# 2011 GREENHOUSE GAS INVENTORY

## Philadelphia Gas Works


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November 2023

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# 1. EXECUTIVE SUMMARY

## 1.1 Introduction

Greenhouse gas (GHG) emissions are becoming a critical business concern for many industrial sectors, especially energy-intensive sectors. At present, many companies are implementing GHG emissions management initiatives on a voluntary basis to demonstrate their attentiveness and commitment to managing the environmental risks and business opportunities associated with these emissions in response to shareholder requests for transparency and accountability. Furthermore, the financial community and general public are showing increasing interest in corporate contributions to global climate change. Amidst these business influences, the regulatory landscape is changing quickly in many states such that GHG management may soon transition from a voluntary to required practice.

Philadelphia Gas Works (PGW) is a municipally owned natural gas distribution company serving the City of Philadelphia. In 2021, the mayor of Philadelphia publicly committed to achieving carbon neutrality by 2050, exceeding the city's previous carbon reduction plan of 80 percent during the same timeframe. In the Climate Action Playbook issued by the City of Philadelphia's Office of Sustainability, an evaluation of PGW's current environmental impact and business opportunities in a low-carbon economy is cited as a component of the city's comprehensive plan to achieve this goal.[1]

In response to these developments, PGW has prepared a GHG inventory based on its operations in calendar year (CY) 2011. This assessment quantifies emissions of carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2O$), and hydrofluorocarbons (HFCs) emissions. Other GHGs, such as perfluorocarbons (PFCs) and sulfur hexafluoride ($SF_6$), do not originate from PGW operations. The intent of this inventory is to establish a baseline against which to measure progress towards achieving future GHG reduction goals.

### 1.1.1 Background

PGW is the largest municipally owned gas utility in the country which operates over 6,000 miles of gas mains and services to deliver approximately 78 billion cubic feet of natural gas to approximately 500,000 customers in the City of Philadelphia annually.[2] PGW is managed by the Philadelphia Facilities Management Corporation (PFMC), a nonprofit corporation.

This report discusses the organizational and operational boundaries employed in the development of the GHG inventory for PGW's carbon footprint and provides information on the calculation methodologies used. The following guidance references were employed in developing this GHG inventory:

- U.S. Environmental Protection Agency (EPA) Mandatory Reporting Rule, 40 CFR Part 98, Subparts C and W;[3]
- EPA Emissions and Generation Resource Integrated Database (eGRID), October 2015;[4]

[1] "Philadelphia Climate Action Playbook," City of Philadelphia Office of Sustainability, released January 2021, https://www.phila.gov/media/20210113125627/Philadelphia-Climate-Action-Playbook.pdf.

[2] https://www.pgworks.com/residential/about-us/about-pgw

[3] https://www.ecfr.gov/cgi-bin/text-idx?tpl=/ecfrbrowse/Title40/40cfr98_main_02.tpl

[4] https://www.epa.gov/egrid/emissions-generation-resource-integrated-database-egrid

- The Greenhouse Gas Protocol Corporate Accounting and Reporting Standard (Revised Edition)[5];
- The Climate Registry (TCR), General Reporting Protocol, Version 3.0 (May 2019)[6] and TCR 2022 Default Emission Factors (May 2022)[7].

Note that whenever there were departures or differences between these references, the EPA Mandatory Reporting Rule took precedence (e.g., stationary combustion sources).

### 1.1.2 Facilities Descriptions

As a local natural gas distribution company, PGW's operations are comprised mainly of the following processes/facilities managed by PGW:

- City Gate Stations, where custody transfer of the natural gas from transmission pipelines to PGW's distribution pipelines occurs;
- Distribution pipelines (mains and services) to transport the gas;
- Metering and Regulating (M&R) stations, which supply Passyunk and Richmond Plants, where gas is either liquefied for storage, or its pressure is reduced prior to entering the distribution pipeline.
- Above and below ground district regulators, where the pressure of the gas in the distribution pipeline is reduced for delivery to customer meters; and
- Two Liquid Natural Gas (LNG) facilities, the Richmond Plant where natural gas is liquefied and stored and the Passyunk Plant which receives the LNG produced at Richmond Plant and stores for supplemental supply during peak demand periods.

Sources of GHG emissions from these distribution processes include methane leaks from pipelines, M&R stations, and customer meters and gas releases from upsets (e.g., excavation damage) and during routine maintenance.[8]

PGW also operates several support facilities (e.g., fueling stations, maintenance shops) and administrative office buildings managed by PGW that generate GHG emissions due to use of the following:

- Building electricity,
- Refrigerants used in air conditioning units,
- Various stationary combustion sources used for comfort cooling/heating,
- Emergency generators for backup power,
- Fleet vehicles, and
- Off-road maintenance and construction vehicles.

## 1.2 Organization of 2011 GHG Emissions Inventory Report

The scope of the inventory is summarized in Section 2 of this report. Section 3 of this document describes the data inputs for the inventory, and Section 4 details methodologies followed for calculating GHG

[5] https://ghgprotocol.org/sites/default/files/standards/ghg-protocol-revised.pdf

[6] https://theclimateregistry.org/registries-resources/protocols/

[7] https://theclimateregistry.org/wp-content/uploads/2022/11/2022-Default-Emission-Factors-Final.pdf

[8] *"Understanding Updates to the EPA Inventory of GHG Emissions from Natural Gas Systems,"* American Gas Association Energy Analysis, EA 2019-02, May 22, 2019.

emissions. Section 5 summarizes the CY2011 GHG emissions from the PGW operations included in this inventory.

