# Appendix A: 2019 Greenhouse Gas Emission Inventory Report

ORANGE COUNTY
NORTH CAROLINA

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# Executive Summary

## INTRODUCTION

This report provides an inventory of greenhouse gas (GHG) emissions that are attributable to human activities in Orange County. It acts as a foundational document for the 2023 climate action plan, which provides a roadmap for reducing carbon emissions while preserving the living standards of County residents. A GHG inventory describes the primary sources of emissions within the County, including those originating from residents, commercial enterprises, and governmental operations. The emissions studied can be either direct or indirect. Direct emissions are those emitted at the location of use such as natural gas combustion in heating buildings, whereas indirect emissions are purchased and used at one location but generated elsewhere, such as those originating from the electrical grid[1]. A GHG inventory is crucial for creating strategies and programs that reduce future emissions and providing insight into the environmental condition of the County during the study year. This report was reviewed by the International Council for Local Environmental Initiatives (ICLEI) for completeness and accuracy to ensure its reliability as a foundation for informed decision-making and action.

This GHG inventory analyzes two different tracks, which are presented separately. The community track encompasses all Orange County residents, including businesses, individuals, and industrial emissions sources. Community emissions were divided into sectors: commercial, residential, and industrial energy; transportation and mobile services; solid waste; and water and wastewater. The County government operations track includes the emissions related to Orange County government activities, including government facilities, vehicle fleets, and employee commuting. The County operations inventory is a subset of the community inventory, and has specific usage portioned out from the community inventory.

This report relies on the best available data to date. If certain data could not be collected, best estimates were used. Emission factors were compiled for each sector from reliable sources, such as the Environmental Protection Agency (EPA) and the US Community Protocol, which update information regularly. This GHG inventory offers a reliable reflection of real-world emissions in Orange County. All calculations were made using the US Community Protocols for Greenhouse Gas Accounting studies, as published by ICLEI[2]. Two appendices are included in this report. Appendix A.1 lists raw usage data collected from utilities and other sources, while Appendix A.2 provides a detailed methodology of all calculations used in determining emission totals.

[1] https://www.epa.gov/climateleadership/scope-1-and-scope-2-inventory-guidance

[2] U.S. Community Protocol for Accounting And Reporting of GHG Emissions Version 1.2 July 2019 ICLEI–Local Governments for Sustainability USA

## COMMUNITY INVENTORY RESULTS

In 2019, the Orange County community produced a total of 1,631,671 metric tons of carbon dioxide equivalent emissions (MT CO2e). As illustrated in the figure below, the greatest percentage of emissions was from transportation and mobile service at 43%, or 702,701 MT CO2e. Energy use (which includes electricity and natural gas) in commercial buildings represents the next largest source at 34%, and energy from residential use followed, contributing 19%. Industrial energy use contributed just 2%. In terms of total amounts, commercial energy produced 556,800 MT CO2e, residential energy resulted in 299,216 MT CO2e, and industrial energy contributed 33,626 MT CO2e. The remainder of the community inventory includes solid waste with 21,350 MT CO2e, water and wastewater with 12,585 MT CO2e, and fugitive emissions with 5,393 MT CO2e.

