. The default methodology below describes the method for calculating emissions from purchased steam or hot water using the Annual GHG Data Report workbook. The alternative methodology, B.2.2, describes a more detailed method.

B.2.1. Default Methodology (to be Calculated by Annual GHG Data Report Workbook)

Data Sources

Scope 2 GHG emissions from purchased steam and hot water are primarily calculated from metered steam and hot water consumption data and published emission factors. Table B-4 shows the preferred and alternate data sources for calculating Scope 2 emissions from steam or hot water use.

Table B-4: Purchased Steam or Hot Water Default Data Sources

Data Element	Preferred Source	Alternate Source
Steam or hot water consumption [MMBtu]	• Metered data on delivered energy	• Purchasing records • Maintenance records
Emission factors [kg/MMBtu]	• Standardized emission factors provided in Table D-1	• N/A

Calculation Steps

To calculate Scope 2 emissions from purchased steam or hot water, do the following:

1. Determine the annual steam and hot water use from all facilities within an agency's organizational boundary

2. Calculate the appropriate emission factors that apply to the steam and hot water used

3. Determine total annual emissions in MT CO_2e.

Step 1: Determine the annual steam and hot water use from all facilities within an agency's organizational boundary

Agencies should begin by calculating the quantity of steam and hot water purchased. If steam purchases are metered and recorded by the agency, those data should be used. Steam and hot water use data should be included for all facilities within an agency's organizational boundary.

Agencies should refer to Federal Energy Management Guidance for preferred sources of steam and hot water data (metered readings or utility bills) and alternate methods for estimating steam and hot water use when metered data are not available.

Step 2: Calculate the appropriate emission factors that apply to the steam and hot water used

Steam and hot water emission factors represent the amount of GHGs emitted per unit of steam and hot water consumed by fuel type. These are usually reported in units of kg of CO_2e per MMBtu of steam or hot water (see Table D-1).

Emission factors depend on the mix of fuel burned to generate purchased steam and hot water.[110] In some cases, obtaining emission factors directly from the supplier may be possible. In cases where this is not possible, the Annual GHG Data Report workbook will calculate emission factors on the basis of steam and hot water being produced by a natural gas boiler (see Table D-1).

The Annual GHG Data Report workbook will calculate the emission factors for steam by dividing the default emission factors for natural gas for CO_2, CH_4, and N_2O by the product of boiler efficiency (default 80 percent),[111] steam production efficiency (75 percent),[112] and distribution loss (10 percent).[113,114]

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[110] Within DOE's 1605(b) Program, *Technical Guidelines, Voluntary Reporting of Greenhouse Gases*, a default emission factor for steam and hot water is provided. However, this factor does not break out emissions by GHG gas and combines emissions from both steam and hot water. This technical guidance calculates its own emission factors for both steam and hot water separately.

[111] DOE, Industrial Technology Programs, Energy Use and Loss Footprints, Assumption and Definitions. See http://energy.gov/sites/prod/files/2014/02/f7/AMO_footprints_definitions_and_assumptions_2014_update.pdf.

[112] eGRID2007 TSD, EPA. See www.epa.gov/cleanenergy/documents/egridzips/eGRIDwebV1_0_UsersManual.pdf.

[113] During the transmission and distribution of steam and hot water, some portion of the energy will be absorbed by the ambient environment due to imperfect insulation. In addition, the transmission lines are relatively short as steam and hot water cannot be transported over long distances without losing significant thermal energy. Due to the short distances, a separate entity rarely owns and controls the transmission system. Therefore, this is regarded as part of Scope 2 as the transmission lines are considered to occur within a generation facility's operational control.

[114] DOE, Office of Policy and International Affairs, 1605(b) Program, *Technical Guidelines, Voluntary Reporting of Greenhouse Gases (1605(b)) Program* (March 2006) p. 154–156. See www.eia.doe.gov/oiaf/1605/pdf/Appendix%20N.pdf.

Equation B-5: Steam Emission Factor Calculation

CO_2 Emission Factor of Steam [kg/MMBtu] =
Emission factor CO_2 [kg/MMBtu] ÷ (boiler efficiency [%] ● steam production efficiency [%] ● (1- distribution loss [%]))
CH_4 Emission Factor of Steam [kg/MMBtu] =
Emission factor CH_4 [kg/MMBtu] ÷ (boiler efficiency [%] ● steam production efficiency [%] ● (1- distribution loss [%))
N_2O Emission Factor of Steam [kg/MMBtu] =
Emission factor N_2O [kg/MMBtu] ÷ (boiler efficiency [%] ● steam production efficiency [%] ● (1- distribution loss [%]))

Hot water calculations are similar to those of steam but don't consider the 75 percent steam production efficiency. The Annual GHG Data Report workbook will calculate the emission factor for hot water by dividing the emission factor for natural gas (see Appendix D) by the product of boiler efficiency (default 80 percent)[115] and distribution loss (10 percent).[116]

Equation B-6: Hot Water Emission Factor Calculation

CO_2 Emission Factor of Hot Water [kg/MMBtu] =
Emission factor CO_2 [kg/MMBtu] ÷ (boiler efficiency ● (1– distribution loss [%]))
CH_4 Emission Factor of Hot Water [kg/MMBtu] =
Emission factor CH_4 [kg/MMBtu] ÷ (boiler efficiency ● (1– distribution loss [%]))
N_2O Emission Factor of Hot Water [kg/MMBtu] =
Emission factor N_2O [kg/MMBtu] ÷ (boiler efficiency ● (1– distribution loss [%]))

Step 3: Determine total annual emissions in MT CO_2e

To determine annual emissions, the Annual GHG Data Report workbook will multiply annual steam and hot water in MMBtu use separately (Step 1) by the emission factors calculated for CO_2, CH_4, and N_2O in kg of CO_2e per MMBtu (Step 2).

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[115] DOE Energy Efficiency and Renewable Energy, Industrial Technology Programs, Energy Use and Loss Footprints, Assumption and Definitions. See http://energy.gov/sites/prod/files/2014/02/f7/ AMO_footprints_definitions_and_assumptions_2014_update.pdf .

[116] DOE, Office of Policy and International Affairs, 1605(b) Program, _Technical Guidelines, Voluntary Reporting of Greenhouse Gases (1605(b)) Program_ (March 2006) p. 154–156. See www.eia.doe.gov/oiaf/1605/pdf/ Appendix%20N.pdf.

Equation B-7: Purchased Steam GHG Emissions

CO_2 Emission [MT CO_2] =   Steam use [MMBtu] ● emission factor [kg CO_2/MMBtu] ● 0.001[MT/kg]
CH_4 Emission [MT CH_4] =   Steam use [MMBtu] ● emission factor [kg CH_4/MMBtu] ● 0.001[MT/kg]
N_2O Emission [MT N_2O] =   Steam use [MMBtu] ● emission factor [kg N_2O/MMBtu] ● 0.001[MT/kg]

Equation B-8: Purchased Hot Water GHG Emissions

CO_2 Emission Factor [MT] =   Hot water use [MMBtu] ● emission factor [kg CO_2/MMBtu] ● 0.001[MT/kg]
CH_4 Emission Factor [MT] =   Hot water use [MMBtu] ● emission factor [kg CH_4/MMBtu] ● 0.001[MT/kg]
N_2O Emission Factor [MT] =   Hot water use [MMBtu] ● emission factor [kg N_2O/MMBtu] ● 0.001[MT/kg]

The Annual GHG Data Report workbook will convert the CO_2, CH_4, and N_2O emissions into units of CO_2e by multiplying the total emissions of each gas in MT by the GWP values provided in sources in Appendix D. Then, it will sum the CO_2e emissions of each of the three gases to obtain total GHG emissions. The Annual GHG Data Report workbook will complete this calculation for both steam and hot water separately.

Equation B-9: Conversion to CO_2e and Determination of Total Purchased Steam and Hot Water Emissions

CO_2e Emissions [MT CO_2e] = MT CO_2 + (MT CH_4 ● CH_4 GWP) + (MT N_2O ● N_2O GWP)

Example B-2: Purchased Steam and Hot Water

A government entity imports steam and hot water at its Nevada facility. After going through utility bills, the agency determines that it consumed 1,000 MMBtu of steam and 2,000 MMBtu of hot water for the year.

Step 1: *Determine the annual steam and hot water use from all facilities within an agency's operational control*

Agency facilities used 1,000 MMBtu of steam and 2,000 MMBtu of hot water this year.

Step 2: *Calculate the appropriate emission factors that apply to the steam and hot water used*

Equation B-5 Steam Emission Factor Calculation

CO_2 Emission Factor of Steam [kg CO_2/MMBtu]	= CO_2 emission factor [kg/MMBtu] ÷ (boiler efficiency [%] ● steam production efficiency [%] ● (1- distribution loss [%])) = 53.02 [kg CO_2/MMBtu] ÷ (0.80 ● 0.75 ● 0.90) = 98.19 [kg CO_2/MMBtu]
CH_4 Emission Factor of Steam [kg CH_4/MMBtu]	= CH_4 emission factor [kg/MMBtu] ÷ (boiler efficiency [%] ● steam production efficiency [%] ● (1- distribution loss [%])) = 1.0×10^{-3} [kg CH_4/MMBtu] ÷ (0.80 ● 0.75 ● 0.90) = 1.85×10^{-3} [kg CH_4/MMBtu]
N_2O Emission Factor of Steam [kg N_2O/MMBtu]	= N_2O emission factor [kg/MMBtu] ÷ (boiler efficiency [%] ● steam production efficiency [%] ● (1- distribution loss [%])) = 1.0×10^{-4} [kg N_2O/MMBtu] ÷ (0.80 ● 0.75 ● 0.90) = 1.85×10^{-4} [kg N_2O/MMBtu]

Equation B-6: Hot Water Emission Factor Calculation

CO_2 Emission Factor of Hot Water [kg CO_2/MMBtu]	= CO_2 emission factor [kg/MMBtu] ÷ (boiler efficiency [%] ● (1- distribution loss [%])) = 53.02 [kg CO_2/MMBtu] ÷ (0.80 ● 0.90) = 73.64 [kg CO_2/MMBtu]
CH_4 Emission Factor of Hot Water [kg CH_4/MMBtu]	= CH_4 emission factor [kg/MMBtu] ÷ (boiler efficiency [%] ● (1- distribution loss [%])) = 1.0×10^{-3} [kg CH_4/MMBtu] ÷ (0.80 ● 0.90) = 1.4×10^{-3} [kg CH_4/MMBtu]
N_2O Emission Factor of Hot Water [kg N_2O/MMBtu]	= N_2O emission factor [kg/MMBtu] ÷ (boiler efficiency [%] ● (1- distribution loss [%])) = 1.0×10^{-4} [kg N_2O/MMBtu] ÷ (0.80 ● 0.90) = 1.4×10^{-4} [kg N_2O/MMBtu]

Step 3: *Determine total annual emissions in MT CO_2e*

Equation B-7: Purchased Steam GHG Emissions

CO_2 Emissions [MT CO_2]	= Steam use [MMBtu] ● CO_2 emission factor [kg/MMBtu] ● 0.001 [MT/kg] = 1,000 [MMBtu] ● 98.19 [kg CO_2/MMBtu] ● 0.001 [MT/kg] = 98.19 [MT CO_2]

CH₄ Emissions [MT CH₄]	= Steam use [MMBtu] ● CH₄ emission factor [kg/MMBtu] ● 0.001 [MT/kg] = 1,000 [MMBtu] ● 1.85×10^{-3} [kg CH₄/MMBtu] ● 0.001 [MT/kg] = 1.85×10^{-3} [MT CH₄]
N₂O Emissions [MT N₂O]	= Steam use [MMBtu] ● N₂O emission factor [kg/MMBtu] ● 0.001 [MT/kg] = 1,000 [MMBtu] ● 1.85×10^{-4} [kg N₂O/MMBtu] ● 0.001 [MT/kg] = 1.85×10^{-4} [MT N₂O]
	Equation B-8: Purchased Hot Water GHG Emissions
CO₂ Emissions [MT CO₂]	= Hot water [MMBtu] ● CO₂ emission factor [kg/MMBtu] ● 0.001 [MT/kg] = 2,000 [MMBtu] ● 73.64 [kg CO₂e/MMBtu] ● 0.001 [MT/kg] = 147.28 [MT CO₂]
CH₄ Emissions [MT CH₄]	= Hot water ● CH₄ emission factor [kg/MMBtu] ● 0.001 [MT/kg] = 2,000 [MMBtu] ● 1.4×10^{-3} [kg CH₄/MMBtu] ● 0.001 [MT/kg] = 2.8×10^{-3} [MT CH₄]
N₂O Emissions [MT N₂O]	= Hot water ● N₂O emission factor [kg/MMBtu] ● 0.001 [MT/kg] = 2,000 [MMBtu] ● 1.4×10^{-4} [kg N₂O/MMBtu] ● 0.001 [MT/kg] = 2.8×10^{-4} [MT N₂O]
Equation B-9: Conversion to CO₂e and Determination of Total Purchased Steam and Hot Water Emissions
Steam CO₂ Emissions [MT CO₂e]	= MT CO₂ + (MT CH₄ ● CH₄ GWP) + (MT N₂O ● N₂O GWP) = 98.19 [MT CO₂] + (1.85×10^{-3} [MT CH₄] ● 25) + (1.85×10^{-4} [MT N₂O] ● 298) = **98.29 [MT CO₂e]**
Hot Water CO₂ Emissions [MT CO₂e]	= MT CO₂ + (MT CH₄ ● CH₄ GWP) + (MT N₂O ● N₂O GWP) = 147.28 [MT CO₂] + (2.8×10^{-3} [MT CH₄] ● 25) + (2.8×10^{-4} [MT N₂O] ● 310) = **147.43 [MT CO₂e]**

Note: Example has been provided for demonstration purposes only and has rounding imposed throughout each of the calculation steps above. Factors are for illustration. The most recent emission factors can be found in the Annual GHG Data Report workbook where their original sources will also be documented. As such results from this example may differ slightly from results generated using the Annual GHG Data Report workbook.**

B.2.2. Alternative Methodology (User Calculated)

The alternative method of calculating Scope 2 purchases of steam and hot water follows the same procedural steps as outlined above in the default methodology. However, in this instance, the agency is able to obtain information from the steam and hot water provider and use factors specific to the plant rather than the defaults. This methodology can be utilized if the actual boiler efficiency and distribution loss is provided by the supplier.

B.3. Purchased Chilled Water

Many agencies purchase chilled water for cooling purposes. Some agencies purchase chilled water generated by a plant or specific equipment owned and operated by another entity. As is the case with electricity and steam purchases, agencies in these circumstances may need to obtain information from their suppliers to estimate the emissions associated with these purchases. If this information is not available, agencies can use default factors to estimate the emissions associated with their purchased chilled water. Use the default methodology if agency chiller type is electric-driven, or when the chiller type is unknown.

B.3.1. Default Methodology (to be Calculated by Annual GHG Data Report Workbook)

Data Sources

Agencies can estimate emissions associated with purchased chilled water by using values for cooling demand, transmission loss adjustment, and coefficient of performance (COP) (Table B-5). Default factor COP values are provided in sources listed in Table D-1.

Table B-5: Purchased Chilled Water Default Data Sources

Data Element	Preferred Source
Cooling demand [MMBtu or ton-hours]	• Agency purchase data
COP	• Default value
Transmission loss adjustment factor	• Default value

Calculation Steps[117]

To calculate Scope 2 emissions from purchased chilled water purchases:

1. Estimate the cooling demand
2. Determine the supplier's COP
3. Calculate the cooling plant inputs from energy cooling demand
4. Determine the annual input of electrical energy from all facilities within an agency's operational control
5. Select the appropriate eGRID subregion output emission rate factors that apply to the chilled water used
6. Calculate total CO_2, CH_4, and N_2O emissions, and convert them to MT.

Step 1: Estimate the Cooling Demand

Agencies should refer to monthly cooling bills to estimate the yearly cooling demand of the relevant facility. If the supplied cooling is reported in ton-hours of cooling, convert it to MMBtu at the rate of 0.012 MMBtu per ton-hour. Determine whether the cooling demand includes or excludes off-site transmission and distribution losses.

Step 2: Determine the Supplier's COP

COP values vary depending on the type of chiller used by the supplier. Default cooling supplier COP values are provided in the sources in Appendix D and in the Annual GHG Data Report workbook, worksheet 3.11 Scope 2 Chilled Water. Use the default value for electric-driven chillers when chiller type is unknown.

Step 3: Calculate the Cooling Plant Inputs from Energy Cooling Demand

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[117] DOE, Office of Policy and International Affairs, 1605(b) Program, *Technical Guidelines, Voluntary Reporting of Greenhouse Gases*, January 2007 available at www.eia.gov/oiaf/1605/gdlins.html.

If they are not billed for their suppliers' transmission losses, agencies can estimate the amount of energy input into the cooling system to meet an entity's demand by multiplying the cooling demand and transmission loss[118] adjustment factor (default percentage of loss 10 percent)[119] then dividing by the COP of the cooling plant. The cooling plant energy input is represented in Equation B-10.

Equation B-10: Energy Input of Cooling Plant Calculation

Energy Input from the Cooling Plant =
    Agency cooling demand [MMBtu] ● transmission loss adjustment factor ÷ COP cooling plant

Step 4: Determine the annual input of electrical energy from all facilities within an agency's operational control

Agencies determine the energy input quantity from the cooling plant and convert it to MWh. Agencies then sum energy input from all relevant facilities.

Step 5: Select the appropriate eGRID subregion output emission rate factors that apply to the chilled water used

The agency should report purchased chilled water by eGRID subregion into the Annual GHG Data Report workbook. The Annual GHG Data Report workbook will utilize appropriate emission factors for CO_2, CH_4, and N_2O, listed in Appendix D. This default methodology assumes an electric driven chiller.

Step 6: Calculate total CO_2, CH_4, and N_2O emissions, and convert them to MT

The Annual GHG Data Report workbook will convert the CO_2, CH_4, and N_2O emissions into units of MT CO_2e by multiplying the total emissions of each gas (in MT) by the GWP value, included in Table D-1. The Annual GHG Data Report workbook will sum the CO_2e emissions of each of the three gases to obtain total GHG emissions.

Equation B-11: Conversion to CO_2e and Determination of Total Emissions

CO_2e Emissions [MT CO_2e] = MT CO_2 + (MT CH_4 ● CH_4 GWP) + (MT N_2O ● N_2O GWP)

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[118] During its transmission and distribution, chilled water will be absorbing energy from the environment, consequently raising its temperature. The transmission lines that transport chilled water are relatively short as chilled water cannot be transported over long distances. Due to the short distances, there is rarely a separate entity that owns and controls the transmission system. Therefore, this is regarded as part of Scope 2 as the transmission lines are considered to occur within a generation facility's operational control.

[119] The transmission loss factor approach and default are provided by the DOE, Office of Policy and International Affairs, 1605(b) Program, *Technical Guidelines, Voluntary Reporting of Greenhouse Gases (1605(b)) Program* (March 2006), p. 154–156. See www.eia.doe.gov/oiaf/1605/pdf/Appendix%20N.pdf. The transmission loss factor is meant to account for the thermal losses incurred while transmitting the steam, hot water, or chilled water from generation plant to end user facility.

Example B-3: Purchased Chilled Water

After going through utility bills, an agency located in eGRID subregion RFC West (see eGrid map in Figure D-1) determines that it has consumed 320,000 ton hours of cooling (from an absorption chiller) for the entire year.

Step 1: Estimate the Cooling Demand

The agency has consumed 320,000 ton hours of chilled water

Conversion from ton hours to MMBtu	$= 320,000 \text{ [ton hours]} \bullet 0.012 \text{ [MMBtu/ton hour]}$ $= 3,840 \text{ [MMBtu]}$

Step 2: Estimate the Supplier's COP

Default value for absorption chiller $= 0.8$

Step 3: Calculate the Cooling Plant Inputs from Energy Demand

Equation B-10: Energy Input of Cooling Plant Calculation

Energy Input from Cooling Plant	$=$ Agency cooling demand [MMBtu] $\bullet$ Transmission loss adjustment factor [%] $\div$ Cooling plant COP $= 3,840 \text{ [MMBtu]} \bullet (1/(1-0.10))/0.80)$ $= 3,840 \text{ [MMBtu]} \bullet 1.11/0.80$ $= 5,328 \text{ [MMBtu]}$

Step 4: Determine the annual input of electrical energy from all facilities within an agency's operational control

The agency converts the energy input from the cooling plant value from Equation B-10 to MWh

Convert to MWh	$=$ Electricity input [MMBtu] $\bullet$ conversion factor [MWh/MMBtu] $= 5,328 \text{ [MMBtu]} \bullet 1/3.413 \text{ [MWh/MMBtu]}$ $= 5,328 \text{ [MMBtu]} \div 3.413 \text{ [MWh]}$ $= 1,561.09 \text{ [MWh]}$

Step 5: Select the appropriate eGRID subregion output emission rate factors that apply to the chilled water

Use eGRID subregion RFC West emission factors for

- $CO_2 = 703.75$ [lb/MWh]
- $CH_4 = 8.33$ [lb/GWh] $= [8.33 \text{ [lb/GWh]} \bullet 0.001 \text{ [lb/MWh]} = 0.00833 \text{ [lb/MWh]}$
- $N_2O = 11.76$ [lb/GWh] $= [11.76 \text{ [lb/GWh]} \bullet 0.001 \text{ [lb/MWh]} = 0.01176 \text{ [lb/MWh]}$

Step 6: Calculate total CO_2, CH_4, and N_2O emissions, and convert them to MT

The agency multiplies the energy input in MWh by the emission factor and converts them to MT

CO_2 Emissions [MT CO_2]	$= 1561.09 \text{ [MWh]} \bullet 703.75 \text{ [lb } CO_2\text{/MWh]} \bullet 4.53592 \times 10^{-4} \text{ [MT/lb]}$ $= 498.32 \text{ [MT } CO_2\text{]}$

CH₄ Emissions [MT CH₄]	$= 1561.09\ \text{[MWh]} \bullet 0.00833\ \text{[lb CH}_4\text{/MWh]} \bullet 4.53592 \times 10^{-4}\ \text{[MT/lb]}$ $= 0.00590\ \text{[MT CH}_4\text{]}$
N₂O Emissions [MT N₂O]	$= 1561.09\ \text{[MWh]} \bullet 0.01176\ \text{[lb N}_2\text{O/MWh]} \bullet 4.53592 \times 10^{-4}\ \text{[MT/lb]}$ $= 0.00832\ \text{[MT N}_2\text{O]}$
Equation B-11: Conversion to CO₂e and Determination of Total Emissions	
CO₂ Emissions [MT CO₂e]	$= \text{MT CO}_2 + (\text{MT CH}_4 \bullet \text{CH}_4\ \text{GWP}) + (\text{MT N}_2\text{O} \bullet \text{N}_2\text{O GWP})$ $= 498.32\ \text{[MT CO}_2\text{]} +(\ 0.00590\ \text{[MT CH}_4\text{]} \bullet 25) + (0.00832\ \text{[MT N}_2\text{O]} \bullet 310)$ $= 498.32 + 0.12 + 2.58$ $= \textbf{501.02 [MT CO}_2\textbf{e]}$

****Note:** Example has been provided for demonstration purposes only and has rounding imposed throughout each of the calculation steps above. Factors are for illustration. The most recent emission factors can be found in the Annual GHG Data Report workbook where their original sources will also be documented. As such results from this example may differ slightly from results generated using the Annual GHG Data Report workbook.**

B.3.2. Alternative Calculation Methodology 1: Non-Electric Chiller, Unknown COP (User Calculated)

This alternative methodology for purchased chilled water should be used when the type of chiller is known to be either absorption or engine-driven and the COP for the chiller is not known. The methodology uses the same equations as the default method, except that it does not use eGRID subregion output emission rate factors (since electricity is not the chiller's energy source). Instead, emission factors for CO_2, CH_4, and N_2O are determined from sources in Table D-1 based on the chiller's energy source. NOTE: If an absorption chiller is powered by waste heat, which is highly likely, then emissions will have to be allocated based on the proportion of energy used for this purpose (see CHP methodology, below). This method uses default COP values from sources cited in Table D-1 for the type of non-electric chiller selected.