## 1.3 Summary of Inventory Results

Table 1-1 summarizes the GHG emissions in total metric tons $CO_2e$ calculated for the CY2011 emissions inventory by PGW source types. These emissions are in total annual metric tons and are also normalized by dividing the total GHG emissions in the year by the total number of customers in the year, for comparison to other inventory years.

**Table 1-1. CY2011 PGW Scope 1 and Scope 2 GHG Emissions Summary**

| Emission Source Type | $CO_2$ (Metric Tons) | $CH_4$ (Metric Tons) | $N_2O$ (Metric Tons) | HFCs (Metric Tons) | Total $CO_2e$ (Metric Tons) | Percent Total $CO_2e$ Emissions |
|---|---|---|---|---|---|---|
| **Scope 1 Emissions** | | | | | | |
| Stationary Combustion Sources | 12,576 | 0.2 | 0.02 | -- | 12,589 | 3% |
| Mobile Combustion Sources | 2,202 | 0.04 | 0.03 | -- | 2,213 | 0.6% |
| Facility Refrigerant Use | -- | -- | -- | 0 | 78 | 0% |
| M&R Station Fugitive | 1 | 15 | -- | -- | 370 | 0.1% |
| Pipelines Fugitive | 424 | 12,538 | -- | -- | 313,882 | 84% |
| Gas Releases | 8 | 231 | -- | -- | 5,781 | 2% |
| Customer Meters Fugitive | 35 | 1,030 | -- | -- | 25,778 | 7% |
| LNG Plant - Fugitive | 4 | 124 | -- | -- | 3,111 | 0.8% |
| **Scope 2 Emissions** | | | | | | |
| Electricity Usage | 8,571 | 0.2 | 0.1 | -- | 8,613 | 2% |
| **Grand Total** | **23,821** | **13,939** | **0.2** | **0** | **372,416** | **100%** |
| **Emissions per Customer Meter** | | | | | **0.73** | |

Table 1-2 shows the CY2011 Scope 1 and Scope 2 GHG emissions contribution in total metric tons $CO_2e$ from different facilities operated by PGW.

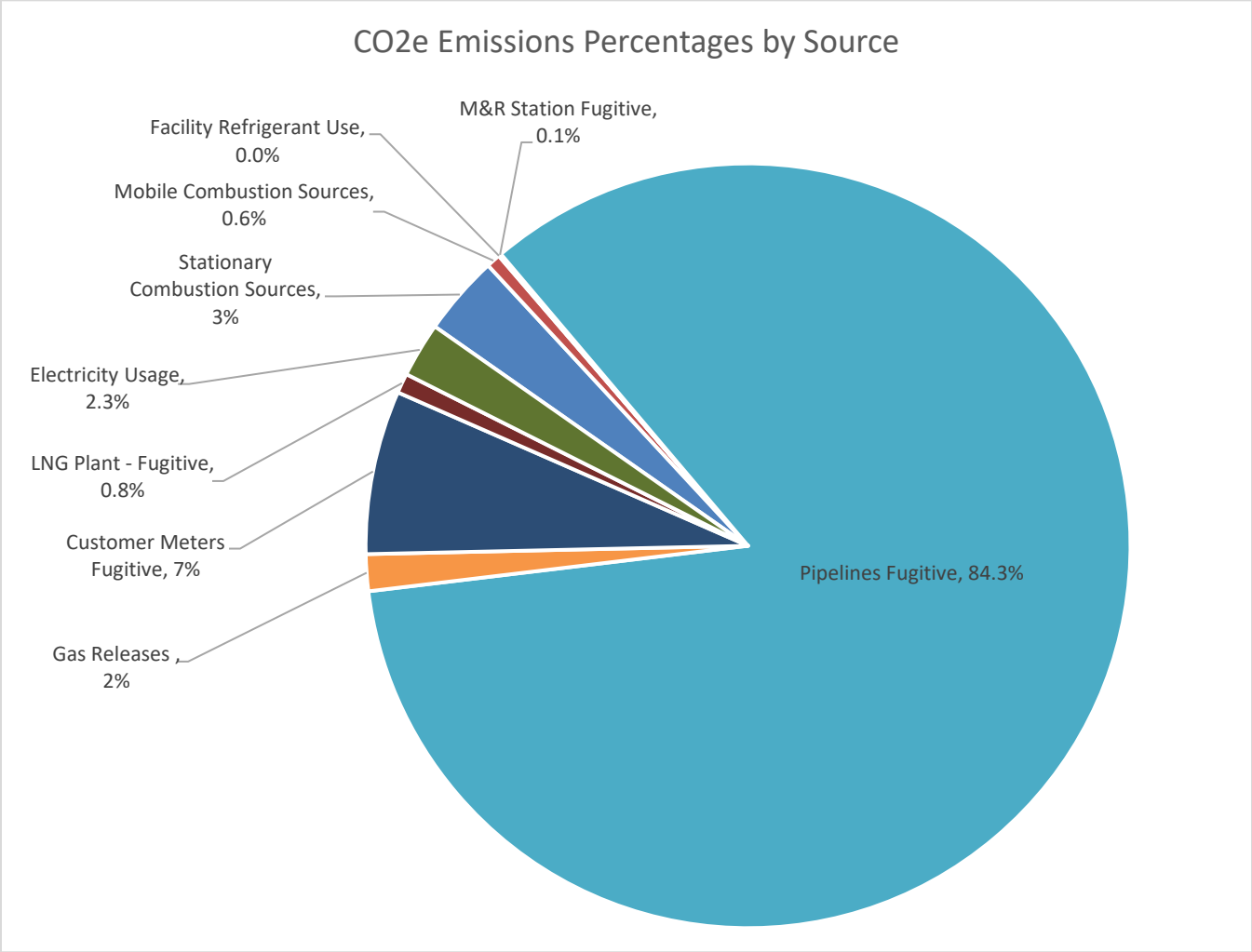
## Table 1-2. CY2011 GHG Emissions Summary by PGW Facilities