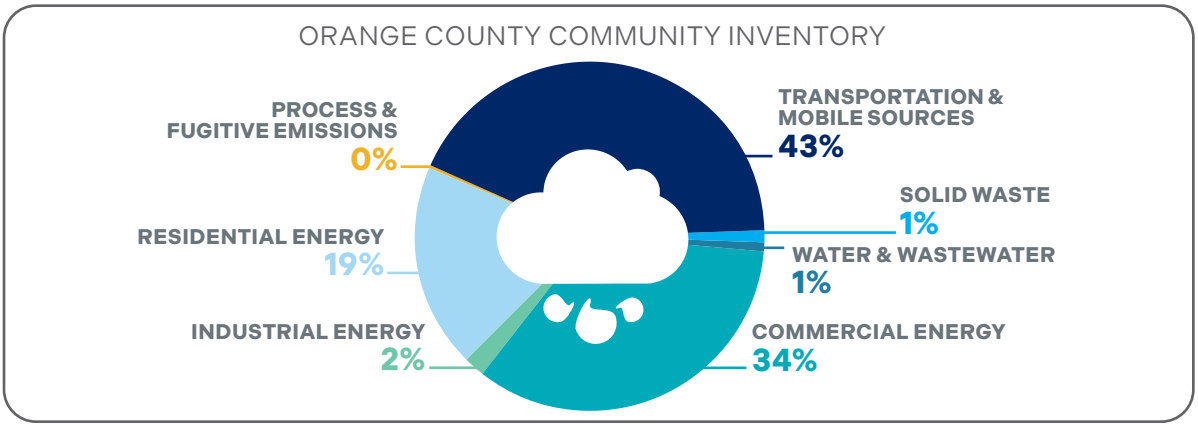


Figure 1: Orange County 2019 community inventory by sector

## COUNTY OPERATIONS INVENTORY RESULTS

County operations GHG emissions were also analyzed. Orange County government operations were responsible for 19,359 MT CO2e. The largest emission sources were employee commuting at 33% (6,329 MT CO2e). Buildings and Facilities contributed 32%, with 6,185 MT CO2e. Water and Wastewater treatment facilities at 23% (4,479 MT CO2e) followed by Vehicle Fleet at 11% with 2,106 MT CO2e. The Transit Fleet accounted for the remaining 1% (251). Fugitive emissions produced 9 MT CO2e (less than 1%).

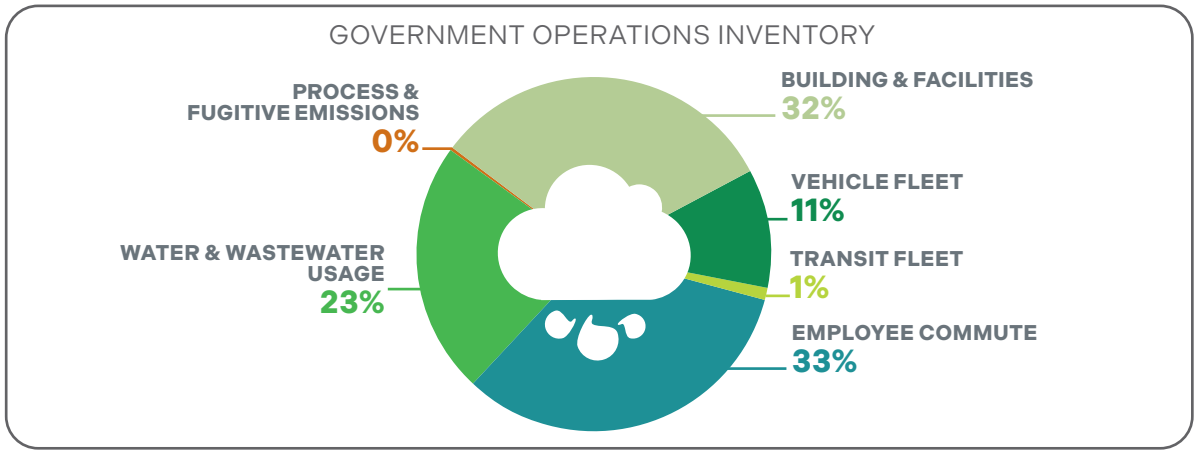


Figure 2. Orange County 2019 government operations emissions by sector

## Introductory Summary

This inventory was performed using the U.S. Community Protocol Version 1.2, as developed by ICLEI and updated for this specific GHG accounting exercise in July 2019. Inventory emissions were calculated using best practices and were based on 2019 data gathered from the County. These "usage" data were assigned an appropriate emission factor to arrive at a figure for emissions emitted. The calculations took place within the ICLEI ClearPath tool. ClearPath assists in GHG accounting and management at the community and municipal levels. Emission factors were compiled from 2019 data and information from the federal Environmental Protection Agency GHG Emission Factors Hub,[3] utilized in the ICLEI ClearPath tool.

As a result, this report compiles data from the County and models GHGs to provide an accurate depiction of the County's real-world emissions. It also identifies key areas to focus on for strategy development and program creation to reduce emissions in the County. Finally, it serves as an update to the County's existing GHG inventories completed in 2005 and 2017.[4]

## Previous Inventories and Climate Resolutions

For two decades, Orange County has been actively striving to reduce carbon emissions. The County's first GHG inventory was conducted in 2005[5] and the second in 2017. The present inventory, therefore, builds upon previous work to provide useful data on how the County is progressing towards reducing carbon emissions.

On June 6, 2017, Orange County Board of County Commissioners adopted a resolution to uphold the Paris Climate Agreement, committing to reduce GHG emissions between 26 and 28 percent by 2025 from 2005 levels and on September 5, 2017, the Board made an additional commitment to transition to a 100% renewable energy-oriented economy by 2050. These resolutions demonstrate the County's leadership towards climate action by creating informed decisions based on data contained in GHG inventories.

Several important comparisons can be made across sectors between 2005, 2017 and today, despite the fact that not all sectors were consistently measured over the years. Specifically, comparisons can be drawn between residential, commercial, and industrial energy, transportation, and solid waste. As shown in figure 3, these sectors have experienced significant emission reductions since 2005. In 2005, Orange County was responsible for emissions amounting to 2.8 million tons of carbon dioxide equivalent. In 2017 emissions in Orange County had fallen to 1.78 million tons of CO2e. By 2019, emissions fell further, to 1.63 million tons of CO2e, a decrease of 40.7% between 2005 and 2019.