B.3.3. Alternative Calculation Methodology 2: Non-Electric Chiller, COP Known (User Calculated)

The second alternative methodology for purchased chilled water should be used when the COP for the chiller, and its emission factors, are known. It uses the same equations as the default method, but uses plant- and fuel-specific emission factors to reflect site-specific efficiencies and conditions instead of default emission factors in sources cited in Table D-1. This alternative methodology is the most accurate of the three, provided that the agency obtains specific, accurate information about a cooling plant's COP and emission factors.

B.4. Purchased Electricity, Steam, or Hot Water from a CHP Facility

Emissions from CHP facilities represent a special case for estimating Scope 2 emissions. Because CHP simultaneously produces electricity and heat (steam and hot water), attributing the total GHG emissions to each product stream would result in double counting and not provide proper credit for the inherent efficiency of cogeneration. Thus, when two or more parties receive the energy streams from CHP plants, GHG emissions are allocated separately for heat production and electricity production. Since output from CHP results in both heat and electricity, the "share" of

the total emissions is determined using a ratio based on the Btu content of heat and/or electricity relative to the CHP plant's total output.

Below are both the default and alternative approaches for calculating Scope 2 emissions for heat (steam or hot water) and power purchases from a CHP facility. It is recommended that agencies use alternative methodologies when possible given the possible overestimation of emissions with the default methods.

B.4.1. Default Methodology (to be Calculated by Annual GHG Data Report Workbook)

Data Sources

The default methodology requires only the quantity of electricity, steam, and/or hot water consumed from the local CHP (Table B-6). The use of these simplified methods will likely result in an overestimation of emissions.

Table B-6: CHP Default Data Sources

Data Element	Preferred Sources
Electricity consumption [MMBtu]	• Agency records or meter information
Steam and/or Hot Water consumption [MMBtu]	• Agency records or meter information

Because of the potential for overestimating Scope 2 emissions, the default methodology is not recommended if agencies possess sufficient data for use of the alternative methodologies. In the absence of alternative data, the default approaches are built on the assumption that an agency is purchasing electricity and heat from standard, less-efficient systems, rather than a CHP.

Default Methodology for Electricity Purchases

If purchased electricity is from a CHP facility, the default methodology for purchased electricity can be used to estimate Scope 2 emissions from this source (see Appendix B.1.1). This methodology assumes that an agency is purchasing electricity from the grid. Grid-average electricity may be produced less efficiently than electricity produced at a CHP facility, so this may result in an overestimation of Scope 2 emissions. This methodology should be used if data from the CHP facility are unavailable.

Default Methodology for Steam or Heat Purchases

If an agency purchases steam or district heating from a CHP facility, the methodology in the steam and hot water section can be used to estimate Scope 2 emissions from this source (see Appendix B.2.1). This methodology assumes that purchased steam or district heating is from a conventional boiler plant. Conventional boiler plants produce steam and heat less efficiently than CHP facilities, so this may result in an overestimation of Scope 2 emissions. This methodology should be used if the data from the CHP facility is unavailable.

B.4.2 Alternative Methodology (User Calculated)

Data Sources

The recommended alternative methodology for CHP (Alternative Calculation Methodology 1) requires only minimal utility purchase information and existing energy/emission datasets from eGRID to calculate plant-specific emissions. When a plant is not present in eGRID, alternative method 2 requires additional Federal facility and utility CHP provider coordination to obtain the same energy, emissions, and allocation data. Table B-7 shows data and sources for both methods.

Table B-7: CHP Alternative Data Sources

Data Element	Preferred Source
Alternative Calculation Methodology 1: CHP Facilities Present in eGRID	
CHP identity	• Federal facility energy manager
Electricity use [MMBtu]	• Agency records or meter information
Steam or hot water [MMBtu]	• Agency records or meter information
Emission factors	• eGRID plant data file
Plant energy input, CHP adjustment, and emissions	• eGRID plant data file
Alternative Calculation Methodology 2: CHP Facilities Not Present in eGRID	
Emissions based on fuel [MT]	• Fuel use data
Total electricity production from the CHP plant [MMBtu]	• Generation and meter readings
Net heat production from the CHP plant [MMBtu]	• Heat content values for steam at different temperature and pressure conditions
Emission factor	• Appendix D

Alternative Calculation Methodology 1: CHP Facilities Present in eGRID

To calculate emissions from heat and power purchases from a CHP facility that is present in eGRID:

1. Determine annual CHP-provided purchased electricity, steam, and/or hot water used at all facilities within agency's operational control
2. Identify and select the appropriate emission factors that apply to the CHP electricity purchased
3. Identify, calculate, and select the appropriate emission factors that apply to the steam purchased
4. Identify, calculate, and select the appropriate emission factors that apply to the hot water purchased
5. Calculate the total annual emissions in MT of CO_2, CH_4, and N_2O
6. Determine the total annual emissions in MT CO_2e.

Step 1: Determine annual CHP-provided purchased electricity, steam, and/or hot water use from all facilities within agency's operational control

Electricity, steam, and/or hot water use data should be included for all facilities that fit with the definition of operational control provided in Chapter 2 of the main Guidance document. This should align with the agency's annual energy consumption reporting to the FEMP. Agencies should use meter readings or utility bill for electricity use data and alternate methods for estimating electricity use when metered data are not available.

Step 2: Identify and select the appropriate emission factors that apply to the CHP electricity purchased

Agencies should use the eGRID CHP plant output emission rate factors corresponding to the year of their inventory activity data. As with standard grid provided electricity, agencies are not expected to retroactively update their inventories with new eGRID output emission rate factors once the inventory has been submitted to CEQ.

The agency should obtain CHP plant-specific data, which is available from the eGRID website, by downloading the most current version of "eGRID Plant, Boiler, and Generator Data Files." This will be an option once the "Plant and Aggregate Files" are downloaded. Find the identified CHP in the plant file using the state and county data elements to simplify the search. Once identified, the CHP specific emission factors are identified in the applicable eGRID data elements:

- Plant Annual CO_2 Output Emission Rate [lb CO_2/MWh] (PLCO2RTA)
- Plant Annual CH_4 Output Emission Rate [lb CH_4/GWh] (PLCH4RTA)
- Plant Annual N_2O Output Emission Rate [lb N_2O/GWh] (PLN2ORTA).

Step 3: Identify, calculate, and select the appropriate emission factors that apply to the steam purchased

Using the eGRID plant file and the identified CHP from purchased electricity, the steam emission factors for the specific CHP can be calculated from existing eGRID data elements. The requisite CHP specific eGRID data elements include:

- Plant Unadjusted Annual CO_2 Emissions [short tons] (UNCO2)
- Plant Unadjusted Annual CH_4 Emissions [lb] (UNCH4)
- Plant Unadjusted Annual N_2O Emissions [lb] (UNN2O)
- Plant Annual CO_2 Emissions [short tons] (PLCO2AN)
- Plant Annual CH_4 Emissions [lb] (PLCH4AN)
- Plant Annual N_2O Emissions [lb] (PLN2OAN)
- CHP Plant Useful Thermal Output (USETHRMO) [MMBtu].

Equation B-12 should be used to calculate the steam emission factor.

Equation B-12: eGRID CHP Plant Steam Emission Factor Calculation

eGRID CHP Steam Emission Factor [lb CO_2/MMBtu] =
   [(UNCO$_2$ – PLCO$_2$AN) ● STLC] ÷ [(USETHRMO ● SP) ● (1 – DL)]

Where:

UNCO$_2$	Plant Unadjusted Annual CO$_2$ Emissions [short tons CO$_2$]
PLCO$_2$AN	Plant Annual CO$_2$ Emissions [short tons CO$_2$]
STLC	Short-ton-to-lb conversion (2,000) [lb/short ton]
USETHRMO	CHP Plant Useful Thermal Output [MMBtu]
SP	Steam Production Efficiency (75%)
DL	Distribution Loss (10%)

Source: eGRID2010 Technical Support Document, EPA. See https://www.epa.gov/energy/egrid .

The CH$_4$ and N$_2$O emission factors are likewise derived by substituting UNCH$_4$ or UNN$_2$O for UNCO$_2$ and by substituting PLCH$_4$AN or PLN$_2$OAN for PLCO$_2$AN. However, STLC is omitted due to a change from reporting in short tons to lb.

Step 4: _Identify, calculate, and select the appropriate emission factors that apply to the hot water purchased_

As with steam (step 3), the hot water emission factors for the specific CHP can be calculated from existing eGRID data elements. The requisite CHP-specific eGRID data elements are the same as those listed under step 3.

Equation B-13 should be used to calculate the hot water emission factor.

Equation B-13: eGRID CHP Plant Hot Water Emission Factor Calculation

eGRID CHP Hot Water Emission Factor [lb CO$_2$/MMBtu] =
    [(UNCO$_2$ – PLCO$_2$AN) ● STLC] ÷ [USETHRMO ● (1 – DL)]

Where:

UNCO$_2$	Plant Unadjusted Annual CO$_2$ Emissions [short tons CO$_2$]
PLCO$_2$AN	Plant Annual CO$_2$ Emissions [short tons CO$_2$]
STLC	Short-ton-to-lb conversion (2,000) [lb/short ton]
USETHRMO	CHP Plant Useful Thermal Output [MMBtu]
DL	Distribution Loss [%], default value of 10%

Source: eGRID2010 Technical Support Document, EPA. See https://www.epa.gov/energy/egrid .

Similar to step 3, the CH$_4$ and N$_2$O emission factors are likewise derived by substituting UNCH$_4$ or UNN$_2$O for UNCO$_2$ and by substituting PLCH$_4$AN or PLN$_2$OAN for PLCO$_2$AN. However, STLC is omitted due to a change from reporting in short tons to lb.

Step 5: _Calculate the total annual emissions in MT of CO$_2$, CH$_4$, and N$_2$O_

To determine annual emissions, multiply annual electricity, steam, and/or hot water use (step 1) by the respective emission factors for CO$_2$, CH$_4$, and N$_2$O in lb per MWh (step 2) or MMBtu (step 3 and 4).

Equation B-14: Electricity Use GHG Emissions

CO$_2$ Emissions [MT CO$_2$] =
Electricity use [MWh] ● Emission factor [lb CO$_2$/MWh] ÷ 2,204.62 [lb/metric ton]
CH$_4$ Emissions [MT CH$_4$] =
Electricity use [MWh] ● Emission factor [lb CH$_4$/ GWh] ÷ 1,000 [MWh/GWh] ÷ 2,204.62 [lb/metric ton]
N$_2$O Emissions [MT N$_2$O] =
Electricity use [MWh] ● Emission factor [lb N$_2$O/ GWh] ÷ 1,000 [MWh/GWh]÷ 2,204.62 [lb/metric ton]

Equation B-15: Purchased Steam Use GHG Emissions

CO$_2$ Emissions [MT CO$_2$] =
Steam use [MMBtu] ● Emission factor [lb CO$_2$/MMBtu] ÷ 2,204.62 [lb/metric ton]
CH$_4$ Emissions [MT CH$_4$] =
Steam use [MMBtu] ● Emission factor [lb CH$_4$/MMBtu] ÷ 2,204.62 [lb/metric ton]
N$_2$O Emissions [MT N$_2$O] =
Steam use [MMBtu] ● Emission factor [lb N$_2$O/MMBtu] ÷ 2,204.62 [lb/metric ton]

Equation B-16: Purchased Hot Water Use GHG Emissions

CO$_2$ Emissions [MT CO$_2$] =
Hot water use [MMBtu] ● Emission factor [lb CO$_2$/MMBtu] ÷ 2,204.62 [lb/metric ton]
CH$_4$ Emissions [MT CH$_4$] =
Hot water use [MMBtu] ● Emission factor [lb CH$_4$/MMBtu] ÷ 2,204.62 [lb/metric ton]
N$_2$O Emissions [MT N$_2$O] =
Hot water use [MMBtu] ● Emission factor [lb N$_2$O/MMBtu] ÷ 2,204.62 [lb/metric ton]

Step 6: _Determine the total annual emissions in MT CO$_2$e_

The final step is to convert CH$_4$ and N$_2$O into units of CO$_2$e, and multiply total emissions of each gas in MT by the GWP value provided in Appendix D. Then, sum the CO$_2$e emissions of each of the three gases to obtain total GHG emissions.

Equation B-17: Conversion to CO$_2$e and Determination of Total Emissions

CO$_2$e Emissions [MT CO$_2$e] = MT CO$_2$ + (MT CH$_4$ ● CH$_4$ GWP) + (MT N$_2$O ● N$_2$O GWP)

Example B-4: Heat and Power Purchases from a Combined Heat and Power Facility

As a notional example, a U.S. Navy facility in New York State directly purchases electric, steam, and hot water from a CHP facility named the Brooklyn Navy Yard Cogeneration Plant. This plant is owned and operated by Edison Mission Energy. For the purposes of this example, the plant is outside of the

U.S. Navy's operational control; the emissions associated with the electricity, steam, and hot water used would be calculated and reported as Scope 2 emissions.

Step 1: Access U.S. Navy Facility Report Energy Use

U.S. Navy Purchases from NTC/MCRD Energy CHP:
- Electricity   750 [MWh]
- Steam   300 [MMBtu]
- Hot Water   150 [MMBtu]

Step 2: Locate NTC/MCRD Energy CHP Plant, its Electricity Emission Factors, and its Emission Values in the eGRID Plant File

- CO_2 Emission Factor [lb CO_2/MWh] = PLCO2RTA = 758.88 [lb CO_2/MWh]
- CH_4 Emission Factor [lb CH_4/GWh] = PLCH4RTA = 14.66 [lb CH_4/GWh]
- N_2O Emission Factor [lb N_2O/GWh] = PLN2ORTA = 1.47 [lb N_2O/GWh]
- CHP Plant Useful Thermal Output [MMBtu] = USETHRMO = 4,733,504.80 [MMBtu]
- Plant Unadjusted Annual CO_2 Emissions [short tons CO_2] = UNCO2 = 1,128,319.78 [short tons CO_2]
- Plant Annual CO_2 Emissions [short tons CO_2] = PLCO2AN = 733,634.46 [short tons CO_2]
- Plant Unadjusted Annual CH_4 Emissions [lb CH_4] = UNCH4 = 43,581.71 [lb CH_4]
- Plant Annual CH_4 Emissions [lb CH_4] = PLCH4AN = 28,336.86 [lb CH_4]
- Plant Unadjusted N_2O Annual N_2O Emissions [lb N_2O] = UNN2O = 4,358.17 [lb N_2O]
- Plant Annual N_2O Emissions [lb N_2O] = PLN2OAN = 2,833.69 [lb N_2O]

Step 3: Calculate CHP Plant Steam Emission Factors from eGRID

CO_2 Emission Factor [lb CO_2/MMBtu]	= [(UNCO2 – PLCO2AN) ● STLC] ÷ [(USETHRMO ● SP) ● (1 – DL)] = [(1,128,319.78 [short tons CO_2] – 733,634.46 [short tons CO_2]) ● 2000[lb/short ton]] ÷ [(4,733,504.80 [MMBtu] ● 0.75) ● (1 – 0.10)] = [394,685.32 [short tons CO_2] ● 2,000 [lb/short ton]] ÷ [3,550,128.60 [MMBtu] ● 0.90] = 789,370,640.00 [lb CO_2] ÷ 3,195,115.74 [MMBtu] = 247.06 [lb CO_2/MMBtu]
CH_4 Emission Factor [lb CH_4/MMBtu]	= [(UNCH4 – PLCH4AN)] ÷ [(USETHRMO ● SP) ● (1 – DL)] = [(43,581.71 [lb CH_4] – 28,336.86 [lb CH_4])] ÷ [(4,733,504.80 [MMBtu] ● 0.75) ● (1 – 0.10)] = 15,244.85 [lb CH_4] ÷ [3,550,128.60 [MMBtu]● 0.90] = 15,244.85 [lb CH_4] ÷ 3,195,115.74 [MMBtu] = 0.004771 [lb CH_4/MMBtu]
N_2O Emission Factor [lb N_2O/MMBtu]	= [(UNN2O – PLN2OAN)] ÷ [(USETHRMO ● SP) ● (1 – DL)] = [(4,358.17 [lb N_2O] – 2,833.69 [lb N_2O])] ÷ [(4,733,504.80 [MMBtu]● 0.75) ● (1 – 0.10)] = 1,524.48 [lb N_2O] ÷ [3,550,128.60 [MMBtu] ● 0.90] = 1,524.48 [lb N_2O] ÷ 3,195,115.74 [MMBtu] = 0.000477 [lb N_2O/MMBtu]

Step 4: Locate/calculate CHP plant hot water emission factors using eGRID information

CO_2 Emission Factor [lb CO_2/MMBtu]	= [(UNCO2 – PLCO2AN) ● STLC] ÷ [USETHRMO ● (1 – DL)] = [(1,128,319.78 [short tons CO_2] – 733,634.46 [short tons CO_2]) ● 2000[lb/short ton]] ÷ [4,733,504.80 [MMBtu] ● (1 – 0.10)] = [394,685.32 [short tons CO_2] ● 2,000 [lb/short ton]] ÷ [4,733,504.80 [MMBtu]● 0.90] = 789,370,640 [lb CO_2] ÷ 4,260,154.32 [MMBtu] = 185.29 [lb CO_2/MMBtu]
CH_4 Emission Factor [lb CH_4/MMBtu]	= [(UNCH4 – PLCH4AN)] ÷ [USETHRMO ● (1 – DL)] = [(43,581.71 [lb CH_4] – 28,336.86 [lb CH_4)] ÷ [4,733,504.80 [MMBtu] ● (1 – 0.10)] = 15,244.85 [lb CH_4] ÷ [4,733,504.80 [MMBtu]● 0.90] = 15,244.85 [lb CH_4] ÷ 4,260,154.32 [MMBtu] = 0.00358 [lb CH_4/MMBtu]
N_2O Emission Factor [lb N_2O/MMBtu]	= [(UNN2O – PLN2OAN)] ÷ [USETHRMO ● (1-DL)] = [(4,358.17 [lb N_2O] – 12,833.69 [lb N_2O)] ÷ [4,733,504.80 [MMBtu] ● (1 – 0.10)] = 1,524.48 [lb N_2O] ÷ [4,733,504.80 [MMBtu] ● 0.90] = 1,524.48 [lb N_2O] ÷ 4,260,154.32 [MMBtu] = 0.000358 [lb N_2O/MMBtu]

Step 5: *Calculate annual emissions in MT of GHGs by type of energy*

Equation B-14: Electricity Use GHG Emissions	
Electric CO_2 Emissions [MT CO_2]	= Electricity use [MWh] ● CO_2 emission factor [lb/MWh] ÷ 2,204.62 [lb/MT] = 750 [MWh] ● 758.88 [lb CO_2/MWh] ÷ 2,204.62 [lb/MT] = 51.63 [MT CO_2]
Electric CH_4 Emissions [MT CH_4]	= Electricity Use [MWh] ● CH_4 emission factor [lb/ GWh] ÷ 1,000 [MWh/GWh] ÷ 2,204.62 [lb/MT] = 750 [MWh] ● 14.66 [lb CH_4/ GWh] ÷ 1,000 [MWh/GWh] ÷ 2,204.62 [lb/MT] = 0.0050 [MT CH_4]
Electric N_2O Emissions [MT N_2O]	= Electricity use [MWh] ● N_2O emission factor [lb/ GWh] ÷ 1,000 [MWh/GWh]÷ 2,204.62 [lb/MT] = 750 [MWh] ● 1.47 [lb N_2O/ GWh] ÷ 1,000 [MWh/GWh]÷ 2,204.62 [lb/MT] = 0.00050 [MT N_2O]
Equation B-15: Purchased Steam GHG Emissions	
Steam CO_2 Emissions [MT CO_2]	= Steam use [MMBtu] ● CO_2 emission factor [lb/MMBtu] ÷ 2,204.62 [lb/MT] = 300 [MMBtu] ● 247.06 [lb CO_2/MMBtu] ÷ 2,204.62 [MT] = 33.62 [MT CO_2]
Steam CH_4 Emissions [MT CH_4]	= Steam use [MMBtu] ● CH_4 emission factor [lb/MMBtu] ÷ 2,204.62 [lb/MT] = 300 [MMBtu] ● 0.004771 [lb CH_4/MMBtu] ÷ 2,204.62 [lb/MT] = 0.00065 [MT CH_4]
Steam N_2O Emissions [MT N_2O]	= Steam use [MMBtu] ● N_2O emission factor [lb/MMBtu] ÷ 2,204.62 [lb/MT] = 300 [MMBtu] ● 0.000477 [lb N_2O/MMBtu] ÷ 2,204.62 [lb/MT] = 0.000065 [MT N_2O]
Equation B-16: Purchased Hot Water GHG Emissions	
Hot Water CO_2	= Hot water use [MMBtu] ● CO_2 emission factor [lb/MMBtu] ÷ 2,204.62 [lb/MT] = 150 [MMBtu] ● 185.29 (lb CO_2/MMBtu) ÷ 2,204.62 [lb/MT]

Emissions [MT CO$_2$]	= 12.61 [MT CO$_2$]
Hot Water CH$_4$ Emissions [MT CH$_4$]	= Hot water use [MMBtu] ● CH$_4$ emission factor [lb/MMBtu] ÷ 2,204.62 [lb/MT] = 150 [MMBtu] ● 0.00358 [lb CH$_4$/MMBtu] ÷ 2,204.62 [lb/MT] = 0.00024 [MT CH$_4$]
Hot Water N$_2$O Emissions [MT N$_2$O]	= Hot water use [MMBtu] ● N$_2$O emission factor [lb/MMBtu] ÷ 2,204.62 [lb/MT] = 150 [MMBtu] ● 0.000358 [lb N$_2$O/MMBtu] ÷ 2,204.62 [lb/MT] = 0.000024 [MT N$_2$O]

Step 6: Determine Annual Emissions in MT CO$_2$e

Equation B-17: Conversion to CO$_2$e and Determination of Total Emissions	
Electricity CO$_2$ Emissions [MT CO$_2$e]	= MT CO$_2$ + (MT CH$_4$ ● CH$_4$ GWP) + (MT N$_2$O ● N$_2$O GWP) = 51.63 [MT CO$_2$] + (0.0050 [MT CH$_4$] ● 25) + (0.00050 [MT N$_2$O] ● 310) = 51.63 [MT CO$_2$] + 0.105 [MT CO$_2$e] + 0.155 [MT CO$_2$e] = 51.89 [MT CO$_2$e]
Steam CO$_2$ Emissions [MT CO$_2$e]	= MT CO$_2$ + (MT CH$_4$ ● CH$_4$ GWP) + (MT N$_2$O ● N$_2$O GWP) = 33.62 [MT CO$_2$] + (0.00065 [MT CH$_4$] ● 25) + (0.000065 [MT N$_2$O] ● 310) = 33.62 [MT CO$_2$] + 0.0137 [MT CO$_2$e] + 0.0202 [MT CO$_2$e] = 33.65 [MT CO$_2$e]
Hot Water CO$_2$ Emissions [MT CO$_2$e]	= MT CO$_2$ + (MT CH$_4$ ● CH$_4$ GWP) + (MT N$_2$O ● N$_2$O GWP) = 12.61 [MT CO$_2$] + (0.00024 [MT CH$_4$] ● 25) + (0.000024 [MT N$_2$O] ● 310) = 12.61 [MT CO$_2$] + 0.00504 [MT CO$_2$e] + 0.00744 [MT CO$_2$e] = 12.62 [MT CO$_2$e]
Total Emissions [MT CO$_2$e]	= Electricity Emissions [MT CO$_2$e] + Steam Emissions [MT CO$_2$e] + Hot Water Emissions [MT CO$_2$e] = 51.89 [MT CO$_2$e] + 33.65 [MT CO$_2$e] + 12.62 [MT CO$_2$e] = 98.16 [MT CO$_2$e]
Note: Example has been provided for demonstration purposes only and has rounding imposed throughout each of the calculation steps above. Factors are for illustration. The most recent emission factors can be found in the Annual GHG Data Report workbook where their original sources will also be documented. As such results from this example may differ slightly from results generated using the Annual GHG Data Report workbook.	