| | | $CO_2e$ Emissions (Metric Tons) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Scope 1 | | | | | | Scope 2 |
| Facility Type | Facility Name | Stationary Combustion Sources | Mobile Combustion Sources | Facility Refrigerant Use | M&R Station Fugitives | Gas Releases | LNG Compressor Leaks | Electricity Usage |
| Gas Processing | Richmond Plant | 2,700 | | 31 | | 0 | 10 | 3,350 |
| | Passyunk Plant | 3,889 | | 26 | | 0 | 1,741 | 1,421 |
| | Ashmead Station | 66 | | | 167 | 206 | | 0 |
| | Ivyhill | 101 | | | | 596 | | 10 |
| | Somerton | 40 | | | | 288 | | 10 |
| | Penrose | 110 | | | | 150 | | 2 |
| | Whitman | 478 | | | | 576 | | 11 |
| | Richmond Station | 980 | | | | 466 | | 19 |
| | 0-60 Station | 0 | | | | 272 | | 19 |
| | 0-30 Station | 434 | | | | 328 | | 2 |
| | 0-34 Station | 337 | | | | 498 | | 17 |
| | North Yard M&R (Richmond)[1] | | | | | 476 | | |
| | Cage M&R (Passyunk)[1] | | | | 46 | 1,908 | | |
| | Above Ground District Regulators[2] | | | | | | | |
| | Below Ground District Regulators[2] | | | | 157 | | | |
| Facilities | Corporate Headquarters (800) | 1,297 | | 0 | | | | 1,611 |
| | Corporate Headquarters (1800) | 1,679 | | 11 | | | | 1,518 |
| | Transportation[3] | 126 | 2,213 | 2 | | | | 0 |
| | 9th and Diamond Meter Shop | 60 | | 0 | | | | 126 |
| | Belfield Station | 42 | | 0 | | | | 63 |
| | Castor Station | 39 | | 2 | | | | 63 |
| | Porter Station | 32 | | 4 | | | | 66 |
| | Tioga Yard | 100 | | 1 | | | | 118 |
| | Frankford District Office | 17 | | 0 | | | | 16 |
| | Germantown District Office | 0 | | 0 | | | | 51 |
| | North Philly District Office | 10 | | 0 | | | | 46 |
| | South Philly District Office | 35 | | 1 | | | | 27 |
| | West Philly District Office | 20 | | 0 | | | | 49 |
| | CNG Fueling Station | 0 | | 0 | | | | |

[1] Electricity usage for North Yard M&R and Cage M&R are included in the electricity usage data for Richmond Plant and Passyunk Plant respectively.
[2] The district regulators do have a small amount of electricity usage associated with them, however, PGW could not quantify it for 2011 and it was assumed the corresponding GHG emissions would be de minimis.
[3] Electricity usage for Transportation is included with Corporate Headquarters (1800). Also, Transportation encompasses vehicles used by all departments at all locations.

Figure 1-1 represents a graphical representation of total PGW 2011 GHG emissions (in $CO_2e$ metric tons) by source category.

**Figure 1-1. CY2011 PGW Greenhouse Gas Emissions by Source Category**




As indicated in Table 1-1 and Figure 1-1, the largest source category of GHG emissions is equipment leaks related to operations. Specifically, pipelines fugitive emissions comprise 84% and customer meter fugitives comprise 7% of the total company-wide GHG emissions. Other sub-categories of fugitives associated with M&R Stations and LNG Plants are less than 1% individually. However, since they are part of the overall fugitive leaks category, they have not been classified as de minimis.

Stationary combustion sources, which include building furnaces, chillers, heaters, microturbines and emergency generators, as well as process equipment such as line heaters, comprise about 3% of the company-wide total. Indirect emissions (Scope 2) from electricity usage have been estimated at 2% of total emissions. Despite the fact that electricity usage makes up a small fraction of PGW's emissions profile, it is recommended that Scope 2 emissions are quantified annually due to increased stakeholder interest.

GHG emissions from HFCs used as refrigerants for comfort cooling comprise less than 0.1% of the company-wide total. The remaining category of mobile sources also comprises of less than 1% of total

emissions. As such, these two source categories are considered de minimis as discussed in Section 4.3, and will only need to be re-evaluated if PGW implements changes in operation of these sources.

# 2. EMISSIONS INVENTORY SCOPE

## 2.1 Principals of Reporting

The following general reporting principles, which are consistent with TCR General Reporting Protocol, form the basis for developing the GHG inventory for PGW. Comments with respect to each principle that are specific to PGW's baseline inventory are provided.

**Relevance** *"Ensure that your GHG inventory appropriately reflects your GHG emissions and serves the decision-making needs of users – both internal and external to your organization."*

PGW's emissions estimates have been developed based on current EPA and TCR calculation methodologies and emission factors.

**Completeness** *"Account for and report all GHG emission sources and activities within the defined inventory boundary."*

All significant GHG sources and activities within the established boundary of operations (as discussed in Sections 2.2, 2.3, and 2.4) have been included in the CY2011 inventory.

**Consistency** *"Use consistent methodologies to allow for meaningful comparisons of emissions over time. Clearly document any changes to the data, inventory boundary, methods, or any other relevant factors in the time series."*

PGW will continue to follow the procedural and calculation methods outlined in this report for each subsequent inventory such that comparisons between reporting years provide meaningful determinations of emissions. Any changes to the methods developed for this baseline inventory that may be implemented in future reporting years will be clearly documented in the subsequent annual inventories.