[3] https://www.epa.gov/climateleadership/ghg-emission-factors-hub

[4] https://www.orangecountync.gov/DocumentCenter/View/10049/Orange-County-Greenhouse-Gas-Inventory-2017

[5] https://www.orangecountync.gov/DocumentCenter/View/2002/Greenhouse-Gas-Emissions-Inventory-and-Forecast-PDF

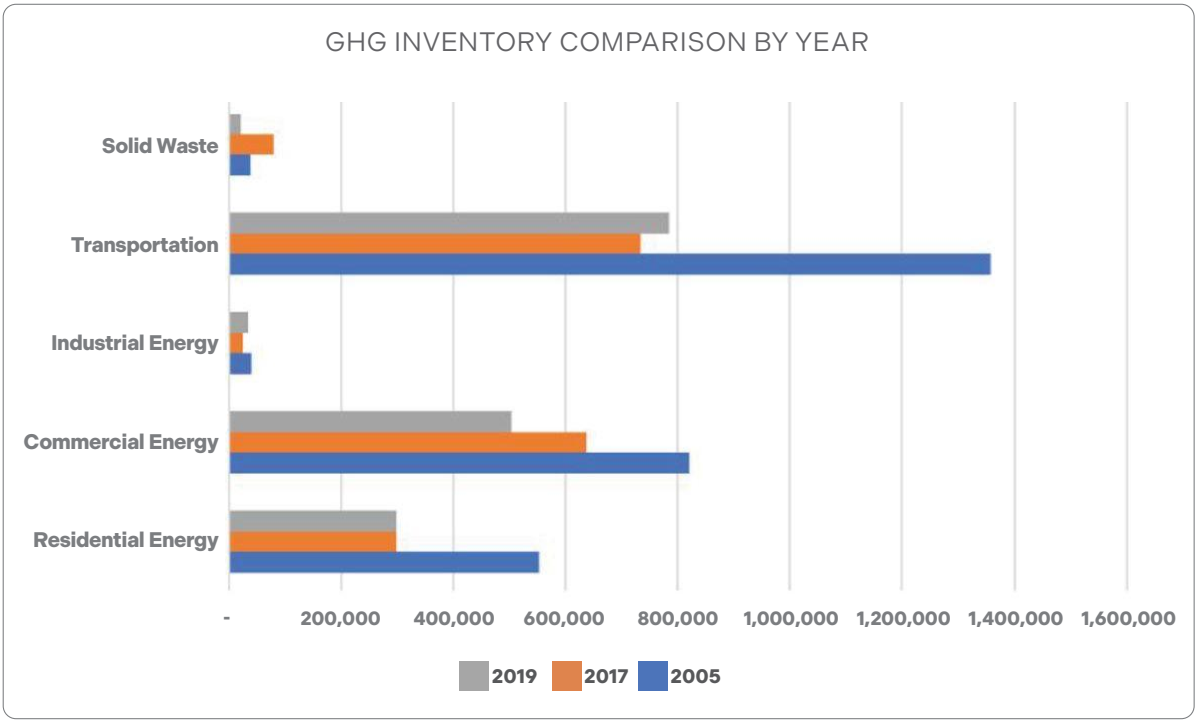


Figure 3. GHG Inventory Comparison by Year

# Methodology

The methodology for this inventory was based upon best practices from the US Community Protocol provided by the ICLEI ClearPath tool, coupled with the United States Environmental Protection Agency GHG Emission Factors, which serve as the benchmark for GHG inventory analysis nationwide. Emissions estimates incorporate real-world usage data (listed in Appendix A.1), which were subsequently processed through ICLEI ClearPath functions.[6]

### *INVENTORY YEAR*

The year 2019 was selected for this inventory because it offers a more typical representation of GHG emissions for the year 2022 since the COVID-19 pandemic significantly reduced travel emissions and markedly impacted other sectors as well. Notably, the years 2020, 2021, and 2022 recorded significantly lower emissions compared to current levels. Additionally, the Science Based Targets Initiative recommends using 2019 as a baseline year for future emission reduction targets.[7]

### *COMMUNITY AND COUNTY OPERATIONS INVENTORIES*

The inventory considers two distinct GHG accounting tracks: community and County operations. The community inventory includes emissions from residents within Orange County's jurisdiction, accounting for both emissions from residents within the County's