Alternative Calculation Methodology 2: CHP Facilities Not Present in eGRID[120]

The process for estimating Scope 2 emissions from the heat and power product streams produced at a CHP facility not present in eGRID involves the following four steps:

1. Obtain total emissions, power, and heat generation information from CHP facility
2. Determine emissions attributable to net heat production[121] and electricity production

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[120] EPA Center for Corporate Climate Leadership, Indirect Emissions from Purchases/Sales of Electricity and Steam, June 2008.

[121] Net heat production refers to the useful heat that is produced in CHP, minus whatever heat returns to the boiler as steam condensate, as shown in the equation below.

a. Determine the Total Scope 1 Emissions from the CHP System
b. Determine the Total Steam and Electricity Output for the CHP System
c. Determine the Efficiencies of Steam and Electricity Production
d. Determine the Fraction of Total Emissions Allocated to Steam and Electricity Production
3. Calculate emissions attributable to the agency's portion of heat and electricity consumed
4. Convert to units of CO_2e and determine total emissions.

Step 1: Obtain total emissions, power, and heat generation information from the CHP facility

Obtain the following information from the CHP plant owner or operator to estimate Scope 2 GHG emissions:
- Total emissions of CO_2, CH_4, and N_2O from the CHP facility, based on fuel input information
- Total electricity production from the CHP plant, based on generation meter readings
- Net heat production from the CHP plant.

Equation B-18: Net Heat Production Calculation

Net Heat Production [MMBtu]=
Heat of steam export [MMBtu] – heat of return condensate [MMBtu]

Step 2: Determine emissions attributable to net heat production and electricity production

The most consistent approach for allocating GHG emissions in CHP plants is the efficiency method, which allocates emissions of CHP plants between electric and thermal outputs on the basis of the energy input used to produce the separate steam and electricity products. To use this method, obtain the following information:

- The total emissions from the CHP plant
- The total steam (or heat) and electricity production
- The steam (or heat) and electricity efficiency of the facility.

Use the following steps to determine the share of emissions attributable to steam (or heat) and electricity production:

Step 2a: Determine the Total Scope 1 Emissions from the CHP System

Calculate total Scope 1 GHG emissions using the methods described in Appendix A.

Step 2b: Determine the Total Steam and Electricity Output for the CHP System

To determine the total energy output of the CHP plant attributable to steam production, use published tables that provide heat content values for steam at different temperature and pressure conditions (for example, the Industrial Formulation 1997 for the Thermodynamic Properties of Water and Steam published by the International Association for the Properties of Water and Steam). Energy content values multiplied by the quantity of steam produced at the temperature and pressure of the CHP plant yield energy output values in units of MMBtu.

Alternatively, determine net heat (or steam) production (in MMBtu) by subtracting the heat of return condensate [MMBtu] from the heat of steam export (MMBtu). To convert total electricity production from MWh to MMBtu, multiply by 3.412 MMBtu/MWh.

Step 2c: *Determine the Efficiencies of Steam and Electricity Production*

Identify steam (or heat) and electricity production efficiencies. If actual efficiencies of the CHP plant are not known, use a default value of 80 percent for steam and a default value of 35 percent for electricity. The use of default efficiency values may, in some cases, violate the energy balance constraints of some CHP systems. However, total emissions will still be allocated between the energy outputs. If the constraints are not satisfied, the efficiencies of the steam and electricity can be modified until constraints are met. Facility energy managers should be aware of the need for expert judgment when applying this approach to a specific CHP facility. It is assumed that balancing the energy allocation and thermodynamic balance is within the standard training and skill set for a Federal facility energy manager or specialist. As such, additional instruction is not provided here.

Step 2d: *Determine the Fraction of Total Emissions Allocated to Steam and Electricity Production*

Allocate the emissions from the CHP plant to the steam (or heat) and electricity product streams by using Equation B-19.

Equation B-19: Allocation of CHP Emissions to Steam and Electricity

Step 1:
$$E_H = \frac{H \cdot e_P \cdot E_T}{P \cdot e_H + H \cdot e_P}$$

Where:

E_H = Emissions allocated to steam production

H = Total steam (or heat) output (MMBtu)

e_H = Efficiency of steam (or heat) production

P = Total electricity output (MMBtu)

e_P = Efficiency of electricity generation

E_T = Total direct emissions of the CHP system

EP = Emissions allocated to electricity production

Step 2: $EP = E_T - E_H$

Where:

E_H = Emissions allocated to steam production

E_T = Total direct emissions of the CHP system

EP = Emissions allocated to electricity production

Step 3: Calculate emissions attributable to the agency's portion of heat and electricity consumed

After determining total emissions attributable to heat and electricity production, calculate the agency's portion of heat or electricity consumed, and thus the agency's indirect GHG emissions associated with heat or electricity use. First, obtain electricity and heat consumption information, then use Equation B-20 to calculate the agency's share of emissions, as appropriate.

**Equation B-20: Calculation of Indirect Emissions Attributable
to Electricity Consumption**

Indirect Emissions Attributable to Electricity Consumption [MT] =

Total CHP emissions attributable to electricity production [MT] ● (agency electricity consumption [kWh] ÷ total CHP electricity production [kWh])

**Equation B-21: Calculation of Indirect Emissions Attributable
to Heat (or Steam) Consumption**

Indirect Emissions Attributable to Heat Consumption [MT] =

Total CHP emissions attributable to heat production [MT] ● (agency heat consumption [MMBtu] ÷ CHP net heat production [MMBtu]**)**

Step 4: Convert to units of CO₂e and determine total emissions

Finally, use the GWP values provided in Appendix D to convert CH_4 and N_2O emissions to units of CO_2e. Sum the emissions of all three gases to determine an agency's total emissions from CHP.

Equation B-22: Combined Heat and Power MT CO_2e Emissions

$$\textbf{CO}_2\textbf{e Emissions [MT CO}_2\textbf{e]} = CO_2 \text{ [MT]} + (\text{MT } CH_4 \bullet CH_4 \text{ GWP}) + (\text{MT } N_2O \bullet N_2O \text{ GWP})$$

B.5. Purchased Steam from a MSW WTE Facility

Description

GHG emissions from Municipal Solid Waste (MSW) Waste to Energy (WTE) facilities represent a special case for estimating Scope 2 emissions. WTE plants use MSW as a primary fuel to generate steam through this dual-use energy recovery and waste management application. MSW fuel is comprised of both renewable biomass (such as wood, paper, and food) and nonrenewable materials (such as plastics and tires). All Scope 2 emissions associated are reported through the Annual GHG Data Report workbook, including Scope 2 emissions associated with the FY 2008 base year and biomass combustion. These are known as biogenic emissions. Though biogenic emissions are not subject to agency reduction targets at this time, they are identified and reported within agency inventories under Scope 2.[122]

WTE facilities are sometimes built in proximity to Federal facilities to take mutual advantage of long-term steam purchase agreements and to provide a significant portion of the Federal facilities' thermal energy requirements. Although MSW-fueled CHPs are accounted for in the EPA's eGRID, WTE plants producing only thermal energy are not subject to or participants in the program. This section provides both a site-specific and a simplified approach for calculating the GHG emissions associated with the steam purchases from MSW-fueled WTE plants. Below are the default and alternative approaches for calculating Scope 2 GHG and biogenic CO_2 emissions from MSW-fueled WTE steam purchases, which are incorporated in the default calculations in Tab 2.2 Renewable Energy Data of the FEMP GHG Data Report Workbook. Note that the emissions from WTE CHP plants are primarily a function of the amount of fuel combusted. The efficiency and proportions of energy converted to steam and to electricity are only relevant to energy reporting. In this default methodology the efficiency assumptions are primarily applied to estimate the amount of biomass and fossil fuel embedded in the MSW the plant combusts.

B.5.1. Default Methodology (to be Calculated by Annual GHG Data Report Workbook)

Data Sources

Scope 2 GHG emissions from purchased steam generated by a MSW WTE plant can be calculated from the volume of delivered steam (which is metered) and the default or plant-specific emission

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[122] Due to ongoing analysis, efforts to collect and synthesize data, and the development of accounting approaches that will appropriately reflect the true atmospheric impact of biogenic emissions, reporting includes biogenic GHG emissions, but agencies need not include these emissions in reduction targets at this time. Part or all of the carbon in these fuels is derived from material that was fixed by biological sources on a relatively short timescale. Depending on the full emissions impact of biomass production and use, these emissions may or may not represent a net change in atmospheric CO_2. This contrasts with carbon from fossil fuels, which was removed from the atmosphere millions of years ago.

factors. Table B-8 shows the recommended and alternate activity data and emission factor sources for calculating Scope 2 emissions from MSW-fueled steam purchases.

Table B-8: Steam Purchases from MSW WTE Plants Default Data Sources

Data Element	Preferred Source	Alternate Source
Steam or hot water consumption [MMBtu]	• Agency energy purchase records	• Utility purchase records • Maintenance records
Emission factors	• eGRID Derived Default	• MSW WTE Plant-Provided

Calculation Steps

If site-specific MSW WTE plant emission factors are not available, agencies may use the default methodology, which uses default emission factors derived from sources cited in Appendix D, which are based on similar MSW WTE plants captured via eGRID (plants that generate electricity, not steam). The steps that the Annual GHG Data Report workbook will use to calculate Scope 2 emissions from MSW-fueled, WTE-delivered steam are identical to those used for the alternative method, except for Step 2.

1. Determine annual delivered steam purchased for use by all facilities within agency's operational control
2. Utilize the most recent eGRID derived emission factors that apply to the delivered steam
3. Determine the total annual emissions in MT for each GHG
4. Determine total annual emissions in MT CO_2e.

Table B-9: Indirect Emission Factor Defaults from MSW WTE Purchased Steam Use

Emission Factor	Default Value
CO_2 emissions	350.5 [lb CO_2/MMBtu]
CH_4 emissions	0.1292 [lb CH_4/MMBtu]
N_2O emissions	0.0172 [lb N_2O/MMBtu]
Biogenic CO_2 emissions	385.6 [lb CO_2/MMBtu]

The default emission factors in this table are illustrative only. They were derived from a sample of similar MSW-fueled WTE plants found in the eGRID2007 Version 1.1 Plant File (Year 2005 Data). These plants were selected because their primary fuel was MSW and they produce only electricity (i.e., no CHPs with apportioned data inputs). Using a similar approach to that outlined in Appendix B.4 "Alternative Calculation Methodology 1: CHP Facilities Present in eGRID" approach, these plants' delivered steam emission factors were calculated using the following extracted eGRID data elements:

- Plant annual heat input [MMBtu] (PLHTIAN)
- Plant unadjusted annual CO_2 emissions [short tons] (UNCO2)
- Plant unadjusted annual CH_4 emissions [lb] (UNCH4)
- Plant unadjusted annual N_2O emissions [lb] (UNN2O)

- Plant total nonrenewables generation percent (resource mix) [%] (PLTNPR)
- Plant total renewables generation percent (resource mix) [%] (PLTRPR).

Each plant's annual heat input [MMBtu] was converted to delivered steam using standard assumptions for:

- External boiler efficiency (80 percent)[123]
- Steam conversion efficiency (75 percent)[124]
- Distribution loss (10 percent).[125]

Equation B-23 shows the calculation behind the Annual GHG Data Report workbook in terms of determining delivered steam [MMBtu].

Equation B-23: eGRID MSW WTE Delivered Steam

eGRID MSW WTE Delivered Steam [MMBtu] = DS
  $DS = PLHTIAN \bullet BE \bullet SP \bullet (1 - DL)$

Where:

PLHTIAN	=	Plant annual heat input [MMBtu]
BE	=	Boiler efficiency (80%)
SP	=	Steam production efficiency (75%)
DL	=	Distribution loss (10%)
DS	=	Delivered steam [MMBtu]

The eGRID plant unadjusted annual CO_2 emissions [short tons], plant unadjusted annual CH_4 emissions [lb] (UNCH4), and plant unadjusted annual N_2O emissions [lb] (UNN2O) quantities were used as the numerator and the delivered steam [MMBtu] as the denominators to develop plant specific emission factors for CO_2, CH_4, and N_2O, as shown in Equation B-24.

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[123] DOE, Industrial Technology Programs, Energy Use and Loss Footprints, Assumption and Definitions. See http://energy.gov/sites/prod/files/2014/02/f7/AMO_footprints_definitions_and_assumptions_2014_update.pdf.

[124] eGRID Technical Support Document, EPA. See https://www.epa.gov/energy/egrid.

[125] DOE, Office of Policy and International Affairs, 1605(b) Program, *Technical Guidelines, Voluntary Reporting of Greenhouse Gases (1605(b)) Program* (March 2006) p. 154–156. See www.eia.doe.gov/oiaf/1605/pdf/Appendix%20N.pdf.

Equation B-24: eGRID MSW WTE Delivered Steam

eGRID MSW WTE Delivered Steam Emission Factor [lb CO_2/MMBtu] =
$(UNCO_2 \bullet STLC) \div DS$

Where:

$UNCO_2$ = Plant unadjusted annual CO_2 emissions [short tons CO_2]

STLC = Short-ton-to-lb conversion (2,000) [lb/short ton]

DS = Delivered steam [MMBtu]

The Annual GHG Data Report workbook will calculate emission factors for CH_4 and N_2O using the same equation but without the use of lb/ton conversion. However, as eGRID adjusts out all biogenic CO_2 from its emission factors, the biogenic CO_2 emission factor is generated by back calculating each respective plant's total CO_2 emissions and then breaking out the biogenic CO_2 emissions portion using Equation B-25.

Equation B-25: eGRID MSW WTE Biogenic CO_2 Factor

eGRID MSW WTE Delivered Steam Emission Factor [lb CO_2 (Biogenic)/MMBtu] =
$[(UNCO_2 \bullet STLC) \bullet (PLTRPR/PLTNPR)] \div DS$

Where:

$UNCO_2$ = Plant unadjusted annual CO_2 emissions [short tons CO_2]

STLC = Short-ton-to-lb conversion (2,000) [lb/short ton]

PLTNPR = Plant total nonrenewables generation percent (resource mix) [%]

PLTRPR = Plant total renewables generation percent (resource mix) [%]

DS = Delivered steam [MMBtu]

These emission factors were calculated for all 49 of the eGRID MSW WTE plants. The median plant value for anthropogenic CO_2 was identified, and the derived values used as the default emission factors.

B.5.2. Alternative Methodology (User Calculated)

The alternative methodology for MSW WTE steam purchases is shown below.

Calculation Steps

To calculate Scope 2 emissions from MSW-fueled, WTE-purchased steam, do the following:

1. Determine annual delivered steam purchased for use
2. Obtain the provider plant's most recent emission factors that apply to the delivered steam
3. Determine the total annual emissions in MT for each GHG
4. Determine total annual Scope 2 emissions in MT CO_2e.

Step 1: Determine annual delivered steam purchased for use

Purchased steam and hot water use data should be included for all facilities that fit with the definition of operational control provided in Chapter 2 of the main Guidance document. This should align with the agency's annual energy consumption report to the DOE and maintain consistency with the data used for calculations as outlined in both Appendix B.2 and B.3.

Step 2: Obtain the provider plant's most recent emission factors that apply to the delivered steam

From preliminary Federal GHG inventory experience, local MSW-fueled, WTE thermal plant operators already calculate and maintain records on total fuel input, GHG emission factors, useful heat production, and delivered steam and hot water emission factors. When obtaining these factors, it is imperative that the agency's representative specifically request non-offset adjusted factors as many providers may already have incorporated offsets into their final consumer emission factors. If they have not calculated these factors, it is possible to work with the provider and use the "Alternative Calculation Methodology for CHP Facilities Not Present in eGRID" detailed in Appendix B.3 by specifying a 100-percent allocation to steam production.

If obtaining (or developing) site-specific emission factors is not possible, use the default emission factors outlined in the default methodology (see Appendix B.5.1).

Step 3: Determine total annual emissions in MT for each GHG

To determine annual emissions, multiply annual delivered steam in MMBtu (Step 1) by the emission factors for CO_2, CH_4, and N_2O in lb per MMBtu of delivered steam (Step 2). Divide this product by 2,204.62 to convert them to MT.

Equation B-26: Purchased Steam Use GHG Emissions

CO_2 Emissions [MT] =
Steam use [MMBtu] ● CO_2 emission factor [lb/MMBtu] ÷ 2,204.62 [lb/MT]
CH_4 Emissions [MT] =
Steam use [MMBtu] ● CH_4 emission factor [lb/MMBtu] ÷ 2,204.62 [lb/MT]
N_2O Emissions [MT] =
Steam use [MMBtu] ● N_2O emission factor [lb/MMBtu] ÷ 2,204.62 [lb/MT]
Biogenic CO_2 Emissions [MT] =
Steam use [MMBtu] ● Biogenic CO_2 emission factor [lb/MMBtu] ÷ 2,204.62 [lb/MT]

Step 4: Determine total annual Scope 2 emissions in MT CO_2e

The final step is to convert the anthropogenic CO_2, CH_4, and N_2O into units of CO_2e by multiplying the total emissions of each gas in MT by the GWP value provided in Appendix D. Then, agencies should sum the CO_2e emissions of each of the three gases to obtain total Scope 2 GHG emissions.

Equation B-27: Conversion to CO_2e and Determination of Total Scope 2 Emissions

CO_2e Emissions [MT CO_2e] =

MT CO_2 + (MT CH_4 ● CH_4 GWP) + (MT N_2O ● N_2O GWP)

Biogenic CO_2 emissions resulting from MSW WTE-purchased steam should be clearly identified and included in Scope 2 biogenic emissions subtotals. Biogenic CO_2 emissions should always be clearly identified and reported separately from anthropogenic emissions in the appropriate scope.

Example B-5: Steam Purchases from MSW WTE Plant

A notional National Aeronautics and Space Administration (NASA) facility in Hampton, VA, purchases steam from a local MSW-fueled WTE plant close to its facility to help meet its thermal energy needs.

Step 1: Determine annual delivered steam purchased

The NASA Center's Energy Manager maintains records and bills paid for the purchased steam that are used to generate the facility energy report. For this fiscal year, the total purchased steam delivered and used at the Center is 1,500 MMBtu.

Step 2: Obtain the provider's most recent emission factors

After a request is submitted to the MSW WTE steam plant's account manager, the NASA Center is provided with the following emission factors.