**Transparency** *"Address all relevant issues in a factual and coherent manner, based on a clear audit trail. Disclose any relevant assumptions and make appropriate references to the accounting and calculation methodologies and data sources used."*

The documentation of information and assumptions used to produce this inventory is available in the Appendices to this report.

**Accuracy** *"Ensure that the quantification of GHG emissions is neither systematically overstating nor understating your true emissions, and that uncertainties are reduced as much as practicable. Achieve sufficient accuracy enabling users of your data to be able to make decisions with reasonable assurance of the integrity of the reported information."*

In compiling this inventory, every effort has been made to ensure that emissions estimates are precise and credible. However, the calculations have been based on operating data available for the CY2011 reporting year. It is expected that such recordkeeping may improve in subsequent inventory years as PGW personnel recognize the relevance to tracking GHG emissions. As the accuracy of the data records improves, so will the accuracy of the overall emissions inventory.

## 2.2 Geographic Boundaries

The geographic scope of the PGW GHG emissions inventory includes all U.S. facilities owned and operated by PGW, majority of which are located in the City of Philadelphia.[9]

## 2.3 Organizational Boundaries

The organizational boundaries of a GHG inventory are based on the legal and financial structure of the organization. To determine the organizational boundaries, the financial structure of the corporation must be examined, including the number of wholly or partially owned facilities and the percentage of financial and operational control that the organization exerts over assets.

The Climate Registry follows the World Resources Institute (WRI)/ World Business Council for Sustainable Development (WBSCD) GHG Protocol *Corporate Accounting and Reporting Standard* (Revised Edition) guidance on setting organizational boundaries. There are typically two ways of reporting GHG emissions – either by management control or equity share. Management control reporting requires reporting of 100% of the emissions from sources that are under the organization's control, including both wholly owned and partially owned sources. Equity share reporting requires reporting 100% of emissions sources that are wholly owned and reporting of partially owned sources based on the percentage of financial interest that an organization has in facilities or operations. Companies can choose to conduct their GHG emissions inventory based on either management control or equity share.

Under the management control approach, a company should account for 100% of the GHG emissions from operations over which it has control. However, control can be based on whether the organization has financial or operational control over the entity. For financial control reporting, the company would have control over the entity's operations with a view to gaining economic benefit from the activities. For operational control, a company would have full authority to introduce and implement its operating policies at the facility. With this method, a facility needs to provide documentation from any partners with whom ownership is shared, acknowledging who will be reporting the emissions from that facility.

When reporting using the equity share approach, only a company's economic interest in an operation is considered. The equity share will usually be the same as the ownership percentage. Equity share reporting provides a more accurate allocation of risk and liability associated with GHG emissions and aligns with generally accepted financial accounting practices. However, obtaining information from facilities that are not wholly owned can be difficult.

Philadelphia Facilities Management Corp. is an entity under City of Philadelphia that owns all sites represented in the CY2011 inventory with one exception[10] and PGW operates them.

## 2.4 Operational Boundaries

Operational boundaries provide the scope for the types of operations and emissions sources that will be included in the inventory. The WRI/WBCSD Protocol strongly encourages, and The Climate Registry requires, the inclusion of both Scope 1 and Scope 2 emissions. Scope 1 or direct emissions are emissions from sources that are owned or controlled by PGW. Scope 2 emissions are emissions that occur from PGW's actions but are produced by sources owned or controlled by another entity. These emissions originate from

[9] Two of the M&R stations are located outside of the City of Philadelphia, one is in Feasterville and the other in Cheltenham.

[10] Ivy Hill M&R station is fully owned and operated by PGW.

the purchase and consumption of electricity, steam, heating, and cooling. Scope 3 emissions are other indirect emissions not owned or controlled by PGW, such as employee commuting and business travel, office product use and disposal, and outsourced activities. Scope 3 emissions have not been accounted for in the CY2011 inventory.

**Table 2-1. Typical GHG Emissions Sources in the Natural Gas Storage and Distribution Sectors**

| Direct Emissions (Owned or Controlled by the Company) | Indirect Emissions (Not Owned or Controlled by the Company) | Other Indirect Emissions (Not Owned or Controlled by the Company) |
|---|---|---|
| Stationary combustion from process heaters, chillers, vaporizers, internal combustion (IC) engines and gas turbine generators and compressors, facility boilers and furnaces.<br>Venting from pneumatic devices, storage tanks, and purges or blowdowns from pipelines, M&R stations, and maintenance and inspection operations.<br>Fugitive leaks from pipelines, M&R stations, customer meters, and storage facilities<br>Mobile combustion from fleet vehicles. | Electricity, steam, heating and cooling purchased and consumed (e.g., office buildings). | Upstream extraction, production, and transportation of fuels (e.g., emissions from the extraction of natural gas).<br>Employee commuting, including business travel.<br>Office products use and disposal.<br>Outsourced activities and contracting.<br>Downstream combustion of natural gas sold to end users. |

## 2.5 Approach Utilized for CY2011 GHG Emissions Inventory

To complete PGW's GHG baseline emissions inventory, direct emissions from relevant sources were quantified in accordance with the specific recommendations of the Mandatory GHG Reporting Rule for the applicable sectors/sources. Mobile emissions, refrigeration, fugitives, and indirect emissions from electricity purchased were quantified in accordance with TCR General Reporting Protocol.

Table 2-2 provides a summary of the PGW emissions sources that were quantified as part of the GHG emissions inventory and the protocol used for each source category. Details on the emissions calculations and inventory results are given in Sections 4 and 5 of this report, respectively.