[6] https://icleiusa.org/clearpath

[7] https://sciencebasedtargetsnetwork.org/wp-content/uploads/2020/11/SBTs-for-cities-guide-nov-2020.pdf

limits and from people who recreate and work in Orange County; the community inventory is inclusive of all towns within the County. Required sectors for community GHG inventories are: 1) community building energy use from kilowatt hours and natural gas therms usage, and other significant energy sources 2) transportation emissions from vehicle miles traveled in the County, 3) solid waste disposed, 4) wastewater and water electricity used and gallons consumed. In contrast, the County operations inventory encompasses emissions resulting from Orange County operations and facilities, making it a subset of the community inventory. Although County emissions represent a small fraction of the emissions inventory, managing them is vital, given the government's ability to influence and lead by example to combat climate change. The County operations inventory includes emissions from County buildings, County vehicle fleets, employee commutes, and water consumption.[8]

### *CALCULATING EMISSIONS*

#### GREENHOUSE GASSES

Local governments are expected to evaluate emissions of the six internationally recognized greenhouse gasses (GHG) under the Kyoto Protocol,[9] namely carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF6). Each of these greenhouse gasses is reported and converted into metric tons (MT), differentiated by their respective Global Warming Potential (GWP). The GWP of each is benchmarked on Carbon dioxide's potential, which is set at 1, as it serves as the reference point for the other gasses. Methane, with a GWP of 28, is largely emitted from landfills, wastewater, and natural gas leakage. Nitrous Oxide, with a higher GWP of 265, is primarily associated with energy production and wastewater treatment. Hydrofluorocarbons, having a wide GWP range of 12-11,700, are mainly tied to refrigerant usage. Perfluorocarbons, with a GWP between 6,500-9,200, typically result from manufacturing and production processes. Sulfur Hexafluoride, possessing the highest GWP of 23,900, is principally connected with power transmission and distribution. This inventory primarily uses Carbon dioxide, Methane, and Nitrous Oxide[10] to establish the carbon dioxide emission equivalents (CO2e) for all sectors analyzed.[11]

#### SECTOR ACTIVITY DATA AND EMISSIONS FACTORS

The process of calculating Carbon dioxide equivalents (CO2e) utilizes both activity data and emission factors. When activity data is multiplied by corresponding emission factors, the result is an amount of carbon dioxide-equivalent emissions. By converting each sector's activity data into carbon dioxide equivalents, a comparative ratio for each sector can be established, enabling further analysis and facilitating decision-making about potential reduction strategies.

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[8] Data was not available for solid waste from County Operations to be differentiated from community waste, therefore all solid waste emissions are included only in the community inventory.

[9] https://unfccc.int/resource/docs/convkp/kpeng.pdf

[10] As referenced in the US Community Protocol the high GWP GHG's perfluorocarbons and sulfur hexafluoride are not required to complete an accurate inventory. The County reported no refrigerant loss, and therefore hydrofluorocarbons do not appear in the inventory. All other GHGs are measured and reported.

[11] https://icleiusa.org/ghg-protocols

***EMISSIONS REPORTING***

Emissions are quantified using the measure of Carbon dioxide equivalent (CO2e) and compared across sectors. Each sector is individually reported and assessed in relation to others, offering a comprehensive picture of emissions across the County. The community inventory covers building energy use, transportation, solid waste, wastewater, and water. Building energy is further divided into commercial, residential, and industrial use and consists of both electricity and natural gas consumption. The municipal inventory includes building energy use, employee commute, vehicle fleet, water, and wastewater.

# Results

The following sections detail the findings from the community and County government operations GHG inventories, with results organized by sectors. The community and County operations inventories are separate endeavors, but the information is combined within this report. Each inventory should be considered as a benchmark for future emission reductions. Calculation methodologies for all results are provided in Appendix A.2.

# Community Inventory

In Orange County, total community emissions were 1,631,671 MT CO2e. This result includes emissions from the combustion of fuel for transportation and mobile services, onsite burning of natural gas in commercial, residential, and industrial buildings, emissions linked to electricity procurement for commercial, residential, and industrial edifices, emissions connected to water and wastewater services within the County, as well as solid waste emissions emanating from the County.

**TABLE 1: ORANGE COUNTY COMMUNITY INVENTORY BY SECTOR**

| Sector | MT CO2e | Percentage (%) |
|---|---|---|
| Transportation & Mobile Sources | 702,701 | 43% |
| Commercial Energy | 556,800 | 34% |
| Residential Energy | 299,216 | 19% |
| Industrial Energy | 33,626 | 2% |
| Solid Waste | 21,350 | 1% |
| Water & Wastewater | 12,585 | 1% |
| Process & Fugitive Emissions | 5,393 | 0.33% |
| **Total** | 1,631,671 | |

### *COMMERCIAL ENERGY*

Commercial energy is the largest emitter of the three classes of energy emissions (the others being residential and industrial), producing 556,800 MT CO2e. Data on commercial electricity energy consumption was provided by Piedmont Electric Cooperative, extrapolated from 2017 data from Duke Energy, and obtained from the cogeneration plants at the University of North Carolina Chapel Hill. Data for natural gas usage was sourced from Dominion Energy.