Site-Specific MSW WTE Purchased Steam Emission Factors
- CO_2 Emission Factor   320.5 [lb CO_2/MMBtu]
- CH_4 Emission Factor   0.1475 [lb CH_4/MMBtu]
- N_2O Emission Factor   0.0165 [lb N_2O/MMBtu]
- Biogenic CO_2 Emission Factor   390.5 [lb CO_2/MMBtu]

Step 3: Determine total annual emissions in MT for each GHG

Equation B-26: Purchased Steam Use GHG Emissions

➤ *Reported as Scope 2:*

Purchased Steam CO_2 Emissions [MT CO_2]	= 1,500 [MMBtu] ● 320.5 [lb CO_2/MMBtu] ÷ 2,204.62 [lb/MT] = 218.06 [MT CO_2]
Purchased Steam CH_4 Emissions [MT CH_4]	= 1,500 [MMBtu] ● 0.1475 [lb CH_4/MMBtu] ÷ 2,204.62 [lb/MT] = 0.1004 [MT CH_4]
Purchased Steam N_2O Emissions [MT N_2O]	= 1,500 [MMBtu] ● 0.0165 [lb N_2O/MMBtu] ÷ 2,204.62 [lb/MT] = 0.01123 [MT N_2O]

➤ *Reported as biogenic in Scope 2:*

Purchased Steam Biogenic CO_2 Emissions [MT CO_2]	= 1,500 [MMBtu] ● 390.5 [lb CO_2/MMBtu] ÷ 2,204.62 [lb/MT] = 265.7 [MT Biogenic CO_2]

Step 4: Determine total annual Scope 2 emissions in MT CO_2e	

Equation B-27: Conversion to CO_2e and Determination of Total Scope 2 Emissions

Steam CO_2 Emissions [MT CO_2e]
$$\text{Steam } CO_2 \text{ Emissions} = \text{MT } CO_2 + (\text{MT } CH_4 \bullet CH_4 \text{ GWP}) + (\text{MT } N_2O \bullet N_2O \text{ GWP})$$
$$= 218.06 \text{ [MT } CO_2] + (0.1004 \text{ [MT } CH_4] \bullet 25) + (0.01123 \text{ [MT } N_2O] \bullet 310)$$
$$= 218.06 \text{ [MT } CO_2] + 2.108 \text{ [MT } CO_2e] + 3.481 \text{ [MT } CO_2e]$$
$$= \mathbf{223.65 \text{ [MT } CO_2e]}$$

Note: Example has been provided for demonstration purposes only and has rounding imposed throughout each of the calculation steps above. Factors are for illustration. The most recent emission factors can be found in the Annual GHG Data Report workbook where their original sources will also be documented. As such results from this example may differ slightly from results generated using the Annual GHG Data Report workbook.**

B.6. Quantifying Scope 2 Emissions from Renewable Energy Sources

B.6.1. Default Methodology (to be Calculated by Annual GHG Data Report Workbook)

Federal agencies may reduce their Scope 2 emissions from electricity by purchasing energy generated from renewable energy sources, including purchased renewable energy and environmental attributes embodied in RECs. A REC is a transferable certificate issued when one MWh of electricity is generated and delivered to the grid from a renewable energy source. RECs are generally defined by states and certification organizations as representing the "environmental attributes" of electricity generated from renewable energy sources. This allows REC owners to claim the attributes of renewable energy (such as GHG emissions benefits) when matched with conventional electricity. Buyers can purchase RECs on the basis of the generation resource (such as wind, solar, geothermal), year, and location. In addition, RECs may be associated with energy from MSW WTE projects and influence purchases of conventional electricity in market-based accounting to estimate Scope 2 emissions impacts like other renewable energy. Like biomass generation, MSW WTE projects account separately for their biogenic CO_2, CH_4, and N_2O created by combustion, and for anthropogenic CO_2 from the portion of the fuel that comes from fossil sources. Agencies will need to specify the nature of their renewable energy use based on the following categories included in the Annual GHG Data Report workbook:

- The category **Agency Owns Energy and RECs from Project** (typical of many on-site and remote systems purchased directly with appropriations) is for situations where the agency owns and uses all the energy from the project along with its renewable/environmental attributes. This is excluded from market-based reporting because emissions are in Scope 1, not Scope 2.
- Purchases from suppliers that are not on Federal or Indian land include the pure **REC-only purchase** category for unbundled RECs (RECs dissociated from their underlying energy) from an off-site third party supplier. The **Green-energy purchase** category covers bundled energy and RECs from an off-site third party supplier. Both of these categories involve 100% ownership of the RECs. Even if the purchase is only a portion of an entire project's generation, the agency is only buying a portion and has no claims or need to report the rest of the renewable energy generated at the source. Both of these transactions are in Scope 2 and are included in market-based accounting, but not location-based accounting.
- For projects on Federal or Indian land bought through FAR Part 12 or other mechanisms that don't involve agency ownership of equipment the appropriate category is **Hosted**

Project (Green Energy) if the agency is using anywhere between 1% and 100% of the bundled renewable energy (energy bundled with its associated RECs), with the rest of the bundled renewable energy going to a non-Federal consumer. If a site is only receiving RECs from an on-site project, no energy, the appropriate category is **Hosted Project (RECs)** with the agency receiving 0% to 100% of the RECs associated with an on-site project but none of the energy. Usually these types of projects fall into Scope 2 because they are structured so a private developer builds and owns the project and sells RECs and/or green energy (bundled RECs) to the host agency. Therefore they are typically reported in market-based accounting but not location-based accounting. In unusual cases where an agency owns a project but only keeps a portion of the RECs or green energy the emissions would be considered Scope 1 and would not be reported in location or market-based accounting for Scope 2.

These hosted selections are important, because their emissions are recognized as a positive contribution to meeting Scope 3 targets, so it is important to know if the agency is hosting any renewable generation that is not used by the site (no RECs and no energy delivered to the site).

- **RECs Transferred but Energy Used by Agency** is for situations where a site is receiving energy from a renewable energy project but does not own any of the RECs associated with that energy. This makes the energy the same as conventional energy and therefore emissions are reported as if the energy were coming from the electric grid or a fossil fuel. If the agency actually owns the source project the emissions would be considered Scope 1, however this would be an unusual situation because agencies that own renewable energy projects are precluded from using tax and other incentives to reduce their costs, so it is usually more cost-effective to allow for private development and ownership of a renewable energy project. More typically the emissions are considered Scope 2. In either case, because the agency does not own any of the RECs in order to claim the environmental attributes, the energy from this category is treated as grid-based electricity and attributed with the same emissions as other electricity supplied to the agency in both the location- and market-based accounting. If the energy is non-electric it will be treated as natural gas or another fossil fuel and attributed with the fossil fuel emissions that would come from an equivalent amount of non-electric energy from fossil fuels.

Calculation Steps

Scope 2 emissions from RECs and renewable energy purchases will be reported as actual emissions at the point of conversion to useful energy and will be included in market-based accounting of Scope 2 emissions. To calculate the impact on an agency GHG inventory:

1. Determine location-based emissions which exclude Scope 2 renewable electricity purchases (RECs and RECs bundled with energy)
2. Determine market-based emissions, which include Scope 2 renewable electricity purchases (RECs and RECs bundled with energy) and reduce energy from non-renewable sources included in the location-based emissions.

3. The emissions from the market-based calculation compared to the location-based calculation documents the impact of renewable energy purchases in emissions. This is reflected in agency GHG target calculations.

Table B-10 provides an illustration of the calculations and steps.

Table B-10: Location- versus Market-Based Accounting Example

	Location-Based Energy Use	Location-Based GHG Emissions (MT CO$_2$e)	Market-Based Energy Use	Market-Based GHG Emissions (MTCE)
Electricity from Grid Supplier	1,000,000 MWh	562,000	998,000	560,000
Fossil Fuel Consumption	10 BBtu	530	10 BBtu	530
Thermal or Other Energy from a Supplier, Renewable	10 BBtu	0	10 BBtu	0
Thermal or Other Energy from a Supplier, Fossil Fueled	10 BBtu	980	10 BBtu	980
Agency Owns Energy and RECs from Project	500 MWh	0	500 MWh	0
Green-energy Purchase			500 MWh	0
REC-only Purchase			500 MWh	0
Hosted Project (Green Energy)			500 MWh	0
Hosted Project (RECs)			500 MWh	0
RECs Transferred but Energy Used by Agency, electric	500 MWh	280	500 MWh	280
RECs Transferred but Energy Used by Agency, non-electric	10 BBtu	980	10 BBtu	980
Total Electric Energy Use/Emissions	**1,001,000 MWh**	**563,790**	**1,001,000 MWh**	**561,790**
Total Non-Electric Energy Use/Emissions	**40 BBtu**	**2490**	**40 BBtu**	**2490**

Data Sources

Table B-11 shows the data elements and their sources.

Table B-11: Preferred Data Sources for Calculating REC and Renewable Energy Purchases

Data Element	Preferred Source
Emission factors	• eGRID derived default • Actual emissions from renewable energy source
Fuel/Technology	• REC • Supplied by renewable energy supplier
Amount of RECs purchased [MWh]	• REC

National Defense Authorization Act, Section 2582, established a renewable energy goal specific to the DOD. As a result, DOD may adjust their Scope 3 emissions by allowing renewable energy projects on their land, defined as "Scope 3 percentage points". Scope 3 percentage points are created when renewable energy is generated from a project on DOD land, but the hosting agency does not purchase associated energy and/or RECs. See Section 4.3.2 of the Guidance for further details. Calculations for Scope 3 percentage points use the market- and location-based emissions implicit emission factor that are also used to estimate Scope 2 impacts of renewable energy purchases. Scope 3 percentage points have no emissions reduction value, but can be used to show progress towards achieving Scope 3 goals in units of percent progress towards target achievement. They are determined by calculating avoided GHG emissions from relevant agency-hosted electric and non-electric renewable projects, and converting the results to the percentage of Scope 3 emissions.

Appendix C. Calculating Scope 3 Emissions

Scope 3 emissions are indirect emissions not covered by Scope 1 or Scope 2. They occur as a consequence of agency activities, but originate from sources not controlled by the agency. Refer to Chapter 2 of the Guidance document for further information on organizational boundaries.

Scope 3 categories selected for inclusion in annual inventories are shown in Table C-1. Beginning in FY 2010, agency reporting includes emissions for all those Scope 3 categories which the agency included in their Scope 3 target.

Table C-1: Scope 3 Emissions Categories

Scope 3 Emissions Categories
• Federal Employee Business Air Travel
• T&D Losses from Purchased Electricity
• Contracted MSW Disposal
• Federal Employee Business Ground Travel
• Federal Employee Commuting
• Contracted Wastewater Treatment
• Leased space over 10,000 rentable square feet accounted for separately, outside current agency Scope 3 targets

Agencies may not have access to quality FY 2008 data for some Scope 3 emissions categories. Per Chapter 5 of the Guidance document, agencies should use the earliest year for which data are available to include in the FY 2008 base year inventory. For example, if an agency's employee commuting data becomes available in 2011, those emissions should be incorporated into the FY 2008 baseline.

C.1. Federal Employee Business Air Travel

Description

Business air travel includes official business-related travel aboard third-party owned or operated aircraft. For reporting purposes, Scope 3 emissions from business air travel are limited to those from the combustion of fuels (such as the fuel consumed by an aircraft), but not the life cycle emissions associated with fuel production or manufacturing capital equipment and infrastructure (such as the emissions associated with aircraft manufacturing) or the radiative forcing impacts of high altitude air travel GHG emissions.[126]

This category excludes aircraft owned and leased by the reporting agency as they are captured under Scope 1.

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[126] Given the scientific debate surrounding radiative forcing impacts of air travel and for consistency with national and international GHG accounting guidance, the air travel methodology in this section does not incorporate radiative forcing adjustments. In addition to GHG emissions, air travel also impacts the climate through creation of contrails and changes in cirrus cloud formation.

Agencies should use the methodology described in the following section.

C.1.2. Methodology (to be Calculated by Annual GHG Data Report Workbook)[127]

Data Sources

Agencies report estimated business air travel GHG emissions via the Annual GHG Data Report workbook. Agencies should work with their travel agency and travel system to compile air travel data presented in Table C-2, which shows the data elements and their sources. After FY15 GSA Travel Trax (Travel Management Information Service) will no longer collect agency travel data and will not be available as a data source for air travel.

Table C-2: Federal Employee Air Travel Data Sources

Data Element	Preferred Source
Passenger miles traveled by segment categorized by short, medium, long, or unspecified haul [miles]	• Agency travel records, ETS, (which includes contractors Concur and E2 Solutions in FY16) vendor reports, and DTS
Emission factors [kg GHG/passenger-mile] by short, medium, long haul or unknown	• Appendix D

Calculation Steps

Air travel emissions are calculated using Equation C-1. These calculations use average passenger estimates to determine GHG emissions for any given flight. The following steps detail the calculation methods utilized by the Annual GHG Data Report workbook:

1. Identify the total passenger-miles by segment class (i.e., short, medium, long, or unspecified)

2. Determine the appropriate emission factor based upon the flight characteristics

3. Calculate the GHG emissions using the appropriate emission factor

4. Determine total annual emissions in MT CO_2e.

Step 1: Identify the total passenger-miles by segment class (i.e., short, medium, long, or unspecified) for all agency flights

ETS, Concur, DTS, travel records, or travel agencies should be able to provide mileage traveled for each segment of each passenger trip. Agencies should compile data for each flight segment and calculate total segments by segment class. Results will be most accurate if agencies are able to collect travel distances for each segment of multi-segmented trips; however, a less accurate result can be obtained using aggregate passenger miles and the appropriate unknown segment class emission factor in Appendix D. For example, ETS/Concur systems can provide an air travel detail report that has fields for segment length (short-, medium- and long-haul) along with passenger

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[127] This methodology is based on EPA Center for Corporate Climate Leadership Greenhouse Gas Inventory Protocol Core Module Guidance, *Optional Emissions from Commuting, Business Travel and Public Transport, 2008*.

miles for each segment type. By summing the total passenger miles for short-, medium- and long-haul segments for the fiscal year reported an agency can generate the data needed to estimate emissions from air travel.

Step 2: Determine the appropriate emission factor based upon the flight characteristics

The Annual GHG Data Report workbook will use the flight mileage data compiled within segment classes to determine the appropriate emission factors for each segment class. The sources for these distance-based emission factors can be found in Appendix D and are derived from aggregated data of typical emissions per passenger-miles.

Step 3: Calculate the GHG emissions using the appropriate emission factor

The Annual GHG Data Report workbook will use the aggregated passenger-miles by segment class and Equation C-1 to determine the GHG emissions for each segment class. Emission factors will be applied automatically based upon the segment distance traveled. The Annual GHG Data Report workbook will also automatically convert the emissions to MT.

Equation C-1: Airline Business Travel Emissions

CO_2 emissions[MT] =
Passenger-miles traveled [miles] ● appropriate CO_2 emission factor [kg/mi] ● 0.001 [MT/kg]
CH_4 emissions[MT] =
Passenger-miles traveled [miles] ● appropriate CH_4 emission factor [g/mi] ● 0.000001 [MT/g]
N_2O emissions [MT] =
Passenger-miles traveled [miles] ● appropriate N_2O emission factor [g/mi] ● 0.000001 [MT/kg]

Step 4: Determine total annual emissions in MT CO_2e

The Annual GHG Data Report workbook will use the GWP values found in Table**Error! Reference source not found.**D-1 to convert CH_4 and N_2O emissions to units of CO_2e, then sum the emissions from all three gases.

Equation C-2: Conversion of GHG MT to CO_2e Emissions

CO_2e Emissions [MT CO_2e] = MT CO_2 + (MT CH_4 ● CH_4 GWP) + (MT N_2O ● N_2O GWP)

Example C-1: Calculate Airline Business Travel Emissions

A Federal energy manager calculates the emissions for travel in FY 2008. The manager works in Chicago, but attended two separate work events in San Francisco and New Orleans during the year. The New Orleans trip was via a direct flight; the flight to San Francisco had a stop in Denver. To determine the emissions associated with the business trips in FY 2008, the federal manager should do the following:

Step 1: Identify the total passenger-miles for each segment of each trip

The manager's flight records are as follows, where the 3-letter acronyms represent airports:

MDW(Chicago) to MSY (New Orleans): 831 miles
MSY (New Orleans) to MDW (Chicago): 831 miles
ORD (Chicago) to DEN (Denver): 891 miles
DEN (Denver) to SFO (San Francisco): 970 miles
SFO (San Francisco) to DEN (Denver): 970 miles
DEN (Denver) to ORD (Chicago): 891 miles

Step 2: Determine the appropriate emission factor (EF) based upon the flight characteristics

Sources in Appendix D indicate that all flight segments are long haul. The EFs for this situation are as follows:

0.199189 kg CO_2/passenger-mile
0.0060 g N_2O/passenger-mile
0.000800084 g CH_4/passenger-mile

Step 3: Calculate the GHG emissions associated with each trip and convert to MT

Use Equation C-3 to calculate the emissions from each segment in MT.

Equation C-3: Airline Business Travel Emissions

CO_2 emissions [MT]	$=$ Passenger-miles traveled [miles] ● appropriate CO_2 EF [kg/mi] ● 0.001 [MT/kg] $= (831 + 831 + 891 + 970 + 970 + 891)$ [miles] ● 0.199189 [kg/mi] ● 0.001 [MT/kg] $= 5384$ [miles] ● 0.199189 [kg/mi] ● 0.001 [MT/kg] $= 1.018$ [MT]
CH_4 emissions [MT]	$=$ Passenger-miles traveled [miles] ● appropriate CH_4 EF [g/mi] ● 0.000001 [MT/g] $= (831 + 831 + 891 + 970 + 970 + 891)$ [miles] ● 0.00084 [g/mi] ● 0.000001 [MT/g] $= 5384$ [miles] ● 0.00084 [g/mi] ● 0.000001 [MT/g] $= 4.523 \times 10^{-6}$ [MT]
N_2O emissions [MT]	$=$ Passenger-miles traveled [miles] ● appropriate N_2O EF [g/mi] ● 0.000001 [MT/g] $= (831 + 831 + 891 + 970 + 970 + 891)$ [miles] ● 0.00630060 [g/mi] ● 0.000001 [MT/g] $= 5384$ [miles] ● 0.0060 [g/mi] ● 0.000001 [MT/g] $= 3.23 \times 10^{-5}$ [MT]

Step 4: Determine total annual emissions in MT CO_2e

Using the appropriate GWP, convert all GHG gases to CO_2e, then sum to determine the total emissions in MT CO_2e.

Equation C-4: Convert GHG MT to CO_2e Emissions

CO_2e Emissions [MT CO_2e]	$=$ MT CO_2 + (MT CH_4 ● CH_4 GWP) + (MT N_2O ● N_2O GWP) $= 1.018$ [MT CO_2] + (4.523 x 10^{-6} [MT CH_4] ● 25) + (3.23 x 10^{-5} [MT N_2O] ● 310) $= 1.018$ [MT CO_2] + 9.498 x 10^{-5} [MT CO_2e] + 1.00 x 10^{-2} [MT CO_2e] $= \mathbf{1.028}$ **[MT CO_2e]**

Note: Example has been provided for demonstration purposes only and has rounding imposed throughout each of the calculation steps above. Factors are for illustration. The most recent emission factors can be found in the Annual GHG Data Report workbook where their original sources will also be documented. As such results from this example may differ slightly from results generated using the Annual GHG Data Report Workbook**

C.2. Transmission and Distribution Losses

Description

This category includes the emissions associated with the purchased electricity consumed by the T&D system.

C.2.1. Default Methodology (to be Calculated by Annual GHG Data Report Workbook)[128]

Data Sources

The Annual GHG Data Report workbook will utilize this default calculation methodology. It will automatically draw from the existing FEMP energy reporting data reported under Scope 2 and subsequently apply an appropriate loss factor for the location to calculate T&D energy losses (Table C-3). The Annual GHG Data Report workbook will calculate the lost quantity of energy and estimate its resultant GHG emissions using the appropriate emission factors.

Table C-3: T&D Losses Default Data Sources

Data Element	Preferred Source
Total electricity purchases [MWh]	• Agency records, preferably based on metered use
National average T&D loss factor [%]	• Electricity: EPA eGRID T&D loss factors by region, World Bank T&D losses by foreign country and eGRID US National Average for U.S. Territories %[129]

Calculation Steps

Electricity T&D losses are calculated using Equation C-5. These calculations account for the eGRID output emission rate factors adjustments that exclude T&D losses. The following steps detail the calculation methods to be utilized by the Annual GHG Data Report workbook:

1. Import the electricity purchased data by eGRID subregion from FEMP energy reporting
2. Determine the electricity T&D loss adjustment factor for the eGRID region, country or U.S. Territory
3. Calculate the T&D loss quantity and the associated GHG emissions
4. Determine total annual emissions in MT CO_2e.

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[128] This methodology is based on Rothschild (Pechan) and Diem (EPA), Guidance on the Use of eGRID Output Emission Rates, April 2009, p. 2. See www.epa.gov/ttn/chief/conference/ei18/session5/rothschild.pdf.

[129] EPA Emission Factors Hub, eGRID Summary Tables, Table 9 at https://www.epa.gov/sites/production/files/2015-10/documents/egrid2012_summarytables_0.pdf, and World Bank Economic Development Indicators Table 5.11 at http://wdi.worldbank.org/table/5.11#.

Step 1: Import the electricity purchased data by eGRID subregion from FEMP energy reporting

All agencies are required to report their total electricity consumption through FEMP energy reporting by eGRID subregion. These quantities will be used in the Annual GHG Data Report workbook to account for the electricity usage under the Scope 2. To the greatest extent feasible, the Annual GHG Data Report workbook will automatically import these data for calculation of the T&D losses.

Step 2: Determine electricity T&D loss adjustment factor

This default methodology will use the latest T&D loss factor for the eGRID subregion where the electricity is purchased and Equation C-5 to determine the electricity loss adjustment.

Equation C-5: Distribution Loss Adjustment Factor Calculation

Distribution Loss Adjustment Factor = $T \div (1-T)$ Where: T = T&D loss factor for specific eGRID subregion or national average when subregion is unknown.

Step 3: Calculate the T&D loss quantity and the associated GHG emissions

The Annual GHG Data Report workbook will apply the appropriate eGRID subregional T&D loss value to determine the total quantity of electricity lost in transmission and distribution. It will also subsequently apply the appropriate eGRID output emission rate factors as provided in the sources in Table D-1.

Equation C-6: Calculation of Electricity T&D Losses and Emissions

CO_2 emissions [MT] =   Electricity purchased [MWh] ● T&D adjustment factor ● CO_2 emission factor [kg/MWh] ● 0.001 [MT/kg]
N_2O emissions [MT] =   Electricity purchased [MWh] ● T&D adjustment factor ● N_2O emission factor [kg/MWh] ● 0.001 [MT/kg]
CH_4 emissions [MT] =   Electricity purchased [MWh] ● T&D adjustment factor ● CH_4 emission factor [kg/MWh] ● 0.001 [MT/kg]

Source: DOE 1605(b), Technical Guidance

Step 4: Determine total annual emissions in MT CO_2e

Use the GWP values found in the sources in Table D-1 to convert them to units of CO_2e, then sum the emissions from all three gases.

Equation C-7: Conversion of GHG MT to CO₂e Emissions

$$\text{CO}_2\text{e Emissions [MT CO}_2\text{e]} = \text{MT CO}_2 + (\text{MT CH}_4 \bullet \text{CH}_4 \text{ GWP}) + (\text{MT N}_2\text{O} \bullet \text{N}_2\text{O GWP})$$

Example C-2: Determine Transmission and Loss Emissions for Purchased Electricity

A Federal energy manager for a Veterans Affairs hospital in southern Texas is tasked to determine the T&D loss from electricity purchased during the fiscal year. To determine the emissions associated with that T&D loss, the federal manager should do the following:

Step 1: Collect the electricity purchased data by eGRID subregion, U.S. Territory or country

The FEMP energy reporting data indicate that total purchased electricity for the hospital facility is 20,000 MWh and is located in El Paso TX, which eGRID assigns the T&D loss factor of 7.03% for the ERCOT region.

Step 2: Determine electricity T&D loss adjustment factor

Equation C-8 is then used to calculate the loss adjustment factor (note: equation and example use the U.S. average T&D loss factor.)

Equation C-8: Distribution Loss Adjustment Factor Calculation

$$0.0703 \div (1 - 0.0833) = 0.0703 \div 0.9297 = 0.0756$$

Step 3: Calculate the T&D loss quantity and the associated GHG emissions

Because the facility is in southern Texas, it is within the ERCT eGRID subregion (see eGrid map in Figure D-1), so the ERCT eGRID output emission rate factor is used for the calculation.