**Table 2-2. PGW Direct and Indirect GHG Emissions Sources**

| Category | Type of Source | GHGs | Fuel Type | Data Source | Protocol |
|---|---|---|---|---|---|
| Direct Emissions from Stationary Combustion | Generators/engines<br>Process Heaters<br>Chillers<br>Vaporizers<br>Compressors<br>Boilers and furnaces | $CO_2$<br>$CH_4$<br>$N_2O$ | Natural gas<br>Diesel fuel | (1) Fuel use records<br>(2) Hours of operation and heat input rating (when the actual fuel usage record is unavailable) | 40 CFR 98, Subpart C |
| Direct Emissions from Venting Processes | Pneumatic devices (controllers and isolation valves)<br>Pipeline Blowdowns, Dig-ins and Pressure Relief Valves<br>M&R Station Blowdowns and Odorizer/Sampling Vents | $CO_2$<br>$CH_4$ | -- | (1) Compressor blowdown details (number of blowdowns and volume between isolation valves) and Device counts<br>(2) Pipeline mains and services lengths, venting pressure.<br>(3) Station counts, hours of operation, and station inlet pressures | 40 CFR 98, Subpart W |
| Direct Emissions from Fugitive Processes | Pipelines<br>LNG Plants<br>M&R stations<br>District regulators<br>FSD stations<br>Customer meters | $CO_2$<br>$CH_4$ | -- | (1) Pipeline design (pipeline construction material, main length and services counts)<br>(2) Station inlet pressure and location (vault or above-ground)<br>Station and meter count<br>(3) Leak test reports<br>(4) Compressor operating hours | 40 CFR 98, Subpart W<br>NGIS Protocol |
| Direct Emissions from Mobile Combustion | Fleet vehicle emissions | $CO_2$<br>$CH_4$<br>$N_2O$ | Gasoline<br>Diesel fuel<br>Natural gas | (1) Vehicle miles traveled and type of vehicle | TCR |
| Direct Emissions from Refrigerant Use | Building AC Systems | HFCs | -- | (1) Purchasing records<br>(2) Site inventory<br>(3) Default data based on type of units. | TCR |
| Indirect Emissions from Energy Purchased and Consumed | Purchased electricity | $CO_2$<br>$CH_4$<br>$N_2O$ | -- | (1) Purchasing records (meter readings) | TCR |

# 3. DATA INPUTS AND COLLECTION

This section describes the data input and collection process for performing GHG emissions calculations.

## 3.1 Direct Emissions from Stationary Combustion Units

The following data were collected to quantify direct GHG emissions from stationary combustion units at PGW's facilities in accordance with the EPA GHG Mandatory Reporting Rule:

- Type of fuel
- Annual fuel usage

Operating hours and rated heat input capacity were used to estimate fuel usage in cases where this information was unavailable.

## 3.2 Direct Emissions from Venting Processes

40 CFR 98, Subpart W was followed to determine direct emissions from natural gas distribution processes at PGW's facilities. These include GHG emissions associated with M&R facilities and distribution pipelines. PGW also operates LNG facilities which store LNG at very low temperatures to keep it in the liquid state. These systems are designed to avoid contact with the outside air and therefore, both vented and fugitive emissions tend to be minimal. Subpart W guidelines were followed in determining emissions from compressor leaks and pneumatic devices.

The following data were collected from PGW to quantify direct vented GHG emissions from gas releases from pipelines, M&R facilities, District regulators, and LNG plants:

- Number of M&R stations
- Number of pneumatic control loops and isolation valves at each M&R station
- Emergency gas releases at M&R stations
- Number of odorizer and sampler vents
- Length of main and service pipelines
- Volume of gas released from LNG storage facilities
- Number of gas-driven pneumatic actuators and controllers at M&R stations and LNG facilities
- Pneumatic actuators bleeding types (high, low, continuous, intermittent) and if available, bleeding rates specifications (vendor data).
- Applicable pipeline pressures.

## 3.3 Direct Emissions from Fugitive Processes

The following data were collected to quantify Scope 1 fugitive GHG emissions from PGW's distribution pipelines, M&R stations, customer meters, and LNG production and storage facilities in accordance with 40 CFR 98, Subpart W. Subpart W provides "leaker emission factors" for various components at aboveground transfer stations (connectors, block valves, control valves, pressure relief valves, orifice meters, regulators, and open-ended lines) and requires leak detection testing to determine the number of components in each station that are found to be leaking in a given reporting year. For below-grade M&R Stations, pipeline mains and services, and customer meters, Subpart W provides population count emissions factors. For LNG

centrifugal compressor wet seal leaks, API's Compendium of Greenhouse Gas Methodologies[11] include leak rates based on compressor operating hours. Therefore, for these sources, the following data were collected:

- Length of pipelines (mains and services)
- Total number and types of M&R stations
- Inlet pressure of M&R stations
- Number of customer meters
- Number of Leaking Components
- Number of LNG compressor operating hours

Relevant data were obtained from various leak test reports for PGW's facilities. Per Subpart W, leak testing is only required for T-D Transfer Stations. For the remaining (non-T-D Transfer) above-grade M&R stations and district regulators, emission factors for component leaks were computed using Subpart W guidance and the results of 2011 leak testing at the T-D Transfer Stations. Please refer to Appendix B for detailed calculations.

## 3.4 Direct Emissions from Mobile Combustion

The following data were collected to quantify GHG emissions from vehicles operated by PGW in accordance with TCR General Reporting Protocol:

- Vehicles' make and model
- Model year
- Fuel type
- Annual fuel usage
- Annual vehicle miles traveled
- Vehicle fuel economy data (mpg – miles per gallon)

Relevant data were obtained from the internal fleet tracking system maintained by PGW on a per vehicle basis.