Of the commercial total, electricity accounted for 258,454 MT CO2e, natural gas contributed 79,263 MT CO2e, and coal-powered cogeneration accounted for 219,083 MT CO2e. Thus, commercial energy constitutes 34% of total community emissions in Orange County.

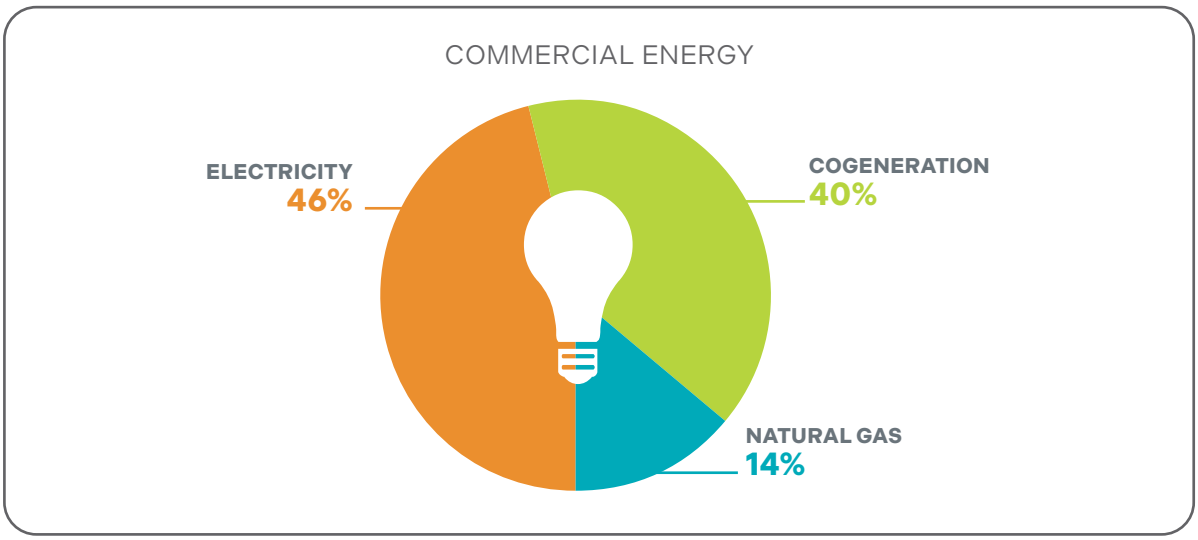


Figure 4. Commercial Energy Breakdown

### *RESIDENTIAL ENERGY*

Residential energy consumption incorporates emissions from natural gas combustion, electricity production, the burning of Liquid Petroleum Gas (LPG), and the use of distillate fuel oil No. 2, all specific to residential communities within Orange County. Data regarding Orange County's residential electricity usage was supplied by Piedmont Electric Cooperative and Duke Energy, while Dominion Energy provided data for natural gas. Statewide data served as the source for LPG and oil No. 2 usage - Orange County's proportionate share was established based on population demographics. Electricity data for 2019 from Duke Electricity was extrapolated from 2017 usage statistics.

Overall residential energy use contributed 299,216 MT CO2e. Of that total, emissions attributed to electricity was 200,750 MT CO2e, natural gas contributed 70,445 MT CO2e, LPG resulted in 26,538 MT CO2e, and distillate fuel oil no. 2 generated 1,483 MT CO2e. Residential energy constituted 19% of total community emissions.