Equation C-9: Calculate Electricity T&D Losses and Emissions

CO₂ emissions [MT]	= Electricity purchased [MWh] • CO₂ emission factor [kg/MWh] • T&D adjustment factor • 0.001 [MT/kg] = 20,000 [MWh] • 518.4731 [kg/MWh] • 0.0756 • 0.001 [MT/kg] = 784.095 [MT] CO₂
CH₄ emissions [MT]	= Electricity purchased [MWh] • CH₄ emission factor [kg/MWh] • T&D adjustment factor • 0.001 [MT/kg] = 20,000 [MWh] • 00758 [kg/MWh] • 0. 0756 • 0.001 [MT/kg] = .0115 [MT] CH₄
N₂O emissions [MT]	= Electricity purchased [MWh] • N₂O emission factor [kg/MWh] • T&D adjustment factor • 0.001 [MT/kg] = 20,000 [MWh] • .00559 [kg/MWh] • 0. 0756 • 0.001 [MT/kg] = .0085 [MT] N₂O

Step 4: Determine total annual emissions in MT CO₂e

Using the appropriate GWP, convert all GHG gases to CO₂e, then sum to determine the total emissions in CO₂e.

Equation C-10: Convert GHG MT to CO₂e Emissions

CO₂e Emissions	= MT CO₂ + (MT CH₄ • CH₄ GWP) + (MT N₂O • N₂O GWP) = 784.095 [MT CO₂] + (.00758 [MT CH₄] • 25) + (.0085 [MT N₂O] • 298) = 1032.89 [MT CO₂] + .286 [MT CO₂e] + 2.521 [MT CO₂e]

[MT CO₂e]	= 786.903 [MT CO₂e]

Note: Example has been provided for demonstration purposes only and has rounding imposed throughout each of the calculation steps above. Factors are for illustration. The most recent emission factors can be found in the Annual GHG Data Report workbook where their original sources will also be documented. As such, results from this example may differ slightly from results generated using the Annual GHG Data Report workbook.

C.3. Federal Employee Business Ground Travel

Business ground travel refers to official business travel by Federal employees aboard third-party-owned or -operated ground vehicles.[130] It does not include daily commutes to, from, or within an employee's official station, only official business travel as defined in the Federal Travel Regulation. Scope 3 emissions from business travel include those from the combustion of fuels (such as the fuel consumed by a vehicle), but not the life cycle emissions associated with fuel production or manufacturing capital equipment and infrastructure (such as the emissions associated with vehicle manufacturing).

Business ground travel includes the following:

- Passenger vehicle business travel: personal vehicles (POVs), rental vehicles, shuttles, taxi cabs, and other local transportation while at the temporary duty station not included in mass transit.

- Mass transit: transit rail (such as subway or tram), commuter rail, intercity rail (such as Amtrak), buses, and shuttles

Due to the current lack of data for many modes of business ground travel, the default methodology estimates emissions for only POV, rental vehicles and mass transit.

Agencies may utilize a combination of the default and alternative methodologies to calculate total emissions from business travel if travel data are managed in multiple systems or processes. When doing so, agencies should avoid double counting.

C.3.1. Default Methodology: Detailed Rental and POV Data (to be Calculated by Annual GHG Data Report Workbook)

Agencies should use the default methodology to estimate GHG emissions for ground business travel (Table C-4). If agencies have their own specific data available, they may use it, provided they justify any modifications.

Data Sources for Default Methodology

Agencies should obtain the following information:

- Total number of Agency Business Trips with Rental Car expenses

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[130] The current methodologies presented do not include provisions for business travel over water (ferries, water taxis, etc.). However, agencies may choose to additionally report such emissions if sufficient data and methods become available at the time of reporting.

Table C-4: Default Ground Travel Methodology Data Sources

Data Element	Preferred Sources
Number of rental vehicles	• ETS and DTS vendor reports and travel agency data when available
POV mileage, if available	• Travel reimbursement forms, ETS and DTS vendor reports when available
Historical average mileage weighted by class of rental car	• Travel reimbursement reports, Defense Travel Management Office (DTMO), ETS reports or equivalent in other agencies
Vehicle emission factors	• Appendix D

Calculation Steps for Default Methodology

Calculation steps include the following:[131]

1. Report sum agency car rentals

2. If data is available prorate the rental car sum by class based on DTMO or ETS class use data, obtained from rental car companies. Use class data that most closely corresponds to vehicle classes used in the default methodology and document the assumptions. If other data is lacking use the passenger car gasoline category as the default.

3. Determine the GHG emissions for each vehicle used. The Annual GHG Data Report workbook will provide a default estimate based on GSA calculations, currently 210 miles per trip.

4. Sum the total annual GHG emissions for all vehicles used

5. Convert emissions to CO_2e.

Step 1: Report sum of agency car rentals.

Agencies should sum temporary duty rental cars and mileage reimbursed for POV. For example, for DOD DTMO will calculate annually the weighted mileage and number of rental cars by class. POV reimbursed mileage should be obtained from ETS/DTS vendor reports and travel agency data. Agencies may need to compile data from sub-agencies depending on how travel services are organized within the agency. The count of rentals, ideally by vehicle type, from reports is one input to the number of agency business trips used in the default methodology.

Step 2: Calculations will be built into the Annual GHG Data Report workbook based upon DTMO or other sources for weighted mileage by car class. Both rental cars and POV mileage will use the standard of passenger cars from source in Appendix D. Sources indicate the emission factors for passenger cars used in the default methodology. All standard passenger vehicles are considered LEVs, assuming that all rental vehicle fleets consist of vehicles less than 5 years old.

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[131] Default calculation methodology is derived in part from the EPA Center for Corporate Climate Leadership guidance for *Optional Emissions from Commuting, Business Travel and Product Transport*.

Step 3: *Determine the GHG emissions for each vehicle used*

The Annual GHG Data Report workbook will use Equation C-11 to calculate the emissions for each vehicle class used.

Equation C-11: Emissions for Each Vehicle

CO_2 emissions[kg] =   Distance traveled for a given vehicle class [miles] ● CO_2 emission factor for that vehicle's auto class [kg/mi]
N_2O emissions [kg] =   Distance traveled for a given vehicle class [miles] ● N_2O emission factor for each vehicle control technology [g/mi] ● 0.001 [kg/g]
CH_4 emissions[kg] =   Distance traveled for a given vehicle class [miles] ● CH_4 emission factor for each vehicle control technology [g/mi] ● 0.001 [kg/g]

Source: EPA Center for Corporate Climate Leadership, Optional Emissions from Commuting, Business Travel and Product Transport.

Step 4: *Sum the total GHG annual emissions for all vehicles used*

The Annual GHG Data Report workbook will use Equation C-12 to sum the emissions of CO_2, N_2O, and CH_4 for all vehicles used and convert them to MT

Equation C-12: Total Emissions Calculations

Total CO_2 emissions from ground travel [MT] =   (CO_2 from vehicle class 1 [kg] + CO_2 from vehicle class 2 [kg] + CO_2 from vehicle class 3 [kg] …) ● 0.001MT/kg
Total N_2O emissions from ground travel [MT] =   (N_2O from vehicle class 1 [kg] + N_2O from vehicle class 2 [kg] + N_2O from vehicle class 3 [kg] …) ● 0.001MT/kg
Total CH_4 emissions from ground travel [MT] =   (CH_4 from vehicle class 1 [kg] + CH_4 from vehicle class 2 [kg] + CH_4 from vehicle class 3 [kg] …) ● 0.001MT/kg

Source: EPA Center for Corporate Climate Leadership, Optional Emissions from Commuting, Business Travel and Product Transport.

Step 5: *Convert emissions to CO_2e*

The Annual GHG Data Report workbook will use Equation C-13, the N_2O and CH_4 emissions, and their respective GWPs to convert these gases to CO_2e, then sum all CO_2 and CO_2e emissions to generate the total emissions for business ground travel.

Equation C-13: Ground Travel MT CO₂e Emissions

CO₂e Emissions [MT CO₂e] = MT CO_2 + (MT CH_4 ● CH_4 GWP) + (MT N_2O ● N_2O GWP)

C.4. Federal Employee Commuting

Description

Employee commuting includes the travel of employees between their homes and primary worksites or between their homes and alternate worksites.

C.4.1. Default Methodology (to be Calculated by Annual GHG Data Report Workbook)

Data Sources for Default Commuter Survey Methodology

The default methodology uses information on miles traveled per day by type of transportation derived from answers to a commuter survey administered to agency personnel. The default methodology includes at least the eight mandatory questions listed in Table C-6 in order to obtain information on employee commuting habits.[132,133] An alternative survey should use the eight mandatory questions developed by the John A. Volpe National Transportation Systems Center to calculate GHG emissions from employee commuting. These questions ask respondents for information on their typical weekly commute, including:

- Modes of transportation used to commute to and from work

- Mileage traveled by each mode

- Location of their worksite

- Participation in an alternative work schedule (AWS)

- Number of occupants in a vehicle if carpool/vanpool are used.

Agencies may choose to use an alternative methodology through the GSA Carbon Footprint Tool by which they select additional, optional questions for inclusion in their surveys. These questions will be noted as optional in the survey, and respondents will not be required to answer them to complete the survey. The optional questions ask respondents for information on a variety of issues related to commuting, including:

- Telework

- Transit subsidies

- Distance and duration of commute

- Willingness to utilize mass transit options.

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[132] Agencies should be aware that there are privacy rights to be considered when developing and administering any voluntary survey.

[133] This methodology is derived from EPA Center for Corporate Climate Leadership, Optional Emissions from Commuting, Business Travel, and Product Transport methodology. See www.epa.gov/stateply/documents/resources/commute_travel_product.pdf.

Table C-5: Commuter Travel Data Sources

Data Element	Preferred Source	Alternate Source
Mode	• Commuter questionnaire	• Public transit records • Regional/national transportation surveys
Agency average number of commuting days (by mode)	• Commuter questionnaire	• Regional/national transportation surveys (such as U.S. Census Bureau)
Roundtrip distance (by mode) [mi]	• Commuter questionnaire	• Commuter address (payroll records, personnel records, parking permits) • Regional/national transportation surveys (such as U.S. Census Bureau)
Emission factors [g/passenger-mile]	• Appendix D Sources	• N/A

Agencies should collect employee commuting data from a statistically appropriate number of respondents and extrapolate from a representative sample of employees to estimate commuting patterns of all employees. Agencies should record their sampling and extrapolation methodologies and include them in the GHG Reporting Qualitative Content portion of their annual GHG inventory submission to FEMP. In order to issue the survey, agencies will need to submit the email addresses of individuals within a representative sample to the GSA Carbon Footprint Tool. All responses in the Carbon Footprint Tool are made anonymous, and e-mail addresses will not be present on any output generated by the tool.

The GSA Carbon Footprint Tool will administer the commuter surveys, automatically calculate emissions, and present them in the format required for entry in the Annual GHG Data Report workbook. The GSA Carbon Footprint Tool will not be able to calculate employee commuting emissions from outside data sources or surveys.

Commuter emissions are to be included each annual inventory. For significant changes in emissions to be captured in a timely fashion, agencies should ensure that the commuter survey is administered at least every two years

Calculation Steps

Agencies should use the following steps to calculate commuter emissions, which are also employed by the GSA Carbon Footprint Tool.

1. Collect commuter data by frequency, distance, and mode of travel using the eight mandatory questions

2. Sum mileage by transportation mode for the typical working week and working day.

3. Estimate the average number of commuting days within the agency and calculate emissions by transportation mode.

4. Sum transportation mode emissions and convert them to MT.

5. Convert emissions to CO_2e and determine total emissions.

Step 1: Collect commuter data by frequency, distance, and mode of travel using the eight mandatory questions developed by the Volpe Center

Agencies should collect activity data for commuters using the eight mandatory questions in the default methodology (Table C-6).

Table C-6: Mandatory Commuter Survey Questions

Question No.	Question
1	Please select your agency/operating administration or office
2	What is the 5-digit zip code at your primary duty station? (e.g., 20590, 02142)
3	What is your employment status? (Full-time, intern, employee, contractor, etc.)
4	How did you travel **TO WORK** each day during the week and what was the distance? • Monday-Friday (questions below answered for each day) o Number of miles for 1st method of transportation (POV – passenger car, POV – sport utility vehicle (SUV)/truck [gasoline], POV – SUV/truck [diesel], POV – motorcycle, car pool, van pool, bus, metro/transit rail, commuter rail, intercity rail, walking and/or bicycling) o Number of miles for 2nd method of Transportation – *if applicable* o Number of miles for 3rd method of Transportation – *if applicable*
5	If you selected carpool/vanpool: What was the average total number of people in your vehicle, including yourself?
6	Did you use the same method(s) of transportation indicated above to commute FROM WORK at the end of your workdays? 　**-If yes, mandatory questions complete.** 　**-If no, questions 7 and 8**
7	How did you travel **FROM WORK** each day during the week and what was the distance? • Monday-Friday (questions below answered for each day) o Number of miles for 1st method of transportation (POV – passenger car, POV – SUV/truck [gasoline], POV – SUV/truck [diesel], POV – motorcycle, car pool, van pool, bus, metro/transit rail, commuter rail, intercity rail, walking and/or bicycling) o Number of miles for 2nd method of transportation – *if applicable* o Number of miles for 3rd method of transportation – *if applicable*
8	If you selected carpool/vanpool from work: What was the average total number of people in your vehicle, including yourself?

At a minimum, agencies should allow respondents to select from the eleven transportation modes below when choosing the mode of transportation they use to commute to and/or from work. Emission factors for these modes are available from sources listed in Appendix D.

- POV – passenger car
- POV – SUV/truck (gasoline)
- POV – SUV/truck (diesel)

- POV – motorcycle
- Car pool
- Van pool
- Bus
- Metro/transit rail
- Commuter rail
- Intercity rail
- Walking and/ or bicycling.

Step 2: *Sum mileage by transportation mode for the typical working week and working day*

The mandatory survey questions will allow agencies to capture miles by transportation mode during a respondent's typical week. Respondents will indicate the days they telework, and they will indicate whether or not they participate in an AWS. The total weekly mileage by transportation mode should be divided by the 5-work days within a working week to arrive at average mileage per work day for each mode. Refer to Equation C-14 for the calculation of average mileage per work day.

Equation C-14: Average Transportation Mode Mileage per Work Day

> **Average Transportation Mode Mileage per Work Day =**
>   Sum of weekly commuting miles by mode [mi]/ 5 [work days/week]

Step 3: *Estimate the average number of commuting days within the agency and calculate emissions by transportation mode*

Respondents are assumed to have 230 commuting days; respondents that participate in an alternative work schedule are assumed to have 205 commuting days. The average number of commuting days for an agency will be calculated using Equation C-15.

Equation C-15: Average Agency Number of Commuting Days

> **Average Agency Commuting Days =**
>
> (Number of respondents participating in AWS/total number of respondents) * 205 [commuting days/year]+ (number of respondents not participating in an AWS/total number of respondents)* 230 [commuting days/year]

The Annual GHG Data Report workbook will use Equation C-16 to calculate GHG emissions from each mode of transportation (See Appendix D for sources of emission factors for commuting.) Note that the listed emission factors assume that commuting vehicles have two passengers per carpool and four passengers per van-pool. See Example C-3.

Equation C-16: Emissions by Transportation Mode

CO_2 emissions [kg] =
Average daily commute distance traveled by transportation mode [miles/day] ● average agency commuting days [days/year]● emission factor [kg/mi]
N_2O emissions [kg] =
Average daily commute distance traveled by transportation mode [miles/day] ● average agency commuting days [days/year]● emission factor [g/mi] ● 0.001 [kg/g]
CH_4 emissions [kg] =
Average daily commute distance traveled by transportation mode [miles/day] ● average agency commuting days [days/year]● emission factor [g/mi] ● 0.001 [kg/g]

Source: EPA Center for Corporate Climate Leadership, Optional Emissions from Commuting, Business Travel and Product Transport.

Step 4: Sum transportation mode emissions and convert them to MT

Use Equation C-17 to add the respective CO_2, N_2O, and CH_4 emissions from each transportation mode.

Equation C-17: Total Emissions Calculations

Total CO_2 emissions from commuter travel [MT] =
(CO_2 from mode 1 [kg] + CO_2 from mode 2 [kg] + CO_2 from mode 3 [kg] …) ● 0.001MT/kg
Total CH_4 emissions from commuter travel [MT] =
(CH_4 from mode 1 [kg] + CH_4 from mode 2 [kg] + CH_4 from mode 3 [kg] …) ● 0.001MT/kg
Total N_2O emissions from commuter travel [MT] =
(N_2O from mode 1 [kg] + N_2O from mode 2 [kg] + N_2O from mode 3 [kg] …) ● 0.001MT/kg

Source: EPA Center for Corporate Climate Leadership, Optional Emissions from Commuting, Business Travel and Product Transport.

Step 5: Convert emissions to CO₂e and determine total emissions

Use Equation C-18 to multiply the N_2O and CH_4 emissions by their respective GWPs (see sources in **Error! Reference source not found.**D-1) to determine the total CO_2e emissions.

Equation C-18: Commuter Travel MT CO_2e Emissions

CO_2e Emissions [MT CO_2e] = MT CO_2 + (MT CH_4 ● CH_4 GWP) + (MT N_2O ● N_2O GWP)

Example C-3: Estimate Employee Emissions from Commuting

The Department of Commerce is attempting to estimate total commuter emissions for a notional facility in Chicago to determine the emissions associated with their employees' commutes.

Step 1: Collect commuter data by frequency, distance, and mode of travel

The agency uses the mandatory commuter survey questions and, after tabulating mileage by mode, determines that respondents travel 5,000 miles by single occupant vehicle, 2,000 miles by transit rail, 1,000 by bus, and 4,000 by carpool per week. In addition, the survey determines that respondents commute an average of 225 days per year.

Step 2: Sum mileage by transportation mode for the typical working week and working day

The average daily mileages by commuting mode are calculated by dividing the total weekly mileages by 5. They are displayed by mode in the table below.

Mode of Transportation [type]	Number of trips per year	Average daily mileage [miles]
Single occupant vehicle	225	1,000
Transit Rail	225	400
Bus	225	200
Carpool	225	800

Step 3: Estimate the average number of commuting days within the agency and calculate emissions by transportation mode

Equation C-19 allows for the calculation to determine emissions by transportation mode. It is used one time for each mode listed in the table above. The number of commuting days per year was determined in step 1.The emission factors for passenger cars and mass transit are found in Appendix D.

Equation C-19: Emissions by Transportation Mode

➢ *Single occupant vehicle*

CO_2 emissions [kg]	= Average daily commute distance traveled by transportation mode [miles/day] ● average agency commuting days [days/year]● emission factor [kg/mi] = 1,000 [miles/day] ● 225 ● 0.364 [kg/mi] = 81,900 [kg CO_2]
CH_4 emissions [kg]	= Average daily commute distance traveled by transportation mode [miles/day] ● average agency commuting days [days/year]● emission factor [g/mi] ● 0.001 [kg/g] = 1,000 [miles/day] ● 225 ● 0.031 [g/passenger-mile]) ● 0.001 [kg/g] = 6.975 [kg CH_4]
N_2O emissions [kg]	= Average daily commute distance traveled by transportation mode [miles/day] ● average agency commuting days [days/year]● emission factor [g/mi] ● 0.001 [kg/g] = 1,000 [miles/day] ● 225 ● 0.032 [g/passenger-mile]) ● 0.001 [kg/g] = 7.2 [kg N_2O]

➢ *Transit Rail*

CO_2 emissions [kg]	= Average daily commute distance traveled by transportation mode [miles/day] ● average agency commuting days [days/year]● emission factor for transit rail [g/passenger-mile] 400 [miles/day] ● 225 ●0.001 [kg/g] = 400 [miles/day] ● 225 ● 0.163 [kg/passenger-mile] = 14,670 [kg CO_2]
CH_4 emissions [kg]	= Average daily commute distance traveled by transportation mode [miles/day] ● average agency commuting days [days/year]● emission factor for transit rail [g/passenger-mile] 400 [miles/day] ● 225 ●0.001 [kg/g] = 400 [miles/day] ● 225 ● 0.004 [g/passenger-mile]) ● 0.001 [kg/g] = 0.36 [kg CH_4]
N_2O emissions [kg]	= Average daily commute distance traveled by transportation mode [miles/day] ● average agency commuting days [days/year]● emission factor for transit rail [g/passenger-mile] ● 0.001 [kg/g] = 400 [miles/day] ● 225 ● 0.002 [g/passenger-mile]) ● 0.001 [kg/g] = 0.18 [kg N_2O]

➢ *Bus*

CO_2 emissions [kg]	= Average daily commute distance traveled by transportation mode [miles/day] ● average agency commuting days [days/year] ● emission factor for bus [kg/passenger-mile] = 200 [miles/day] ● 225 ● 0.107 [kg/passenger-mile] = 4,815 [kg CO_2]
CH_4 emissions [kg]	= Average daily commute distance traveled by transportation mode [miles/day] ● average agency commuting days [days/year] ● emission factor for bus [g/passenger-mile] ● 0.001 [kg/g] = 200 [miles/day] ● 225 ● 0.0006 [g/passenger-mile]) ● 0.001 [kg/g] = 0.027 [kg CH_4]
N_2O emissions [kg]	= Average daily commute distance traveled by transportation mode [miles/day] ● average agency commuting days [days/year] ● emission factor for bus [g/passenger-mile] ● 0.001 [kg/g] = 200 [miles/day] ● 225 ● 0.0005 [g/passenger-mile]) ● 0.001 [kg/g] = 0.0225 [kg N_2O]

➢ *Carpool*

CO_2 emissions [kg]	= Average daily commute distance traveled by transportation mode [miles/day] ● average agency commuting days [days/year] ● emission factor for carpool [kg/passenger-mile] = 800 [miles/day] ● 225 ● 0.182 [kg/passenger-mile] = 32,760 [kg CO_2]
CH_4 emissions [kg]	= Average daily commute distance traveled by transportation mode [miles/day] ● average agency commuting days [days/year] ● emission factor for carpool [g/passenger-mile] ● 0.001 [kg/g] = 800 [miles/day] ● 225 ● 0.016 [g/passenger-mile]) ● 0.001 [kg/g] = 2.88 [kg CH_4]

N₂O emissions [kg]	= Average daily commute distance traveled by transportation mode [miles/day] ● average agency commuting days [days/year] ● emission factor for carpool [g/passenger-mile] ● 0.001 [kg/g] = 800 [miles/day] ● 225 ● 0.016 [g/passenger-mile]) ● 0.001 [kg/g] = 2.88 [kg N₂O]

Step 4: *Sum single occupant and multiple passenger travel emissions and convert them to MT*

Use Equation C-20 to add the respective CO_2, N_2O, and CH_4 emissions from all employees.