## 3.5 Direct Fugitive Emissions from Refrigeration & Air Conditioning Equipment

The following data were collected to quantify direct fugitive GHG emissions from refrigeration and air conditioning equipment in accordance with TCR General Reporting Protocol:

- Refrigerant Type
- Type of Refrigerant System
- Refrigerant Capacities & Charges

## 3.6 Indirect Emissions from Energy Purchased and Consumed

The following data were collected to quantify indirect GHG emissions associated with electricity consumption in accordance with TCR General Reporting Protocol:

[11] API's Compendium of Greenhouse Gas Emissions Methodologies (2021) Section 6.5.4.1 (Table 6-37)

- Total energy purchased and consumed by PGW

This information was obtained from PGW's electricity purchase records, as available.

# 4. EMISSIONS CALCULATIONS AND REPORTING

The methodologies used in quantifying GHG emissions are discussed in this section. As previously mentioned, emissions of $CO_2$, $CH_4$, and $N_2O$ are significant for gas industry operations and are thus included in this inventory. Emissions of HFCs from refrigerant usage are also accounted for in this baseline inventory.

## 4.1 Scope 1 Emissions

Scope 1 direct emissions from PGW operations result from stationary combustion sources emissions, process venting, process fugitive emissions, refrigeration sources, refrigerant use, and mobile sources emissions.

$CO_2$ equivalent (or $CO_2e$) is calculated by converting non-$CO_2$ GHG emissions to $CO_2e$ using the relative global warming potentials (GWPs) of the individual GHGs. The GWPs contained in the 40 CFR 98 were used in this inventory and are included in Appendix A.

### 4.1.1 Direct GHG Emissions from Stationary Combustion

As indicated in Table 2-2, emissions from stationary combustion sources were estimated using Subpart C of the Mandatory GHG Reporting Rule. This subpart incorporates multiple approaches called tiers for determining $CO_2$ emissions and each tier has specific data requirements and calculation procedures. The lowest accuracy estimates using Tier 1 are based on fuel-specific default emission factors and default high heat values for the fuels provided in tables in the rule, along with the annual total fuel consumption. Tier 2 substitutes site-specific HHV data measured monthly for the default HHV used in the Tier 1 calculation. Tier 3 is a mass balance approach based on measured carbon content of the fuel. Tier 4 requires the use of continuous emissions monitoring systems.

Tier 1 calculations were used for all PGW facilities which burn pipeline quality natural gas. Sample equations are shown in Table 4-1 and detailed calculations are provided in Appendix B. Emission factors used to estimate emissions from stationary combustion are included in Appendix A.

**Table 4-1. Direct Stationary Combustion GHG Emissions Calculation Equations**

| | | **$CO_2$ Tier 1 Calculations** |
|---|---|---|
| $CO_2$ Emissions ($MTCO_2$) | = | Fuel Specific $CO_2$ Emission Factor (kg $CO_2$/MMBtu) x Fuel Specific Higher Heating Value (MMBtu/gal or MMBtu/scf) x Fuel Usage (gal/yr or MMscf/yr) x 0.001 (MT/kg) |
| $CH_4$ Emissions ($MTCH_4$) | = | Default $CH_4$ Emission Factor (kg $CH_4$/MMBtu) x Default Higher Heating Value (MMBtu/gal or MMBtu/scf) x Fuel Usage (gal/yr or MMscf/yr) x 0.001 (MT/kg) |
| $N_2O$ Emissions ($MTN_2O$) | = | Default $N_2O$ Emission Factor (kg $N_2O$/MMBtu) x Default Higher Heating Value (MMBtu/gal or MMBtu/scf) x Fuel Usage (gal/yr or MMscf/yr) x 0.001 (MT/kg) |
| Total Carbon Dioxide Equivalent ($MTCO_2e$) | = | $CO_2$ Emissions ($MTCO_2$) + [$CH_4$ Emissions ($MTCH_4$) x $CH_4$ GWP] + [$N_2O$ Emissions ($MTN_2O$) x $N_2O$ GWP] |

For combustion sources for which actual fuel usage data are not directly available, fuel usage is approximated by using either the heat input rating capacity, expressed in terms of million British Thermal Units per hour (MMBtu/hr), and actual hours of operation or the heat input rating capacity and the potential hours of operation.

Appendix A summarizes the relevant GHG emissions factors for the various fuel types used by PGW. $CO_2$, $CH_4$, and $N_2O$ emissions are summarized in Section 5 and detailed in Appendix B for each combustion unit at each of PGW's facilities.

### 4.1.2 Direct GHG Emissions from Venting Processes

PGW operates distribution pipelines and M&R stations, from which venting occurs. The emissions factors provided by the 40 CFR 98, Subpart W are based on pipeline length for pipeline vented emissions and on the number and type of components (e.g., isolation valves, control loops, etc.) and number of stations for M&R and regulating stations. Table 4-2 identifies sample equations for calculating vented GHG emissions. Emission factors used to estimate emissions from venting processes are included in Appendix A.