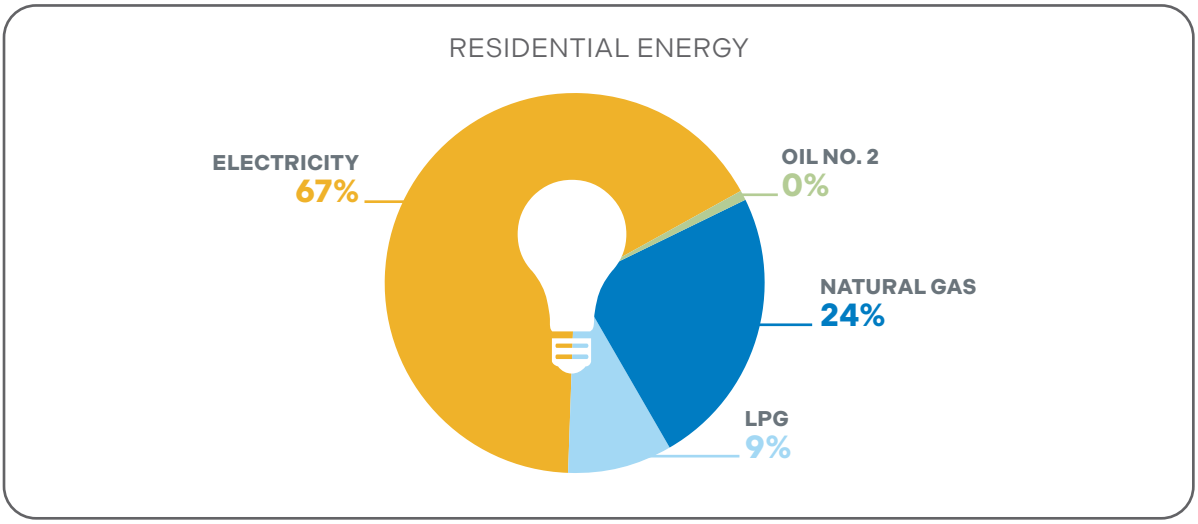


Figure 5. Residential Energy Breakdown

### *INDUSTRIAL ENERGY*

Industrial Energy data was supplied by two entities: Dominion Energy for natural gas and Duke Energy for electricity. The cumulative emissions from industrial energy amounted to 33,626 MT CO2e. Industrial electricity accounted for 18,024 MT CO2e, making up 53% of all emissions from industrial energy. Emissions originating from the combustion of natural gas totaled 15,602 MT CO2e, contributing to 46% of overall industrial energy emissions. Industrial energy usage comprises 2% of the total community emissions in Orange County.

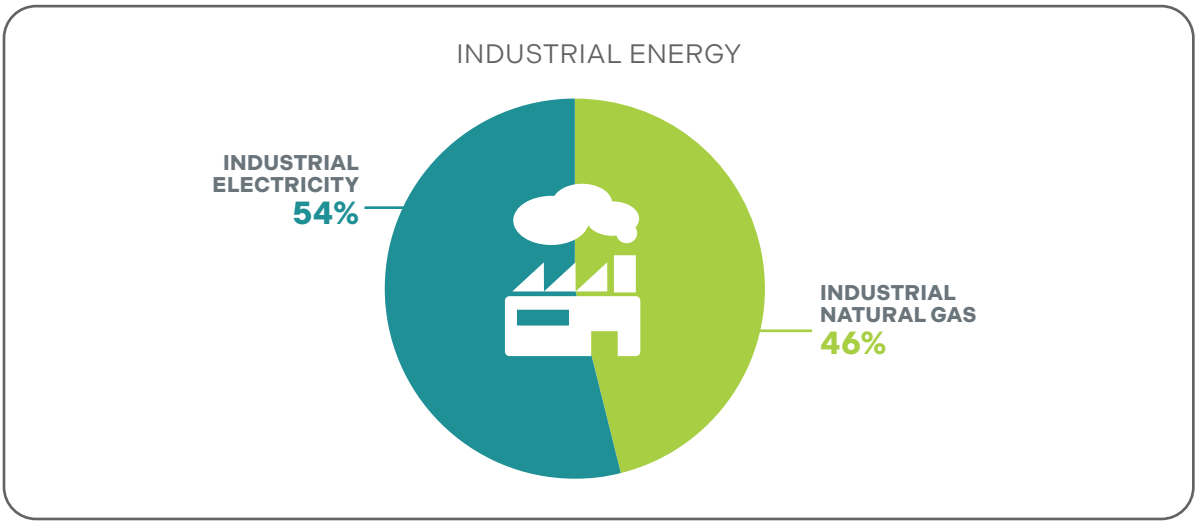


Figure 6. Industrial Energy Breakdown

### TRANSPORTATION AND MOBILE SOURCES

Transportation and Mobile sources are the primary contributor of emissions in Orange County, generating 702,701 MT CO2e and accounting for 43% of the County's total emissions. Orange County is characterized by its widespread rural communities, where reliance on cars is significant, leading to a considerable amount of Vehicle Miles Traveled (VMT) within the County. The emissions produced by gasoline fuel vehicles is 513,127 MT CO2e, while the emissions produced from diesel vehicles equaled 189,575 MT CO2e.