Equation C-20: Total Emissions Calculations

Total CO₂ emissions from commuter travel [MT]	= (CO_2 from mode 1 [kg] + CO_2 from mode 2 [kg] + CO_2 from mode 3 [kg] …) ● 0.001 [MT/kg] = (CO_2 single occupant [kg] + CO_2 transit rail [kg] + CO_2 bus [kg] + CO_2 carpool [kg]) ● 0.001 [MT/kg] = (81,900 [kg] + 14,670 [kg] + 144450 [kg] + 32,760 [kg]) ● 0.001 [MT/kg] = 134,145 [kg] ● 0.001 [MT/kg] = 134.145 [MT CO_2]
Total CH₄ emissions from commuter travel [MT]	= (CH_4 from mode 1 [kg] + CH_4 from mode 2 [kg] + CH_4 from mode 3 [kg] …) ● 0.001 [MT/kg] = (CH_4 single occupant [kg] + CH_4 transit rail [kg] + CH_4 bus [kg] + CH_4 carpool [kg]) ● 0.001 [MT/kg] = (6.975 [kg] + 0.36 [kg] + 0.027 [kg] + 2.88 [kg]) ● 0.001 [MT/kg] = 10.24 [kg] ● 0.001 [MT/kg] = 0.0102 [MT CH_4]
Total N₂O emissions from commuter travel [MT]	= (N_2O from mode 1 [kg] + N_2O from mode 2 [kg] + N_2O from mode 3 [kg] …) ● 0.001 [MT/kg] = (N_2O single occupant [kg] + N_2O transit rail [kg] + N_2O bus [kg] + N_2O carpool [kg]) ● 0.001 [MT/kg] = (7.2 [kg] +0.18 [kg] + 0.0225 [kg] +2.88 [kg]) ● 0.001 [MT/kg] = 10.29 [kg] ● 0.001 [MT/kg] = 0.0103 [MT N_2O]

Step 5: *Convert to CO_2e and determine total emissions*

Use Equation C-21 to multiply the total N_2O and CH_4 emissions by their respective GWP (see **Error! Reference source not found.**) to determine the total CO_2e emissions.

Equation C-21: Commuter Travel MT CO_2e Emissions

Total CO₂e emissions [MT CO₂e]	= MT CO_2 + (MT CH_4 ● CH_4 GWP) + (MT N_2O ● N_2O GWP) = 134.145 [MT CO_2] + (0.0102 [MT CH_4] ● 25) + (0.0103 [MT N_2O] ● 310) = 134.145 [MT CO_2]+ 0.214 [MT CO_2e] + 3.19 [MT CO_2e] = **137.55 [MT CO₂e]**

Note: Example has been provided for demonstration purposes only and has rounding imposed throughout each of the calculation steps above. As such results from this example may differ slightly from results generated using the Annual GHG Data Report workbook.**

C.4.2. Alternative Personnel Population Methodology

Data Sources for Alternative National Average Commuter Data Methodology

The alternative methodology assumes that the mix of transportation used by agency personnel for commuting and commuting distances are consistent with U.S. Census Bureau and other national data. The total number of agency personnel who commute is assumed to be all employees excepting only the number of FTEs in situations that do not involve commuting. For example, DOD uses information from its personnel systems to estimate the percentage of total active duty military population or others in a deployed status who do not commute and subtract these from the total commuting population. An agency like NOAA might estimate the share of its total FTEs at remote stations like Antarctica who do not commute, USCG FTEs at sea on extended cruises, the Department of Commerce the number of employees assigned to telecommuting, etc. The Annual GHG Data workbook will provide input cells for both the estimated number of commuters and numbers excluded from commuting along with an area for agencies to document the data sources and assumptions used to derive each figure.

Step 1 – Calculate the Number of Agency Commuters

Identify the total number of Civilian (in the case of DOD) and Federal agency employees in the U.S. and territories (full time, in permanent positions) from agency data systems such as the Defense Manpower Data Center for DOD. Multiply this number by an agency-specific factor to account for the portion of agency employees that are in a deployed status and/or work under other conditions where they do not commute, for example personnel assigned to DOD bases and base housing. Developing both of these values will be the responsibility of the reporting agency and will be the only input needed for this methodology.

Step 2 – Determine National Vehicle Mix

The most recent information on the national mix of vehicles from the American Community Survey, (available through the U.S. Census Bureau American FactFinder at http://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml) will be incorporated into the Annual GHG Data Report workbook, with adjustments to match the transportations/modes used in the default method for calculating GHG emissions. The values are subject to the following search/query results and adjustments:

- The Census Bureau Factfinder Advanced Search will retrieve data from *Table 08301, Means of Transportation to Work*. The most recent 1 year estimate available will be used to determine the national vehicle mix. The results will be used to populate column B in the Annual GHG Data Report workbook tool with the total number of vehicles by listed vehicle category.
- Because of the transportation mode categories used with the GHG emission factors for commuting, "Car, Truck or Van" numbers will need to be allocated into 3 sub-categories – Car, SUV/Lt Truck (Gasoline), and SUV/Lt Truck (Diesel). Data on total U.S. vehicle registrations will be accessed from the most current edition of the Transportation Energy Data Book (http://cta.ornl.gov/data/chapter4.shtml), specifically *Chapter 4, Light Vehicles and Characteristics, Table 4.1, Summary Statistics for Cars* and *Table 4.2, Summary Statistics for Two-Axle, Four Tire Trucks*. The vehicle registration data from the most

recent year reported from each of these tables will be used to determine the percentage of vehicles that are cars (i.e., 113,676,000 cars/(113,676,000 cars+120,523,000 trucks) = 48.5% of registrations as cars.

- The available data from the previous data source are insufficient to estimate the percentage of SUVs or light duty trucks that are diesel powered. R.L. Polk data estimates that there were 796,794 diesel cars, SUVs, and light trucks registered in the U.S. (excluding those used commercially) in 2012. Comparing this to total light vehicle registrations in 2012 (232,137,000) results in an estimated diesel percentage of 0.34%, which is used to estimate the number of SUV/Lt Truck (Diesel) vehicles.

The Annual GHG Data Report workbook automatically calculates the relative percentage of each vehicle type by dividing the total number of vehicles by the number of vehicles by vehicle type, illustrated in the third column of Figure 3 below. The data sources and queries explained above will be updated as necessary as data sources and query methods change over time.

Step 3 – Determine Average Commuting Distance

The Department of Transportation Federal Highway Administration's National Household Travel Survey On-Line Analysis Tools (http://nhts.ornl.gov/tools.shtml) will be used to determine the national average length in miles of a one way commute to work which will be incorporated into the alternative methodology in the Annual GHG Data Report workbook. The data will be accessed through the website's *Table Designer* (Table Designer help information can be found at http://nhts.ornl.gov/tables09/help/Default.aspx) using the following procedures:

1. Under the *Statistics* table heading ensure the *Survey* field reflects the latest NHTS data source, for example, "2009 NHTS."
2. In the *Analysis Variable* field select the "pencil" icon, and under the "Travel Day" heading check the "Average Person Trip Length (Travel Day PT)" button and click *Select*.
3. Next, specify the *Type of Table* as "Two-way", and *Statistics* as "Mean".
4. Under the *Row Variable* heading click on the green highlighted " + " icon and select "TRPTRANS" and click "Submit" (submit button is at the top of the page). The pull-down menu for *Row Variable* should now contain HHFAMINC (the tool's default) and TRPTRANS.
5. Under the *Column Variable* heading click on the green highlighted " + " icon and select "WHYTRIP1S" and click "Submit" (submit button is at the top of the page). The pull-down menu for *Column Variable* should now contain "HHFAMINC" (the tool's default), "TRPTRANS" and "WHYTRIP1S".
6. Return to the *Row Variable* heading and specify/select "TRPTRANS", and the *Column Heading* and select "WHYTRIP1S". When done, select the "Create Table" button at the bottom of the page. Follow instructions then select "Output Area". Tabular output data for daily roundtrip travel length is generated.

The one way trip length data in the results will be doubled to create a round-trip estimate and prepopulated into the fourth column of the data input table illustrated in Table C-7 below, in the row corresponding to the appropriate transportation mode.

Step 4 – Convert Emissions to CO_2e and Determine Total Emissions

Use Equation C-21 above to multiply the N_2O and CH_4 emissions by their respective GWPs (see **Error! Reference source not found.**D-1) to determine the total CO_2e emissions. The values in the alternative methodology input table will automatically be copied to a table that uses the same emission factors and transportation mode categories as the default methodology based on the commuter survey.

Table C-7: Input Table for Alternative Method for Commuter GHG Emissions

Federal Agency Employee Commute

Enter total # of civilian employees in the U.S. + territories	100,000	Agency Data Source: XXX
Enter total # of agency personnel in the U.S. + territories	0	Agency Data Source: XXX
Enter % of personnel or FTEs in non commute status (i.e., military in base housing, deployment to remote sites or at sea, etc.)	0.0%	Agency Data Source/Assumptions: XXX
Calculated number of military commuters	0	
Calculated # of total commuters	100,000	

	United States			Input for FEMP Reporting Portal	
	Estimated # Vehicles	%	Avg. roundtrip commute distance (miles)	Vehicle Miles/D	VehicleType
Total:	141,337,148	100.0%			
Car, truck, or van:	125,006,865	88.4%			
Drove alone	107,990,698	76.4%			
Car	121,545,061	86.0%	27	2309867	POV Passenger Car
SUV or Light Truck (Gasoline)	62,400,849	44.2%	22	988085	POV SUV or Truck (gasoline)
SUV or Light Truck (Diesel)	218,725	0.2%	22	3463	POV SUV or Truck (diesel)
Carpool (assume 2-4 persons)	12,938,583	9.2%	27	245887	Carpool
Vanpool (assume 5-7+ persons)	615,780	0.4%	22	9751	Vanpool
Public transportation (excluding taxicab)	7,157,671	5.1%			
Bus or trolley bus	3,721,480	2.6%	30	78676	Bus
Streetcar or trolley car (carro publico	83,801	0.1%	17	993	Metro or Transit Rail
Subway or elevated	2,527,736	1.8%	18	31334	Metro or Transit Rail
Railroad	779,236	0.6%	81	44900	Commuter Rail
Commuter Rail (assume 80%)	623,389	0.4%	33	14564	Commuter Rail
Intercity rail (assume 20%)	155,847	0.1%	81	8980	Intercity Rail
Taxicab	160,553	0.1%	17	1929	POV Passenger Car
Motorcycle	294,635	0.2%	23	4724	Motorcycle
Bicycle	832,750	0.6%	7	4171	Bicycle
Walked	3,932,118	2.8%	1	3728	Walk
Other means	1,242,769	0.9%	55	48537	
Worked at home	6,171,591	4.4%			

Data on total U.S. vehicle registrations	Source: Transportation Energy Data Book: Edition 34 - Sep 2015,Ch 4 Light Vehicle Characteristics, http://cta.ornl.gov/data/chapter4.shtml
Transportation mode	American Community Survey, Table B08301, Means of Transportation to Work,
Commute distance	Commute distance information from DOT FHA National Household Travel Survey (NHTS) On-Line Analysis Tool

Vehicle Assumptions:

% Passenger Vehicles That Are Cars	% SUV/Light Trucks That Are Diesel	% Passenger Vehicles That Are SUV or Lt Truck
48.5%	0.3%	51.5%

C.5. Contracted Wastewater Treatment

Description

Appendix A.6 provides guidance on inventorying emissions from agency-controlled wastewater treatment. Although this contracted wastewater treatment calculation methodology is identical, the data sources for contracted wastewater treatment differ because of the inherent scope boundary issues between Scope 1 and Scope 3. As such, contracted wastewater treatment population inputs only include Federal employees.

Agencies should account for contracted wastewater treatment emissions associated with Federal employees in leased facilities. The agency maintains direct operational control over the presence of Federal employees at the facilities, so the agency should account for the employees' direct wastewater contribution to the wastewater treatment systems. The ownership status of the facility does not affect whether employees are included. Only Federal employees are to be included in the calculation of an agency's emissions associated with Scope 3 wastewater treatment. An agency may also voluntarily include contractor employees and visitors in its calculation of Scope 3 wastewater treatment emissions. For example, an agency for which government-owned, contractor-operated (GOCO) facilities constitute a significant portion of the agency may choose to voluntarily report the Scope 3 wastewater treatment emissions associated with contractor employees at those facilities, in an attempt to more realistically report the full impact of the wastewater treatment emissions from the agency's activities. If an agency's Scope 3 wastewater treatment emissions include contractor employees or visitors, the agency should explicitly note this in the qualitative statement accompanying its inventory. See Section A.6.1 for methods for estimating visitor populations served.

C.5.1. Default Methodology (to be Calculated by Annual GHG Data Report Workbook)

Data Sources[134]

Table C-8 shows the data elements and their preferred and alternate sources.

Table C-8: Contracted Wastewater Treatment Default Data Sources

Data Element	Preferred Source	Alternate Source
Employees served[135]	• Agency records	• N/A

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[134] Both the minimum and alternative methodologies are based on EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks* and *LGO Protocol*, Chapter 10. Agencies should be aware that because there is no widely accepted methodology for calculating emissions associated with wastewater treatment and the *LGO Protocol* is not from a federal source. See https://www.theclimateregistry.org/tools-resources/reporting-protocols/local-goverment-operations-protocol/ for the *LGO Protocol*.

[135] For the purposes of the default Scope 3 contracted wastewater treatment methodology, only Federal employees should be considered, as the subject agency maintains direct operational control over their presence at a Federal facility. Furthermore, the inclusion of "on-site contractors" introduces a host of definitional uncertainties and could potentially necessitate new data collection to adequately determine operational control over on-site contract personnel in question.

Data Element	Preferred Source	Alternate Source
Type of WWTP	• Wastewater treatment contractor	• Default provided

Calculation Steps

Employees served data is reported in the Annual GHG Data Report workbook. The Annual GHG Data Report workbook will utilize a national average composition of WWTP treatment and applies the default wastewater treatment methodology outlined in Appendix A.6.1.

C.5.2. Alternative Methodology (User Calculated)

Data Sources

Table C-9 shows the data elements and their sources.

Table C-9: Contracted Wastewater Treatment Data Sources

Data Element	Preferred Source
Employees served	• Agency records
Wastewater treatment processes used	• Wastewater treatment contractor
Digester gas [cu ft/day]	• Wastewater treatment contractor
Fraction of CH_4 in biogas	• Wastewater treatment contractor
BOD_5 load [kg BOD_5/day]	• Wastewater treatment contractor
Fraction of overall BOD_5 removal performance	• Wastewater treatment contractor
N load	• Wastewater treatment contractor

Calculation Steps

See Appendix A.6 for alternative methodology wastewater calculations.

C.6. Contracted MSW Disposal

Description

Contracted disposal of agency waste refers to the off-site disposal of MSW performed by an independent entity. Agencies are not required to report contracted MSW disposal at fully-serviced leased spaces for GHG inventories. This is consistent with the most recent "Interim Guidance for Calculating Federal Compliance with Executive Order 13693 Waste Diversion Goals" which only encourages but does not require agency reporting "…from buildings smaller than 5,000 gross square feet, leased facilities, and/or non-building waste if useful to agency waste management efforts." Appendix A provides guidance on inventorying emissions from agency-controlled (Scope 1) MSW disposal. The mass balance methodology[136] for contracted landfill disposal of MSW

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[136] This method is based upon the estimate approach used in the EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2007, p. A-304, and EPA Center for Corporate Climate Leadership, Landfill Offset Methodology.

generating CH4 used in this Scope 3 methodology differs from the LandGEM-based approach used for Scope 1. Even though waste disposed of in a particular reporting year generates emissions over a period more than 50 years, the methodology used for Scope 3 emissions allocates to the current reporting year all future emissions from waste that is disposed in the current year. Emissions from any waste disposed in past years are not allocated to the current reporting year.

The rationale for this differing approach is primarily due to the lack of control over the MSW once it is released to the contractor for disposal. It also eliminates the temporal data management complexities inherent with agencies applying a multi-year first-order decomposition model like LandGEM. This approach also enables a more temporally consistent, "apples-to-apples" comparison of emissions impacts of waste disposal options.

In addition to Federally-owned facilities, agencies should account for contracted solid waste disposal emissions associated with Federal employees in leased facilities and, where feasible, in leased facilities where Federal employees are the primary occupant unless otherwise specified in CEQ guidance on calculating compliance with waste diversion goals. The agency maintains direct operational control over the presence of Federal employees at the facilities, so the agency should account for the employees' contribution to solid waste disposal. The ownership status of the facility does not affect whether employees are included. Federal employees are included in the calculation of an agency's emissions associated with Scope 3 solid waste disposal. An agency may also voluntarily include contractor employees and visitors in its calculation of Scope 3 solid waste disposal emissions. For example, an agency for which GOCO facilities constitute a significant portion of the agency may choose to voluntarily report the Scope 3 solid waste disposal emissions associated with contractor employees at those facilities, in an attempt to more realistically report the full impact of the solid waste disposal emissions from the agency's activities. If an agency's Scope 3 solid waste disposal emissions include contractor employees or visitors, the agency should explicitly note this in the qualitative statement accompanying its inventory. Section A.6.1 outlines methods for estimating visitor populations served that may be adapted for solid waste disposal.

C.6.1. Default Methodology (to be Calculated by Annual GHG Data Report Workbook)

Data Sources

Table C-10 shows the data elements and their sources.

See www.epa.gov/climatechange/emissions/downloads09/Annex3.pdf and www.epa.gov/stateply/documents/resources/draft_landfill_offset_protocol.pdf.

Table C-10: Contracted Solid Waste Disposal Default Data Sources

Data Element		Preferred Source
Mass of solid waste disposed [short ton] [137]		• Reporting to the Office of Federal Sustainability (OFS) under E.O. 13693, Sec. 2(i) • Waste management contractor • Landlord
Mass of biogenic CO_2 and CH_4 [MT (Mg)]		• Will be calculated by Annual GHG Data Report workbook using EPA method
Does the landfill have a LFG collection system?		• Annual GHG Data Report workbook will assume 50% include LFG collection system • Waste management contractor • Landlord
Methane concentration rate, k		• Default will be provided by Annual GHG Data Report workbook
Potential methane generation capacity, Lo		• Default will be provided by Annual GHG Data Report workbook
NMOC concentration [ppmv]		• Default will be provided by Annual GHG Data Report workbook
Methane content of LFG [% by volume]		• Default will be provided by Annual GHG Data Report workbook
If LFG collection system	Efficiency of LFG collection system	• Default will be provided by Annual GHG Data Report workbook
	Oxidation factor	• Default will be provided by Annual GHG Data Report workbook

* 1 MT = 1 Mg (megagram)

Calculation Steps

To calculate Scope 3 emissions from contracted MSW disposal, do the following:

1. Input solid waste disposal data in Annual GHG Data Report workbook to calculate the CH_4 and CO_2 generation

2. Calculate emissions from landfills and solid waste facilities.

Step 1: Input solid waste disposal data in Annual GHG Data Report workbook to calculate the CH_4 and CO_2 generation

Agencies report annual disposal of solid waste in the Annual GHG Data Report workbook. Waste collected from a federal agency has a variety of potential fates including landfilling, recycling, and incineration.[138] Agencies should collect this data as part of reporting of waste diversion. When an agency does not have data on how waste was treated, it should follow the methodology used in the

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[137] If only volume data are available, the conversion factor of 1.5 Mg/m3 may be used. EPA 2009 (reference).

[138] For waste disposal off site of a federal agency, where the fate of the waste is gasification, agencies can report zero Scope 3 emissions from this activity at this time.

most recent Federal guidance for waste data reporting. These ratios should not be applied to known amounts of waste sent off site since that waste presumably already has the recycling removed from it. These ratios may be used if agencies are using a proxy method (such as a tons of waste per employee factor) to estimate total waste amounts, assuming the method doesn't already incorporate segregated recycling. Amounts of waste not sent to landfills and assumed to be recycled or incinerated for energy recovery are avoided emissions for agency Scope 3 inventories.

Step 2: Calculate emissions from landfills and solid waste facilities

Using this quantitative input, the Annual GHG Data Report workbook will use the EPA's mass balance model and its national default values to calculate an estimate of MSW's anthropogenic CH_4 and biogenic CO_2 emissions over time. The Annual GHG Data Report workbook applies the Scope 1 methodology outlined in Appendix A.7.1 using the national default values for uncontrolled releases, fugitive CH_4 losses, flare combustion, and venting. The derived calculations are outlined in Equation C-22 and Equation C-23, respectively.

Equation C-22: CH₄ Generation per Short Ton of MSW

CH_4 Generation [MT] = MSW_{mass} ● 0.90718 ● DOC ● DOC_f ● MCF ● F ● 16/12
Where:
CH_{4gen} = CH_4 generated by landfill [MT]
MSW_{mass} = Municipal solid waste disposed of in landfill [short ton]
0.90718 = Conversion from short ton to MT [MT/short ton]
DOC = Degradable organic carbon [MT C/MT waste], default value of 0.203
DOC_f = Degradable organic carbon digestible under the anaerobic conditions in the landfill [%], default value of 50%
MCF = Methane correction factor/uncontrolled release of CO_2 [%], default value of 100%
F = Fraction of CH_4 by volume in generated landfill gas, default value of 50%
16/12 = Molecular weight ratio CH_4/C

Source: EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2008. See:
https://www3.epa.gov/climatechange/Downloads/ghgemissions/508_Complete_GHG_1990_2008.pdf .

Equation C-23: Biogenic CO$_2$ Generation per Short Ton MSW

CO$_2$ Generation [MT] = MSW$_{mass}$ ● 0.90718 ● DOC ● DOC$_f$ ● MCF ● F ● 44/12
Where:
CO_{2gen} = CO$_2$ generated by landfill [MT]
MSW$_{mass}$ = Municipal solid waste disposed of in landfill [short ton]
0.90718 = Conversion from short ton to MT [MT/short ton]
DOC = Degradable organic carbon [MT C/MT waste], default value of 0.203
DOC$_f$ = Degradable organic carbon digestible under the anaerobic conditions in the landfill [%], default value of 50%
MCF = Methane correction factor/uncontrolled release of CO$_2$ [%], default value of 100%
F = Fraction of CH$_4$ by volume in generated landfill gas, default value of 50%
44/12 = Molecular weight ratio CO$_2$/C

Source: EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2008. See:
https://www3.epa.gov/climatechange/Downloads/ghgemissions/508_Complete_GHG_1990_2008.pdf.

C.6.2. Alternative Methodology (User Calculated)[139]

Data Sources

Agencies can utilize the same variables listed above for the default methodology but substitute site-specific or facility-level data available from the third-party contractor.