**Table 4-2. Direct Vented GHG Emissions Calculation Equations**

| | | |
|---|---|---|
| Pipeline Blowdowns: | | |
| $CO_2$ or $CH_4$ Emissions ($MTCO_2$/yr or $MTCH_4$/yr) | = | Volumetric Emissions based on Subpart W Eq. W-14B (scf/yr) x (company specific $CO_2$ or $CH_4$ concentration) x Density of $CO_2$ or $CH_4$ ($kg/ft^3$) x 1,000 (MT/kg) |
| Pipeline Mishaps (dig-ins): | | |
| $CH_4$ Emissions ($MTCH_4$/yr) | = | NGSI Protocol Emission Factor for Pipeline Mishaps (kg $CH_4$/mile) x Total Pipeline Length (Mains+Services, miles) x (company specific $CH_4$ concentration) x Density of $CH_4$ ($kg/ft^3$) x 1,000 (MT/kg) |
| $CO_2$ Emissions ($MTCO_2$/yr) | = | Volume of $CH_4$ (scf) / (company specific $CH_4$ concentration) x (company specific $CO_2$ concentration) x Density of $CO_2$ ($kg/ft^3$) x 1,000 (MT/kg) |
| M&R Station Blowdowns, Pressure Relief Valves/Emergency Releases: | | |
| $CO_2$ or $CH_4$ Emissions ($MTCO_2$/yr or $MTCH_4$/yr) | = | (Total Number of Blowdowns/Releases) x Total Volume between isolation valves (scf/occurrence) x (company specific $CO_2$ or $CH_4$ concentration) X Density of $CO_2$ or $CH_4$ ($kg/ft^3$) x 1,000 (MT/kg) |
| Gas Driven Pneumatic Actuators at M&R Stations and LNG Plants: | | |
| $CO_2$ or $CH_4$ Emissions ($MTCO_2$/yr or $MTCH_4$/yr) | = | Actuator bleeding rate (scf/device-yr) x (company specific $CO_2$ or $CH_4$ concentration) X Density of $CO_2$ or $CH_4$ ($kg/ft^3$) x 1,000 (MT/kg) |
| LNG Plant Compressor Blowdowns: | | |
| $CO_2$ or $CH_4$ Emissions ($MTCO_2$/yr or $MTCH_4$/yr) | = | (Total Number of Blowdowns) x Total Volume between isolation valves per compressor (scf/occurrence) x (company specific $CO_2$ or $CH_4$ concentration) X Density of $CO_2$ or $CH_4$ ($kg/ft^3$) x 1,000 (MT/kg) |
| Total Carbon Dioxide Equivalent ($MTCO_2e$) | = | $CO_2$ Emissions ($MTCO_2$) + [$CH_4$ Emissions ($MTCH_4$) x $CH_4$ GWP] |

### 4.1.3 Direct GHG Emissions from Fugitive Processes

The distribution pipelines, M&R stations, and customer meters operated by PGW can emit fugitive GHG emissions from fugitive leaks. Subpart W requires leak detection testing for fugitives from above-ground M&R stations. Subpart W provides population-based emissions factors for vaulted stations and distribution pipeline mains and services. These emission factors are based on mains and services pipeline length, station count and inlet pressure. Subpart W also provides emission factors for customer meters based on meter count. Table 4-3 provides sample equations for calculating fugitive GHG emissions. Emission factors used to estimate emissions from fugitive processes are included in Appendix A.

**Table 4-3. Direct Fugitive GHG Emissions Calculation Equations**

| | | |
|---|---|---|
| Pipeline Fugitives (Mains and Services): | | |
| $CO_2$ Emissions ($MTCO_2$/yr) | = | Subpart W $CO_2$ Emission Factor (Mscf/yr/mile) x 1000 x Density of $CH_4$ ($kg/ft^3$) x Pipeline Length (miles) x 1,000 (MT/kg) |
| $CH_4$ Emissions ($MTCH_4$/yr) | = | Subpart W $CH_4$ Emission Factor (Mscf/yr/mile) x 1000 x Density of $CH_4$, ($kg/ft^3$) x Pipeline Length (miles) x 1,000 (MT/kg) |
| T-D Transfer Stations Fugitives: | | |
| $CO_2$ Emissions ($MTCO_2$/yr) | = | Subpart W Leaker Emission Factor (scf/component-yr) x No. of leaking components x (company specific $CO_2$ concentration) x Density of $CO_2$ ($kg/ft^3$) x 1,000 (MT/kg) |
| $CH_4$ Emissions ($MTCH_4$/yr) | = | Subpart W Leaker Emission Factor (scf/component-yr) x No. of leaking components x (company specific $CH_4$ concentration) x Density of $CH_4$, ($kg/ft^3$) x 1,000 (MT/kg) |
| Above-grade M&R Stations Fugitives: | | |
| $CO_2$ Emissions ($MTCO_2$/yr) | = | Subpart W Leaker Emission Factor (scf/station-yr) x Station Count x (company specific $CO_2$ concentration) x Density of $CO_2$ ($kg/ft^3$) x 1,000 (MT/kg) |
| $CH_4$ Emissions ($MTCH_4$/yr) | = | Subpart W Leaker Emission Factor (scf/station-yr) x Station Count x (company specific $CH_4$ concentration) x Density of $CH_4$ ($kg/ft^3$) x 1,000 (MT/kg) |
| Below-grade M&R Stations Fugitives: | | |
| $CO_2$ Emissions ($MTCO_2$/yr) | = | Subpart W Population Emission Factor (scf/station-yr) x Station Count x (company specific $CO_2$ concentration) x Density of $CO_2$ ($kg/ft^3$) x 1,000 (MT/kg) |
| $CH_4$ Emissions ($MTCH_4$/yr) | = | Subpart W Population Emission Factor (scf/station-yr) x Station Count x (company specific $CH_4$ concentration) x Density of $CH_4$ ($kg/ft^3$) x 1,000 (MT/kg) |
| Customer Meter Fugitives: | | |
| $CO_2$ Emissions ($MTCO_2$/yr) | = | Meter Count x Natural Gas Emission Factor (scf/meter-yr) x (conpany specific $CO_2$ concentration) x Density of $CO_2$ ($kg/ft^3$) x 1,000 (MT/kg) |
| $CH_4$ Emissions ($MTCH_4$/yr) | = | Meter Count x Natural Gas (methane) Emission Factor (scf/meter-yr) x (company specific $CH_4$ concentration) x Density of $CH_4$ ($kg/ft^3$) x 1,000 (MT/kg) |