### SOLID WASTE

Emissions resulting from the waste sector are derived from estimated methane production due to decomposition of solid waste generated in the County. These calculations incorporate data gathered from the landfill and consider factors such as methane capture processes. Solid waste disposal contributes to 1% of the total emissions in Orange County, accounting for 21,350 MT CO2e.[12] In 2013, the County landfill, Orange County Regional Landfill in Chapel Hill, was closed. All subsequent solid waste has been disposed outside of the County. The methane that is still produced at the County's retired landfill is being destroyed through a partnership with the University of North Carolina, Chapel Hill and the County. Data received from Universities Sustainability Office states that the following totals of CO2e have been destroyed during fiscal years 2020 and 2021: 25,000 MTCO2e (2020) and 22,000 MTCO2e (2021). These amounts generally correspond to the EPA[13] and estimations from ClearPath calculations of landfill gas emitted for the same fiscal years: 23,940 MTCO2e (Calendar year 2020) and 18,490 MTCO2e (Calendar year 2021).

### WATER AND WASTEWATER

The Orange Water and Sewer Authority (OWASA) manages some of the County's potable water supply and wastewater disposal and supplied all related data. Total emissions from water and wastewater amount to 12,585 MT CO2e, accounting for 1% of total emissions across the County. Electricity emissions from potable water processes in Orange County are 1,763 MT CO2e. Wastewater electricity consumption is 2,446 MT CO2e and natural gas usage is 196 MT CO2e. Emissions from digester gas consumed 5 MT CO2e. Digester gas flaring emitted 68 MT CO2e. Nitrogen discharge from water treatment emitted 103 MT CO2e. Specific to the community inventory are emissions related to household septic systems which produced 8,004 MT CO2e.

### PROCESSES AND FUGITIVE EMISSIONS

Fugitive emissions, which are defined as unintended leaks or releases of gasses during the transportation or handling of substances like natural gas, contribute less than one percent to the total emissions of the County, amounting to an equivalent of 5,393 MT CO2e. These inadvertent emissions can occur at various stages of production, processing, storage, transmission, and distribution.

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[12] Waste management and landfill operations in Orange County were undergoing changes during recent years, the information used is extrapolated from 2017 data.

[13] https://ghgdata.epa.gov/ghgp/service/facilityDetail/2021?id=1005524&ds=E&et=&popup=true

# County Operations Inventory

The following sections provide detailed insights into the municipal GHG emissions within Orange County. The County's emitting sectors include buildings and facilities, vehicle fleets, transit fleets, and employee commuting. In 2019, the County's municipal activities generated a total of 19,359 MT CO2e, making up roughly 1% of the County's total emissions.

**TABLE 2: ORANGE COUNTY'S COUNTY OPERATIONS INVENTORY BY SECTOR**

| SECTOR | MT CO2e | Percentage (%) |
|---|---|---|
| Employee Commute | 6,329 | 33% |
| Buildings & Facilities | 6,185 | 32% |
| Water and Wastewater | 4,479 | 23% |
| Vehicle Fleet | 2,106 | 11% |
| Transit Fleet | 251 | 1% |
| Processes and Fugitive Emissions | 9 | 0.05% |
| **Total** | **19,359** | |

## BUILDINGS AND FACILITIES

Orange County's government-owned and operated buildings and facilities contribute 32% of the total emissions in the Municipal Inventory, and total 6,185 MT CO2e. The generation and consumption of electricity, along with the combustion of natural gas, are the primary sources of these emissions. Electricity usage for the government consumed 4,510 MT CO2e, where the natural gas combustion consumed 1,675 MT CO2e.[14]

## VEHICLE AND TRANSIT FLEET

The County's vehicle fleet (i.e., County maintenance, County law enforcement vehicles, etc.) represents 11% of total emissions, producing 2,106 MT CO2e. Further, since the County contributes funds towards the operation of transit vehicles (buses, vans, etc.), a portion of those emissions are also included. The County's share of the transit fleet produced 251 MT CO2e.

## EMPLOYEE COMMUTE

A survey of commuting habits was disseminated among all Orange County employees to gauge the carbon impact of the daily commute by the County's workforce. Based on the surveys, employee commuting is estimated at around 33% of the total emissions generated by local government operations, producing 6,329 MT CO2e.

[14] The County does not have any streetlights under its jurisdiction, which are included at the community inventory level.

### WATER AND WASTEWATER

Emissions associated with water and wastewater contribute to 23% of municipal emissions, as these services are managed and operated by government-owned programs. Electricity emissions from potable water processes in Orange County are 1,763 MT CO2e. Wastewater electricity consumption emitted 2,447 MT CO2e. Wastewater natural gas emitted 196 MT CO2e. Emissions from digester gas equal 5 MT CO2e. Digester gas flaring emitted 68 MT CO2e. Nitrogen discharge from water treatment emitted 103 MT CO2e. Total emissions from government related water and wastewater processes is 4,479.[15]

### PROCESSES AND FUGITIVE EMISSIONS

Fugitive emissions account for less than 1% of the total emissions in the municipal inventory of Orange County and are estimated at 9 MT CO2e.