Calculation Steps

The alternative calculation method for contracted solid waste emissions is identical to the default, except for use of the site-specific data and disposal pathways available from the third-party contractor. For example, agencies with data on contracted waste disposal sent to MSW incinerators and WTE plants could use this detail to utilize a stationary combustion emissions methodology found in Appendix A.

C.7. Fully Serviced Leased Space

Description

Scope 3 emissions associated with agency operations in fully serviced leased space occur in leased facilities where the landlord has responsibility for operations and maintenance, including the payment of all utilities. They result from purchased electricity, stationary combustion, purchased steam and hot water, and purchased chilled water. In multi-tenant facilities, purchased electricity includes emissions associated with lighting, plug load, and centralized systems that serve all tenants and may or may not be sub-metered by tenant. Reporting emissions from fully serviced

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[139] This methodology is derived from the EPA Center for Corporate Climate Leadership's Optional Emissions from Commuting, Business Travel, and Product Transport methodology.
See https://nepis.epa.gov/Exe/ZyPDF.cgi/P1001177.PDF?Dockey=P1001177.PDF.

leased space is mandatory for FY 2017 for leases over 10,000 rentable square feet, newly solicited in FY 2016 and later,.

The methodologies used to calculate the components of the fully serviced leased space emissions are identical to the related Scope 1 and Scope 2 categories. Details for purchased electricity are found in Section B.1, stationary combustion in Sections A.1 and A.2, purchased steam and hot water in Section B.2, and purchased chilled water in Section B.3. Federal landlords of these facilities will report the same emissions as Scope 1 or Scope 2, depending on the emissions source.

C.7.1. Default Methodology (to be Calculated by "Fully Serviced Lease Space Scope 3 Emissions" Supplemental Workbook)

FEMP has provided a supplemental "Full Service Leased Space Scope 3 Emissions" Excel workbook to help agencies perform these calculations. By November 30 of each year, GSA will provide agencies with data sufficient to complete the supplemental workbook for all agency leased spaces (GSA occupancy agreements) located in GSA-owned buildings and buildings commercially leased by GSA.

In instances where leasing agencies cannot obtain data from their landlord or GSA, a reasonable methodology will be accepted, and GSA recommends using the methodology laid out in Appendix C for calculating Scope 3 emissions.

Data Sources

In general, data for reporting of fully serviced leased space is managed by facility landlords. If the landlord is a Federal entity (e.g., GSA), the landlord should provide the tenant with emissions data and/or energy data sufficient calculate their emissions. For leases with a private landlord, agencies will need to work with their private landlords to obtain the necessary emissions and/or energy information at no additional cost to the government.

Where an agency has a lease in a multi-tenant building, the tenant agency will need to work with their landlord to determine their share of energy consumption for centralized building systems and common areas. In situations where the landlord is GSA, GSA will provide the pro-rated share to the tenant agency. In other situations, agencies and landlords may apply modeling or other methodologies to pro-rate facility energy used in common areas.

Landlords, should calculate and transmit this data to the agency at the level of individual facilities in order for the agency to adequately check data completeness and accuracy. This will also facilitate agency efforts to better manage the energy and agency-controllable activities in full-service leased space, such as plug loads, occupancy and energy conservation efforts, which can reduce GHG emissions. For electricity, FEMP will provide the capability for agencies to report location and consumption information by facility.

Calculation Steps

The supplemental "Full Service Leased Space Scope 3 Emissions" Excel workbook calculates emissions from purchased electricity, stationary combustion, purchased steam and hot water, and purchased chilled water. The calculations are based on the methodologies developed for these

emissions categories for other reporting as outlined in the Appendices and implemented in the Annual GHG Data Report, to which agencies should refer for detailed discussions of the calculation steps. Table C-11 outlines the relevant Appendix references and data inputs.

Table C-11: Fully Serviced Leased Space Scope 3 Emissions Calculations

Leased Space Emissions Subcategory	Appendix Reference Section	Agency Data Input
Purchased electricity	B.1	• Electricity consumption • Zip code
Stationary combustion	A.1 and A.2	• Fuel volumes consumed in the on-site generation of electricity, steam and heat
Purchased steam and hot water	B.2	• Energy content of purchased steam or hot water consumed
Purchased chilled water	B.3	• Energy content of purchased chilled water

Once agencies complete data entry in the supplemental workbook, results may be directly entered into the Annual GHG Data Report workbook in worksheet 3.19.

C.7.2 Alternative Methodology for Calculating Scope 3 Emissions in Leased Facilities

Only in instances where leasing agencies cannot obtain primary data from their landlord or GSA, a reasonable estimate will be accepted. The following methodology, which summarizes GSA's model for calculating these emissions, is recommended.

The general methodology is to first determine a reasonable estimate of utility consumption per square foot to apply to each lease, based on actual data drawn from sources similar to it in space type (i.e. office, warehouse) and geographic area. Where actual data is not available, these per-square-foot estimates are then multiplied by the square footage of each lease to obtain per-lease estimates of utility consumption. Finally, the estimates of per-lease utility consumption are used as inputs to emissions calculations embedded in FEMP's "Full Service Leased Space Scope 3 Emissions" supplemental workbook, as described above in Table C-11 and Sections A.1, A.2, B.1, B.2, and B.3.

GSA will provide agencies with a tool that incorporates these principles and GSA-researched per-square-foot averages for utility consumption. Using this tool, agencies will be able to estimate utility usage and GHG emissions for each lease simply by entering its square footage, space type, and ZIP code. However, agencies may be able to obtain more accurate estimates by following this Alternative Methodology themselves using more agency-specific data sources, especially if they have significant amounts of leased space dedicated to non-office use and/or concentrated within a specific geographical region.

Data Sources

Where lease-specific data is not available, a variety of alternative data sources can be used to estimate utility consumption per square foot. The ideal source of estimated data is one that is specific to both the space type (i.e., office vs. warehouse) and geographic region (to capture heating and cooling needs specific to the climate). However, because estimates of per-square-foot consumption should generally be averages of multiple existing data points, space types and regions should be defined broadly enough to allow for averaging together multiple existing data points within each combination of space type and geographic region.

Available data sources may include a combination of data reported by an agency's other landlords, meter data from agency-owned buildings, meter data from an agency's net-of-utilities leases, and/or non-agency-specific data such as the Commercial Buildings Energy Consumption Survey (CBECS).

For example, to estimate emissions for agency-occupied spaces in its commercially-leased buildings, GSA uses both data reported by nearby commercial landlords and GSA-paid meter data from nearby net-of-utilities leases. To model geographic differences in average consumption while maintaining a variety of data points within each average, GSA calculates separate averages for each utility within each GSA region. Because the majority of commercially-leased space managed by GSA is classified as office space, GSA does not currently compute separate averages by building type.

Calculation Steps

Once a reasonable estimate of utility use per square foot has been determined for each lease, this estimate should be multiplied by the square footage of the lease (and any necessary conversion factors[140]) to obtain the estimated usage of each utility for the entire lease. These estimates of per-lease utility consumption can then be used as inputs to emissions calculations as described above in Table C-11 and Sections A.1, A.2, B.1, B.2, and B.3.

Equation C-24, Estimated Emissions for Leased Space:

$$\textbf{\textit{Total estimated emissions for each lease is equal to}}:$$

$$\sum_{\textbf{\textit{Utilities}}} \left(Estimated\ Use\ per\ SF_{Utility} * SF_{Lease} * Conversion\ Factor * Emissions\ Factor_{Utility} \right)$$

C.7.3 Alternative Methodology 3 for Reporting Scope 3 Emissions in Leased Facilities

In some cases, private sector landlords may wish to directly calculate and provide GHG emissions to agency tenants without providing the underlying energy data, as allowed by E.O. 13693, Sec.

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[140] For example, because GSA records only the Rentable Square Footage (RSF) of leased assets, but calculates average utility consumption on a per-Gross Square Foot (GSF) basis, GSA uses a conversion factor to estimate the equivalent GSF of each lease in order to incorporate a pro-rata share of common space in its per-lease utility use estimates. The conversion factor is equal to the ratio of GSF to RSF across GSA's entire owned building inventory.

3(h)(iv)(B) (landlords required to report "carbon emission <u>or</u> energy consumption data"). For these situations, FEMP's "Full Service Leased Space Scope 3 Emissions" supplemental workbook will provide a section for direct entry of landlord-reported, lease-level GHG emissions data. Agencies should work with landlords in such cases to ensure that reported data is consistent with the methodologies and principles of Sections A.1, A.2, B.1, B.2, B.3, C.7.1, and C.7.2.

Appendix D. Emission and Conversion Factors

Appendix D includes an overview of the source data for emissions factors used, by scope, as well as commonly used conversions. Emission factors and methodologies referenced in this document were selected because of their applicability to Federal operations, technical authority, and acceptance in other GHG reporting programs. The calculation methods and emission factors were leveraged from existing GHG regulatory and voluntary inventory protocols, with the EPA GHGRP given top priority when applicable, followed by other Federal sources.

The Federal GHG Accounting and Reporting Guidance and associated Annual GHG Data Report workbook rely on EPA's periodically-updated Center for Corporate Climate Leadership GHG Emission Factors Hub (https://www.epa.gov/climateleadership/center-corporate-climate-leadership-ghg-emission-factors-hub) for the bulk of the heating values (Btu conversions), GHG emission factors, and global warming potential (GWP) factors for converting to carbon dioxide equivalent (CO_2e) units. These factors are embedded in the Annual GHG Data Report workbook and are updated for Federal fiscal year reporting when EPA updates the factors in the Hub. In some years EPA may update emissions factors between the time GHG Data Report workbooks are released to agencies and the Federal GHG reporting due date. In this situation the emission factors in the GHG Data Report workbook are to be used regardless of the updated factors on the EPA GHG Emission Factors Hub. FEMP will maintain, archive, and update heat content, emission conversion, and GWP factors across years in the form of each year's Annual GHG Data Report workbook and in coordination with CEQ.

Table D-1 presents a crosswalk between the factor tables in the EPA GHG Emission Factors Hub and other sources with the appendices in the Annual GHG Data Report workbook. Agencies are encouraged to refer to the appendices in the Annual GHG Data Report workbook for more information, specifically Appendix D. Emissions Factor Key, for the most current factors and source data. Table D-2 provides an overview of the data entry worksheets, calculation tables, and appendices of the Annual GHG Data Report workbook. The emission categories in Table D-1 are hyperlinked to the specific workbook tab indicated in Table D-2 to illustrate where the data for the category should be entered and the location of the factors used in the workbook appendices. Table D-3 summarizes general conversion factors commonly used for ease of conversion between various units.

Scope 1 Combustion Emission Factors

Scope 1 greenhouse gas emissions are comprised from sources that are owned or controlled by a Federal agency, including vehicles and equipment, stationary sources, on-site landfills and wastewater treatment, as well as fugitive emissions. For Scope 1 emissions, the methodologies use default emission factors and higher heating values by fuel type from the U.S. EPA's GHGRP and Center for Corporate Climate Leadership guidance.

Scope 1 mobile combustion emissions factors include CH_4 and N_2O emissions for highway vehicles, alternative fuel vehicles, and non-highway vehicles using the EPA Center for Corporate Climate Leadership's Mobile Sources Guidance.
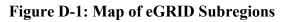
Scope 1 Fugitive F-Gas Emission Factors

Methodologies to calculate emissions associated with Scope 1 fluorinated gas fugitive emission and leak rate estimation factors use the EPA Center for Corporate Climate Leadership direct hydrofluorocarbon (HFC) and perfluorocarbon (PFC) emissions factors from refrigeration and air conditioning equipment use.

Scope 2 Emission Factors

Scope 2 greenhouse gas emissions result from the generation of electricity, heat or steam purchased by a Federal agency.

For Scope 2 purchased electricity, the Annual GHG Data Report workbook will use the most current eGRID subregion output emission rate factors provided by the EPA eGRID database at the time of each annual inventory to calculate default category GHG emissions. This database divides the electric grid into 26 subregions with unique emission factors based on the regional electricity generation mix. Figure D-1 shows the eGRID subregion map illustrating the approximate boundaries of the eGRID subregions, which are not all defined by clear geographic boundaries but by utility areas.

Figure D-1: Map of eGRID Subregions

This is a representational map: many of the boundaries shown on this map are approximate because they are based on companies, not on strictly geographical boundaries.

Agencies are responsible for reporting their electricity usage according to these subregions and for U.S. Territories, if applicable. Agencies can map a facility's ZIP code to the corresponding eGRID subregion using the EPA Power Profiler website or the Annual GHG Data Report workbook.[141]

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[141] EPA Power Profiler. See www.epa.gov/powerprofiler.

Supplemental purchased steam, hot water, and chilled water emission factors are leveraged from both eGRID and International Energy Agency (IEA) resources.

Steam and hot water emissions factors for CO_2, CH_4 and N_2O are used in calculation step 2 under the default methodology for steam/hot water emissions, in combination with default efficiency percentages. For example, the current workbook uses a steam emission factor with a default boiler efficiency of 80%, a default steam production efficiency of 75% and includes a 0.90 factor to account for transmission losses, based on the formula 1-distribution losses in %. Similarly, the hot water emission factor assumes all but the steam production efficiency. Chilled water factors assume a 10% loss during transmission and use the same source as steam and hot water emission factors for absorption chillers, engine-driven chillers, and electric-driven chillers for natural gas and electricity.

Scope 3 Emission Factors

Scope 3 emissions are comprised from sources not owned or directly controlled by a Federal agency, but related to agency activities, such as transmission and distribution losses from purchased electricity, business travel, employee commuting, contracted solid waste disposal, contracted wastewater treatment and additional emissions sources that exist beyond the examples provided. For Scope 3 emissions, or emissions not covered by the GHGRP or eGRID database, agencies performing alternative methodology calculations should first use the relevant emission factors from the EPA.[142] Ground business and commuter personal vehicle, commuter and mass transit, and airline business travel emission factors from EPA Center for Corporate Climate Leadership are used in the default methodology and provided in the sources referenced in Table D-1. Agencies should refer to the EPA AP 42 website to ensure the emission factors they use are current when calculating alternative emission estimates. Factors from the following sources are used for ground business, commuter mileage, mass transit factors, and airline travel.

Airline business travel emissions factors are categorized by segment travel distance, as follows:

- Long Haul ($\geq$ 700 miles)
- Medium Haul ($\geq$300 and < 700 miles)
- Short Haul (< 300 miles)
- Unknown Segment Class
  - o Unknown distance emission factors are assumed to fit into the Long Haul category based on GSA travel data showing that the average distance for federal business flights is 1,265 miles.

Global Warming Potentials

All gases, chemical formulas and 100-year average for the global warming potential of various chemicals, such as refrigerants and fugitive gases (e.g., Methane, Nitrous Oxide, Nitrogen Trifluoride, etc.), are included in the Annual GHG Data Report workbook. Sources for those

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[142] EPA, AP 42. See www.epa.gov/ttn/chief/ap42/index.html.

GWPs are also included in the Annual GHG Data Report workbook to provide transparency and consistency for reporting.

Table D-1: Emission and Conversion Factor Sources

Scope	Emissions Categories/Worksheets and Associated Tab in Reporting Workbook Using Factor	Factor Type	Default Methodology Emission Factor Source
All scopes	All emission categories; Reporting Workbook Appendix D	Global warming potentials (100-year)	EPA GHG Emission Factors Hub (https://www.epa.gov/climateleadership/center-corporate-climate-leadership-ghg-emission-factors-hub), Tables 10a and 10b
		General conversion factors	EPA GHG Emission Factors Hub (https://www.epa.gov/climateleadership/center-corporate-climate-leadership-ghg-emission-factors-hub), Tables 1 through 6.
		GGE conversion factors	Federal Automotive Statistical Tool (FAST) (https://fastweb.inel.gov)
Scope 1 (including biogenic)	Stationary combustion (agency-owned and -controlled heat and steam); Reporting Workbook Tabs 3.1 – 3.9; Appendices A, B, and D	Heat Values for various fuels (Btu conversion factors)	EPA GHG Emission Factors Hub (https://www.epa.gov/climateleadership/center-corporate-climate-leadership-ghg-emission-factors-hub), Table 1
		CO_2, Methane (CH_4) and Nitrous Oxide (N_2O) emission factors	EPA GHG Emission Factors Hub (https://www.epa.gov/climateleadership/center-corporate-climate-leadership-ghg-emission-factors-hub), Table 1
	Mobile combustion (agency-owned and -controlled vehicles, airplanes, etc.) Reporting Workbook Tabs 3.3, 3.4.	CO_2 emission factors	EPA GHG Emission Factors Hub (https://www.epa.gov/climateleadership/center-corporate-climate-leadership-ghg-emission-factors-hub), Table 2
		Methane (CH_4) and Nitrous Oxide (N_2O) emission factors	EPA GHG Emission Factors Hub (https://www.epa.gov/climateleadership/center-corporate-climate-leadership-ghg-emission-factors-hub), Tables 3, 4, and 5
	Fugitive F-Gas Emission Factors; Reporting Workbook Tabs 3.5, 3.6	GWPs for Refrigeration/Air Conditioning Equipment and other F-Gases	EPA GHG Emission Factors Hub (https://www.epa.gov/climateleadership/center-corporate-climate-leadership-ghg-emission-factors-hub), Tables 10a and 10b
Scopes 1 and 3	Landfill/MSW; Reporting Workbook Tabs 3.8, 3.18.	Emission model equation defaults	EPA GHGRP, Table HH-1 to Subpart H of Part 98 and Landfill Gas Emissions Model (LandGEM)
	Wastewater treatment, Reporting Workbook Tabs 3.7, 3.17.	CH_4 emission factors/model	EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks

Table D-1: Emission and Conversion Factor Sources (cont'd)

Scope	Emissions Categories/Worksheets and Associated Tab in Reporting Workbook Using Factor	Factor Type	Default Methodology Emission Factor Source
Scope 2	Purchased electricity Reporting Workbook Tabs 1.2 – 1.7	CO_2, CH_4, and N_2O emission factors by eGRID subregion	EPA GHG Emission Factors Hub (https://www.epa.gov/climateleadership/center-corporate-climate-leadership-ghg-emission-factors-hub), Table 6 and International Energy Agency (IEA), *Electricity Information Database (2016 edition)* and World *CO2 Emissions from Fuel Combustion Database (2016 edition)*, http://www.iea.org.
	Purchased steam or hot water; Reporting Workbook Tab 3.10.	CO_2, CH_4, and N_2O emission factors	DOE 1605(b), Technical Guidelines[143], Part F: Indirect Emissions
	Chilled water; Reporting Workbook Tab 3.11	CO_2, CH_4, and N_2O emission factors	DOE 1605(b), Technical Guidelines, Part F: Indirect Emissions and Appendix N
	Combined heating and power; Reporting Workbook Tab 3.12.	Electricity, steam, and hot water CO_2, CH_4, and N_2O emission factors	EPA GHG Emission Factors Hub (https://www.epa.gov/climateleadership/center-corporate-climate-leadership-ghg-emission-factors-hub), Table 6 and DOE 1605(b), Technical Guidelines
	Purchased steam from waste-to-energy; Reporting Workbook Tab 2.2	Steam CO_2, CH_4, and N_2O emission factors	EPA, eGRID Derived
	Renewable energy purchases; Reporting Workbook Tab 2.2.	CO_2, CH_4, and N_2O emission factors by eGRID subregion	EPA GHG Emission Factors Hub (https://www.epa.gov/climateleadership/center-corporate-climate-leadership-ghg-emission-factors-hub), Table 6

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[143] Technical Guidelines, Voluntary Reporting of Greenhouse Gases (1605(b)) Program, Office of Policy and International Affairs, United States Department of Energy, January 2007. (http://www.eia.gov/oiaf/1605/January2007_1605bTechnicalGuidelines.pdf)

Table D-1: Emission and Conversion Factor Sources (cont'd)

Scope	Emissions Categories/Worksheets and Associated Tab in Reporting Workbook Using Factor	Factor Type	Default Methodology Emission Factor Source
	T&D losses; Reporting Workbook Tab 3.13.	Loss factors	EPA GHG Emission Factors Hub (https://www.epa.gov/climateleadership/center-corporate-climate-leadership-ghg-emission-factors-hub), Table 6 and International Energy Agency (IEA), *Electricity Information Database (2016 edition)* and World *CO2 Emissions from Fuel Combustion Database (2016 edition),* http://www.iea.org.
	Business air travel; Reporting Workbook Tab 3.14	Custom air travel CO_2, CH_4, and N_2O emission factor model	EPA Center for Corporate Climate Leadership, Optional Emissions from Commuting, Business Travel and Product Transport
	Ground business travel; Reporting Workbook Tab 3.15.	Vehicle CO_2, CH_4, and N_2O emission factors	EPA Center for Corporate Climate Leadership, Optional Emissions Guidance (https://www.epa.gov/climateleadership/center-corporate-climate-leadership-ghg-inventory-guidance-low-emitters)
	Commuter travel; Reporting Workbook Tab 3.16.	Public Transit CO_2, CH_4, and N_2O emission factors	

Table D-2: Annual GHG Data Report Workbook Table of Contents

Work sheet #	Worksheet Title	Function	Data Entry Cells
Electricity			
1.1	Electricity Instructions	Guidance	None
1.2	Goal Building (GHG Target)	Data Input	Columns B (optional facility identifier),C (zip code) & D (consumption in kWh), starting in row 10
1.3	Excluded Building (GHG Target)	Data Input	Columns B (optional facility identifier),C (zip code) & D (consumption in kWh), starting in row 10
1.4	Goal Building (GHG Non-Target)	Data Input	Columns B (optional facility identifier),C (zip code) & D (consumption in kWh), starting in row 10
1.5	Excluded Building (Non-Target GHG)	Data Input	Columns B (optional facility identifier),C (zip code) & D (consumption in kWh), starting in row 10
1.6	Summary of Sheets 1.2-1.5 (zip tool)	Reporting	None
1.7	Elec. Summary eGRID Direct Entry (no link to zip tool)	Data Input	Columns D-G (MWh by energy intensity goal status and GHG target status by eGRID region), rows 23-50, 52
1.8	Combined Electricity Summary (adds 1.6 & 1.7) and Costs	Data Input	Costs in $ (thousands) cells F4:F11 by energy intensity goal status and GHG target status.
Renewable Energy			
2.1	Renewable Energy Instructions	Guidance	None
2.2	Renewable Energy Data	Data Input	Columns A-P (Source information) Q-AD (Renewable electric sources) AE-AR (Renewable non-electric sources), other inputs
2.3	Renewable Energy Emissions and Summary	Reporting	None
Inputs/Calcs for Scopes 1, 2 and 3			
3.1	Direct Fuel Use and GHGs Instructions	Guidance	None
3.2	Scope 1: Goal Subject and Excluded Buildings Energy	Data Input	Columns D (GHG Target Fuel Use, Native Units), E (GHG Target Excluded Fuel Use, Native Units), F (International Fuel Use, Native Units), I (Costs, $000) rows 9-38 (Energy Intensity Goal Subject), 47-76 (Energy Intensity Goal Excluded)
3.3	Scope 1: Vehicles and Equipment Energy	Data Input	Columns C (fuel consumption in native units, GHG Target Subject), D (fuel consumption in native units, GHG Target Excluded), E (fuel consumption in native units, International), J (Cost $000) rows 9-20
3.4	Scope 1: FAST Mobile (Vehicle Fleet) Energy	Data Input	Columns E (annual consumption domestic in GGE), F (annual consumption international GGE), I (Costs $000) rows 9-45. Downloadable data report available on FAST site: fastweb.inl.gov
3.5	Scope 1: Mixed Refrigerants	Data Input	Columns C (quantity purchased/issued),E (quantity returned to supply) lbs, rows 9-87. See EPA's HFC Emission Accounting Tool at: www.epa.gov/snap/reducing-hydrofluorocarbon-hfc-use-and-emissions-federal-sector.
3.6	Scope 1: Fugitive F-gases	Data Input	Columns C (quantity purchased/issued subject to GHG target) D (quantity purchased/issued excluded from GHG target), E (quantity purchased/issued International), G (quantity returned to supply subject to GHG target) H (quantity returned to supply excluded from GHG target), I (quantity returned to supply International) in lbs, rows 11-54 for default gases, rows 57-59 for custom gases with custom GWP in column Q.
3.7	Scope 1: Wastewater Treatment Plant	Data Input	Columns F (Yes or No for type of WWTP), G (population served, see Appendix A) rows 7-13
3.8	Scope 1: Fugitive Landfill Gases	Data Input	Column D row 7 (mass of solid waste disposed of on-site in short tons) row 8 (landfill open date), row 9 (landfill close date) rows 13-14 (LFG production CO2 and CH4)