| | | |
|---|---|---|
| LNG Compressors Leaks: | | |
| $CO_2$ or $CH_4$ Emissions ($MTCO_2$/yr or $MTCH_4$/yr) | = | (No. of Vapor Recovery Compressors) x Subpart W Vapor Recovery Compressors Emission Factor (scf/yr-component) x (company specific $CO_2$ or $CH_4$ concentration) X Density of $CO_2$ or $CH_4$ (kg/ft$^3$) x 1,000 (MT/kg) |
| $CO_2$ or $CH_4$ Emissions ($MTCO_2$/yr or $MTCH_4$/yr) | = | Rod packing emissions from leak test report (scf/yr) x (company specific $CO_2$ or $CH_4$ concentration) X Density of $CO_2$ or $CH_4$ (kg/ft$^3$) x 1,000 (MT/kg) |
| $CO_2$ or $CH_4$ Emissions ($MTCO_2$/yr or $MTCH_4$/yr) | = | (No. of Vapor Recovery Compressors) x API Emission Factor (scf/compressor/hr) x Compressor Operating hours (hr/yr) x (company specific $CO_2$ or $CH_4$ concentration) X Density of $CO_2$ or $CH_4$ (kg/ft$^3$) x 1,000 (MT/kg |
| Total Carbon Dioxide Equivalent ($MTCO_2e$) | = | $CO_2$ Emissions ($MTCO_2$) + [$CH_4$ Emissions ($MTCH_4$) x $CH_4$ GWP] |

### 4.1.4 Direct Emissions from Mobile Combustion

Direct GHG emissions from the combustion of fossil fuel in the fleet vehicles operated by PGW are included in the CY2011 GHG emissions inventory.

$CO_2$, $CH_4$, and $N_2O$ emissions are calculated using the equations provided in Table 4-4. Emission factors are taken from TCR General Reporting Protocol. Appendix A provides a complete list of emission factors.

**Table 4-4. Mobile Combustion GHG Emissions Calculation Equations**

| | | |
|---|---|---|
| $CO_2$ Emissions ($MTCO_2$/yr) | = | $CO_2$ Emission Factor (kg/gallon) x Usage (gallon/yr) / 1,000 (kg/MT) |
| $CH_4$ Emissions ($MTCH_4$/yr) | = | $CH_4$ Emission Factor (g/mile) x Annual Vehicle Miles Traveled (miles/year) / 1,000,000 (g/MT) |
| $N_2O$ Emissions ($MTN_2O$/yr) | = | $N_2O$ Emission Factor (g/mile) x Annual Vehicle Miles Traveled (miles/year) / 1,000,000 (g/MT) |
| Total Carbon Dioxide Equivalent ($MTCO_2e$/yr) | = | $CO_2$ Emissions ($MTCO_2$/yr) + [$CH_4$ Emissions ($MTCH_4$/yr) x $CH_4$ GWP] + [$N_2O$ Emissions ($MTN_2O$/yr) x $N_2O$ GWP] |

## 4.2 Scope 2 Emissions from Energy Purchased and Consumed

PGW purchases electricity for consumption in all of its facilities. TCR General Reporting Protocol references use of emission factors provided by EPA's e-GRID. For PGW's CY2011 GHG inventory, due to unavailability of the 2011 data, the most up-to-date emission factors were used from e-GRID2012 based on data from 2012 for the state of Pennsylvania. Sample equations for calculating indirect GHG emissions from electricity consumption are detailed in Table 4-5. Emission factors used to estimate indirect emissions are included in Appendix A.

**Table 4-5. Indirect GHG Emissions Calculation Equations**

| | | |
|---|---|---|
| $CO_2$ Emissions ($MTCO_2/yr$) | = | $CO_2$ Emission Factor (lb/MWh) x Electricity Consumed (kWh) / 1,000 (kWh/MWh) / 2,204.6 (lb/MT) |
| $CH_4$ Emissions ($MTCH_4/yr$) | = | $CH_4$ Emission Factor (lb/MWh) x Electricity Consumed (kWh) / 1,000 (kWh/MWh) / 2,204.6 (lb/MT) |
| $N_2O$ Emissions ($MTN_2O/yr$) | = | $N_2O$ Emission Factor (lb/MWh) x Electricity Consumed (kWh) / 1,000 (kWh/MWh) / 2,204.6 (lb/MT) |
| Total Carbon Dioxide Equivalent ($MTCO_2e/yr$) | = | $CO_2$ Emissions ($MTCO_2/yr$) + [$CH_4$ Emissions ($MTCH_4/yr$) x $CH_4$ GWP] + [$N_2O$ Emissions ($MTN_2O/yr$) x $N_2O$ GWP] |

## 4.3 De Minimis Emissions

In general, GHG reporting programs will specify some level of emissions (typically up to 5% of total emissions) as de minimis - these emissions do not contribute materially to the total GHG inventory. For PGW's 2011 GHG emissions inventory, the following emissions could be considered de minimis:

- Scope 1 emissions from mobile combustion sources; and
- Scope 1 emissions from facility refrigerant use.

# APPENDIX A. EMISSION FACTORS AND GWP

# APPENDIX B. EMISSION CALCULATIONS

Please refer to accompanying spreadsheet, "PGW 2011 GHG Corporate Inventory FINAL 2023-1027"