Work sheet #	Worksheet Title	Function	Data Entry Cells
3.9	Scope 1: Process Emissions	Data Input	Columns D (GHG Target subject emissions in lbs), E (GHG Target excluded emissions in lbs) and F(International emissions in lbs), rows 7-50 default gases, rows 52-54 for custom gases.
3.10	Scope 2: Steam and Hot Water	Data Input	Columns D (GHG Target subject consumption in BBTU), E (GHG Target Excluded consumption in BBTU), F (GHG International consumption in BBTU), I (Cost $000), picklist for fuel/material in column C. Rows 8-32 for Energy Intensity Goal Subject facilities, rows 38 to 60 for Energy Intensity Goal Excluded facilities.
3.11	Scope 2: Chilled Water	Data Input	Columns E (GHG Target subject consumption in BBTUs), F (GHG Target excluded consumption in BBTUs), G (GHG International consumption in BBTUs), J (costs in $000), picklist for fuel/material in column C. Rows 8-60 for Energy Intensity Goal Subject facilities, rows 68 to 96 for Energy Intensity Goal Excluded facilities.
3.12	Scope 2: Combined Heat and Power (CHP)	Data Input	Columns E (GHG Target subject consumption in BBTUs or MWh), F (GHG Target excluded consumption in BBTUs or MWh), G (GHG International consumption in BBTUs or MWh), J (costs in $000). Column C for plant name, column D picklist for eGRID subregion/fuel. Rows 7-44 for Energy Intensity Goal Subject facilities, rows 50 to 80 for Energy Intensity Goal Excluded facilities.
3.13	Scope 3: Transmission and Distribution Losses	Data Input	None, automatically calculated from other worksheets.
3.14	Scope 3: Air Business Travel	Data Input	Cell D7 lbs CO2 from air travel (GSA method), OR cells D13 to 16 passenger miles for short-, medium-, long-haul and unknown flights for Alternative Methodology.
3.15	Scope 3: Ground Business Travel	Data Input	Cells D7 to D11 number of business trips by vehicle type, OR cells H18 to H30 mileage by vehicle type for Alternative Methodology 1, OR cells D37 to D39 miles traveled for Alternative Methodology 2.
3.16	Scope 3: Commuter Travel	Data Input	Column D rows 8-21 miles by process/vehicle/fuel type.
3.17	Scope 3: Contracted Wastewater Treatment	Data Input	Cell G6, GHG Target Subject Federal employees served.
3.18	Scope 3: Contracted Waste Disposal	Data Input	Cell D7, mass of solid waste disposed off-site in short tons.
3.19	Scope 3: Voluntary Reporting	Data Input	Cells E7:E10, E16:E19, E25:E28

Other Reporting

Work sheet #	Worksheet Title	Function	Data Entry Cells
4.1	Other Reporting Instructions	Guidance	
4.2	New Building Design	Data Input	Columns A-H, starting in row 7
4.3	Source and Clean Energy	Data Input	For building subject to energy intensity goals cells A7:A11 Name of Project Saving Source Energy, B7:B11 Annual Site Energy Increase with Project (MMBTU), C7:C11 Annual Source Energy Saved with Project (MMBTU), D7:D11 Adjustment to Annual Site Energy (MMBTU). Cells A18 to D22 the same except for Energy Intensity Goal Excluded Facilities. Cells A25 to K38 table of inputs for CHP clean energy calculations. Cells A42 to K48 table of inputs for CCS clean energy calculations. Cells A51 to B57 for SMR clean energy input.
4.4	Other Data (Water, Square Footage, Project Financing and Training)	Data Input	Columns B-G, rows 10-111
4.5	Performance Summary	Reporting	
4.6	GHG Results Summary	Reference	
4.7	RE Scope 3 Percentage	Reference	Column B, rows 5 and 6 (row 6 will automatically look up Scope 3 GHG emission target for agency if available)

Appendices

A.	Emissions factors by zip code data	Reference	
B.	Foreign country emissions data	Reference	

Work sheet #	Worksheet Title	Function	Data Entry Cells
C.	RE emissions factors lists	Reference	
D.	Emissions factor key	Reference	
E.	Global Warming Potential Key	Reference	
F.	GGE Conversion	Reference	
G.	Custom RE Summary	Reference	

General Conversion Factors

Commonly used conversion factors are shown in the following table for ease of conversion between various units.

Table D-3: General Conversion Factors

To Convert From	To	Multiply By
Weight		
Kilograms (kg)	Pounds (lb)	2.20462
Pounds (lb)	Kilograms (kg)	0.45359
Pounds (lb)	Metric tons	4.53592×10^{-4}
Short tons	Pounds (lb)	2,000
Short tons	Metric tons	0.90718
Metric tons (MT)	Short tons	1.10231
Metric tons (MT)	Kilograms (kg)	1,000
Million MT CO_2e (MMT CO_2e)	MT CO_2e (MT CO_2e)	1,000,000
Metric tons (MT)	Tons	1
Volume		
Cubic meters (m^3)	Cubic feet (cu ft or ft^3)	35.31467
Cubic feet (cu ft or ft^3)	Cubic meters (m^3)	0.028317
Gallons (liquid, U.S.)	Liters (l)	3.78541
Liters (l)	Gallons (liquid, U.S.)	0.26417
Barrels of Liquid Fuel (bbl)	Cubic meters (m^3)	0.15891
Cubic meters (m^3)	Barrels of Liquid Fuel (bbl)	6.289
Barrels of Liquid Fuel (bbl)	Gallons (liquid, U.S.)	42
Gallons (liquid, U.S.)	Barrels of liquid fuel (bbl)	0.023810
Gallons (liquid, U.S.)	Cubic meters (m^3)	0.0037854
Liters (l)	Cubic meters (m^3)	0.001
Distance		
Feet (ft)	Meters (m)	0.3048
Meters (m)	Feet (ft)	3.28084
Miles (mi)	Kilometers (km)	1.60934
Kilometers (km)	Miles (mi)	0.62137

To Convert From	To	Multiply By
Area		
Square feet (ft^2)	Acres	2.29568×10^{-5}
Square meters (m^2)	Acres	2.47105×10^{-4}
Square miles (mi^2)	Square kilometers (km2)	2.58999
Temperature		
Degrees Celsius (°C)	Degrees Fahrenheit (°F)	°C = (5⁄9) × (°F − 32)
Degrees Fahrenheit (°F)	Degrees Celsius (°C)	°F = (9⁄5) × °C + 32
Degrees Celsius (°C)	Kelvin (K)	K = °C + 273.15
Kelvin (K)	Degrees Rankine (°R)	1.8
Energy		
Joules	Btu	9.47817×10^{-4}
Btu	MMBtu	1×10^{-6}
Btu	BBtu	1×10^{-9}
Ton hour	Btu	1.2×10^4
Ton hour	MMBtu	1.2×10^{-2}
MWh	MMBtu	3.413
Pressure		
Pascals (Pa)	Inches of mercury (in Hg)	2.95334×10^{-4}
Inches of mercury (in Hg)	Pounds per square inch (psi)	0.49110
Pounds per square inch (psi)	Inches of mercury (in Hg)	2.03625

Source: U.S. EPA, GHGRP; Federal Register / Vol. 74, No. 209 / Friday, October 30, 2009 / Rules and Regulations; Table A-2 to Subpart A of Part 98. See https://www.epa.gov/ghgreporting/resources-subpart-ghg-reporting.

Source: DOE, Office of Policy and International Affairs, 1605(b) Program, Technical Guidelines to the Voluntary Reporting of Greenhouse Gases (1605(b)) Program (January 2007). See www.eia.doe.gov/oiaf/1605/January2007_1605bTechnicalGuidelines.pdf.

Appendix E. Definitions

This appendix defines the key terms included in this Guidance. Every effort has been made to maintain consistency in use of definitions across various statutes, regulations, and Executive Orders. However, should any inconsistencies arise, the definitions in this document will be used for the purposes established within this Guidance.

Absolute greenhouse gas emissions: Total GHG emissions without normalization for activity levels and includes any allowable consideration of sequestration.

Additionality: A criterion often applied to GHG project activities, stipulating that project-based GHG reductions should only be quantified if the project activity "would not have happened anyway"—i.e., that the project activity (or the same technologies or practices that it employs) would not have been implemented in its baseline scenario.

Agency: An executive agency as defined in Section 105 of title 5, United States Code, excluding the Government Accountability Office.

Anthropogenic emissions: Emissions produced as a result of human activity that releases GHG emissions into the atmosphere. One of the largest sources of anthropogenic GHG emissions is the combustion of fossil fuels or fossil fuel-based products to produce electricity.

Base year: A specific fiscal year against which an organization's emissions are tracked over time.

Base year emissions recalculation: A recalculation of emissions in the base year that reflects a change in the structure of the organization or reflects a change in the accounting methodology used. It ensures data consistency over time, i.e., comparisons of like with like over time.

Biofuels: Biofuels are fuels developed by converting biomass into liquid fuels. Sources of biomass for biofuels include but are not limited to crops such as corn and soybeans, vegetable oils and animal fats, agriculture or forestry residues, grassy and woody plants, and algae.

Biogenic emissions: Emissions related to the natural carbon cycle as well as those resulting from the production, harvest, combustion, digestion, fermentation, decomposition, or processing of biologically-based materials.

Biological carbon storage: The process of increasing the carbon content of a reservoir/pool other than the atmosphere, including the removal of atmospheric carbon dioxide by biological processes, such as photosynthesis.

Biomass: Biomass literally means living matter, but the term is also used to specifically depict any non-fossilized organic material originating from modern or contemporarily grown plants, animals, or microorganisms (including products, by-products, residues and wastes from agriculture, forestry, and related industries, as well as the non-fossilized and biodegradable organic fractions of industrial and municipal wastes, including gases and liquids recovered from the decomposition of non-fossilized and biodegradable organic material).

Biogenic biomass/biofuel combustion emissions: Emissions resulting from the combustion of materials that naturally sequester CO_2, such as biomass, or biofuels derived from vegetable oils or animal fats.

Biological sequestration: The capture and storage of the atmospheric GHG carbon dioxide by biological processes, such as photosynthesis (through practices such as reforestation or preventing deforestation) or by enhanced soil carbon trapping in agriculture.

British Thermal Unit: The quantity of heat required to raise the temperature of one pound of water by one degree Fahrenheit at 39.2 degrees Fahrenheit.

Carbon dioxide (CO_2): One of the seven primary GHGs, consisting of a single carbon atom and two oxygen atoms. It is the principal anthropogenic GHG and is the reference gas against which other GHG are measured, and therefore has a GWP of 1. While it is a naturally occurring gas, it is also a by-product of burning fossil fuels and biomass, as well as land-use changes and other industrial processes.

Carbon offset: An instrument that represents the sequestration, destruction, or reduction of one metric ton of carbon dioxide equivalent outside an organization's boundary, used to compensate for emissions produced inside the organization's boundary.

Carbon sequestration: The process of increasing the carbon content of a reservoir/pool other than the atmosphere, including the removal of carbon from the atmosphere in carbon sinks (such as oceans, forests, or soils), through anthropogenic or natural processes (biological and geological). For the purposes of this document, carbon sequestration does not include CO_2 captured through carbon capture and storage technologies.

Carbon stock: The quantity of carbon contained in a "pool," meaning a reservoir or system which has the capacity to accumulate or release carbon.

Certification: The method used to ensure that an agency's GHG emissions inventory (either the base year or subsequent years) has met a minimum quality standard and complied with an appropriate set of procedures and protocols for submitting emissions inventory information.

CO_2 equivalent (CO_2e): Aggregated unit used in combining multiple GHG, based on the GWP of each GHG. The reference gas for the GWP used is CO_2, and therefore GWP-weighted emissions are measured in mass units of CO_2 equivalent.

Cogeneration/combined heat and power: A facility producing both electricity and steam heat using the same fuel supply.

Control approach: An emissions accounting approach for defining organizational boundaries in which an organization reports 100 percent of the GHG emissions from operations under its financial or operational control.

Control: The ability of an organization to direct the policies of another operation. It is defined as either operational control (the organization or one of its subsidiaries has the full authority to introduce and implement operating policies at the operation) or financial control (the organization has the ability to direct the financial and operating policies of the operation with a view to gaining economic benefits from its activities).

de minimis: A minimum emissions accounting threshold below which reporting is not indicated. Federal agency GHG inventories have no *de minimis* reporting threshold.

Direct GHG emissions: Emissions from sources that are owned or controlled by the reporting organization.

Double counting: Two or more reporting organizations take ownership of the same emissions or reductions within the same scope. Indirect emissions (Scope 2 and 3) are inherently another entity's direct, Scope 1 emissions.

eGRID non-baseload output emissions rate: The Emissions & Generation Resource Integrated Database (eGRID) 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 US electricity generating plants that provide power to the electric grid and report data to the US Government. eGRID integrates many different Federal data sources on power plants and power companies, from three different Federal agencies: the Environmental Protection Agency (EPA), EIA, and the Federal Energy Regulatory Commission (FERC). eGRID provides the output emissions rate for power plants in a certain aggregation (e.g., eGRID subregion) that combust fuel and have capacity factors less than 0.8, weighted by generation and a percentage of generation determined by capacity factor.

Emission factor: A representative value for the rate of emissions released that relates the quantity of a pollutant released into the atmosphere with an activity associated with the release of that pollutant.

Emissions: Gases and particles that are put into the air or emitted by various sources.

Energy bill: A bill or invoice that shows for each energy or utility commodity, the amount consumed/consumption, with units of measure, rates, and costs, for a specific time period.

Enteric fermentation: The breaking down of food in the gut of ruminant animals, including cattle, producing methane which is eliminated from the animal's body.

Fugitive emissions: For the purpose of this Guidance, emissions that are not physically controlled, but result from the intentional or unintentional releases of GHGs. They commonly arise from the production, processing, transmission, storage, and use of fuels and other chemicals, often through joints, seals, packing, and gaskets.

GHG sink: Any physical unit or process that stores GHGs, usually in reference to forests, soils, and underground or deep sea reservoirs of CO_2.

GHG source: Any physical unit or process that releases GHGs into the atmosphere.

Global warming potential (GWP): A factor describing the radiative forcing impact of one unit of a given GHG relative to one unit of CO_2.

Greenhouse gases (GHGs): Gases that trap heat in the atmosphere. Some GHGs occur naturally and are emitted to the atmosphere through natural processes and human activities, while other GHG are created and emitted solely through human activities. The principal GHGs that enter the atmosphere because of human activities are Carbon Dioxide (CO_2), Nitrous Oxide (N_2O), Methane (CH_4), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), Nitrogen Triflouride (NF_3), and Sulfur Hexafluoride (SF_6).

Green power: A generic term for renewable energy sources and specific clean energy technologies that emit fewer GHG emissions relative to other sources of energy that supply the electric grid. Includes solar photovoltaic panels, solar thermal energy, geothermal energy, landfill gas, some hydropower, and wind turbines. Resources included in a given certification, reporting, or recognition program may vary.

Gross Square Feet: Total area of a building enclosed by the exterior face of the perimeter walls, calculated on a floor-by-floor basis.

Hydrofluorocarbons (HFCs): One of the seven primary GHGs primarily used as refrigerants; a class of gases containing hydrogen, fluorine, and carbon, and possessing a range of GWP values up to 14,800.

Indirect emissions: Emissions that are a consequence of the actions of a reporting entity, but are produced by sources owned or controlled by another entity. For example, emissions that occur at a utility's power plant as a result of electricity purchased by a Federal agency represent the agency's indirect emissions.

Intergovernmental Panel on Climate Change (IPCC): An international body of climate change scientists established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO). The role of the IPCC is to assess the scientific, technical, and socio-economic information relevant to the understanding of the risk of human-induced climate change.

Inventory: A comprehensive and quantified accounting of an agency's GHG emissions and sources.

Lease: A contract which sets forth certain rights and responsibilities of the parties through which an owner of a commercial asset (the Lessor) conveys the right to use its asset to another party (the lessee) for a specified period of time (the lease term) for specified periodic payments.

Livestock: One or more domesticated animals raised in an agricultural setting to produce commodities (e.g., food, fiber, or labor). Livestock generally are raised for profit or for subsistence. The term "livestock" in this document includes poultry or farmed fish. The definition of livestock excludes animals in a wildlife management program (e.g., a herd of elk in a National Park).

Methane (CH₄): One of the seven primary GHGs, consisting of a single carbon atom and four hydrogen atoms; a GWP of 25; and produced through the anaerobic decomposition of waste in landfills, animal digestion, decomposition of animal wastes, production and distribution of natural gas and petroleum, coal production, and incomplete fossil fuel combustion.

Municipal solid waste: A mixed material waste stream consisting of residential solid waste and some non-hazardous commercial, institutional, and industrial wastes. It does not include construction and demolition waste materials.

Newly solicited lease: Per Executive Order 13693 Section 3(h)(iv) and (v), is specifically defined as those leases solicited in FY 2016 and beyond that are all new agency lease solicitations over 10,000 rentable square feet:

(A) criteria for energy efficiency either as a required performance specification or as a source selection evaluation factor in best-value tradeoff procurements; *and*

(B) requirements for building lessor disclosure of carbon emission or energy consumption data for that portion of the building occupied by the agency that may be provided by the lessor through submetering or estimation from pro-rated occupancy data, whichever is more cost-effective; (v) reporting building energy, beginning in fiscal year 2016 as part of the agency Scope 3 greenhouse gas emissions for newly solicited leases over 10,000 rentable square feet.

Nitrous oxide (N_2O): One of the seven primary GHGs, consisting of a two nitrogen atoms and a single oxygen atom; a GWP of 298; and typically generated as a result of soil cultivation practices (particularly the use of commercial and organic fertilizers), fossil fuel combustion, nitric acid production, and biomass burning.

Nitrogen trifluoride (NF_3): One of the seven greenhouse gases, nitrogen trifluoride is a nitrogen-fluorine compound which is a colorless, odorless, nonflammable gas, typically used as an etchant in microelectronics. NF_3 has a GWP of 17,200 when compared over a 100-year period.

Occupancy Agreement (OA): The formal written agreement between GSA and the tenant federal agency defining the financial terms and conditions for the occupancy of GSA-provided space.

Operation: A generic term used to denote any kind of business, irrespective of its organizational, governance, or legal structures. An operation can be a facility, subsidiary, affiliated company, or other form of joint venture.

Operational boundary: The boundaries that determine the direct and indirect emissions associated with operations owned or controlled by the reporting organization. This assessment allows an organization to establish which operations and sources cause direct and indirect emissions, and to decide which indirect emissions to include that are consequences of its operations.

Operational control: Full authority to introduce and implement operating policies at an operation. Operational control is one of two ways to define the control approach.

Organizational boundary: The boundaries that determine the operations owned or controlled by the reporting organization, depending on the consolidation approach taken (equity or control approach).

Perfluorocarbons (PFCs): One of the seven primary GHGs consisting of a class of gases containing carbon and fluorine typically emitted as by-product of industrial and manufacturing processes, and possessing GWPs ranging from 5,700 to 11,900.

Process emissions: Emissions generated from manufacturing processes, such as the CO_2 that arises from the breakdown of $CaCO_3$ during cement manufacture.

Renewable energy: Energy produced by solar, wind, biomass, landfill gas, ocean (including tidal, wave, current, and thermal), geothermal, municipal solid waste, or new hydroelectric generation capacity achieved from increased efficiency or additions of new capacity at an existing hydroelectric project.

Reporting year: The fiscal year in which the reported emissions occurred. For example, if emissions that occurred in FY 2010 are being reported in 2011, the reporting year is FY 2010.

Residual mix: The mix of energy generation resources and associated attributes such as GHG emissions in a defined geographic boundary left after contractual instruments have been claimed/ retired/canceled. The residual mix can provide an emission factor for companies without contractual instruments to use in a market-based method calculation.

Scope 1 emissions: Direct GHG emissions from sources that are owned or controlled by the Federal agency.

Scope 2 emissions: Indirect GHG emissions resulting from the generation of electricity, heat, or steam purchased by a Federal agency.

Scope 3 emissions: Indirect GHG emissions from sources not owned or directly controlled by a Federal agency, but related to agency activities, such as vendor supply chains, delivery services, and employee travel and commuting.

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

Sulfur hexafluoride (SF_6): One of the seven primary GHGs, consisting of a single sulfur atom and six fluoride atoms, a GWP of 23,900, and primarily used in electrical transmission and distribution systems.

Target: A reduction goal in absolute GHG emissions over time. E.O. 13693 directs agencies to develop targets for Scope 1 and 2 GHG reductions and for Scope 3 GHG reductions.

Unbundled: An energy attribute certificate or other instrument that is separate, and may be traded separately, from the underlying energy produced.

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

United States: The fifty States, the District of Columbia, the Commonwealth of Puerto Rico, Guam, American Samoa, the United States Virgin Islands, and the Northern Mariana Islands, and associated territorial waters and airspace.

Verification: An assessment of the reliability of a GHG inventory, considering completeness and accuracy. Independent verification can be either second-party or third-party verification.