## Conclusion

In 2019 in Orange County, the community generated a total of 1,631,671 MT C02e and County government operations produced 19,359 MT CO2e. The most significant contributors were transportation and mobile sources, accounting for 43% of community emissions. Commercial energy sources, including electricity, natural gas, and UNC-CH Cogeneration Coal Boilers, were the second highest contributor, constituting 34% of the emissions. Residential energy was the third highest contributor; other sources contributed relatively minor amounts in comparison. As for the emissions attributable to Orange County's government operations, three primary areas were prominent: Employee commute, Buildings and Facilities and Water and Wastewater are responsible for 33%, 32%, and 23% of the total emissions, respectively. Moving forward, Orange County is committed to maintaining its leadership role in North Carolina's efforts to reduce greenhouse gas emissions.

[15] This is not considered double counting emissions according to ICLEI protocols, since these are two separate inventories. In other sectors, municipal data is included in the community inventory in a less explicit way. For example, all County's municipal facilities electricity is included in the community's commercial electricity.

# Appendix A.1: Attached Use Data

***COMMUNITY INVENTORY***

| Activity | Unit | Data | Source |
|---|---|---|---|
| Duke Residential Electricity | kWh | 477,946,069 | Duke Energy 2017 |
| Piedmont Residential Electricity | kWh | 173,705,809 | Piedmont Electric Cooperative 2019 |
| Dominion Residential Natural Gas | MMBtu | 1,324,493 | Dominion Energy 2019 |
| LPG Usage | MMBtu | 417,443 | Orange County U.S. Census, and Energy Information Administration (EIA) 2019 |
| Distillate fuel oil #2 | MMBtu | 19,925 | Orange County U.S. Census, and Energy Information Administration (EIA) 2019. |
| Dominion Commercial Natural Gas | MMBtu | 1,490,289 | Dominion Energy 2019. |
| Duke Commercial Electricity | kWh | 793,824,045 | Duke Energy 2017 |
| Piedmont Educational Electricity | kWh | 9,947,766 | Piedmont Electric Cooperative 2019 |
| Piedmont Commercial Electricity | kWh | 35,193,563 | Piedmont Electric Cooperative 2019 |
| UNC-CH Boiler #6 Coal MMBTU | MMBtu | 848,000 | 2018 Annual Air Emissions Inventory Cogeneration Facility |

### *COMMUNITY INVENTORY CONTINUED*

| Activity | Unit | Data | Source |
|---|---|---|---|
| UNC-CH Boiler #7 Coal MMBTU | MMBtu | 913,000 | 2018 Annual Air Emissions Inventory Cogeneration Facility |
| Diesel Transportation | VMT | 128,745,750 | Google Environmental Insights Explorer (EIE) 2019 |
| Gasoline Transportation | VMT | 1,243,103,837 | Google Environmental Insights Explorer (EIE) 2019 |
| Solid Waste | Tons | 53,150 | 2017 GHG Inventory |
| Potable Water Electricity | kWh | 5,722,491 | 2019 Orange Water And Sewer Authority (OWASA) |
| Gas combustion | scf/day | 108,960 | 2019 Orange Water And Sewer Authority (OWASA) |
| Wastewater Electricity | kWh | 7,939,258 | 2019 Orange Water And Sewer Authority (OWASA) |
| Wastewater Natural Gas | Therms | 36,890 | 2019 Orange Water And Sewer Authority (OWASA) |
| Flaring of Digester Gas | Cubic ft/day | 54,480 | 2019 Orange Water And Sewer Authority (OWASA) |
| Septic Systems Emissions | Population | 65,884 | 2019 Orange County U.S. Census Data |
| Daily Nitrogen discharge | kg N/day | 135 | 2019 Orange Water And Sewer Authority (OWASA) |

### *COUNTY OPERATIONS INVENTORY DATA*

| Activity | Unit | Data | Source |
|---|---|---|---|
| Building and Facilities | MWH | 14,639 | 2019 Orange County Usage |
| | Therms | 315,060 | 2019 Orange County Usage |
| Vehicle Fleet | Gallons | 238,996 | 2019 Orange County Usage |
| Transit Fleet | Gallons | 28,595 | 2019 Orange County Usage |
| Employee Commute | Miles | 17,443,305 | 2019 Orange County Commute Survey |
| Wastewater Electricity | kWh | 7,939,258 | 2019 Orange Water And Sewer Authority (OWASA) |
| Digester Gas Combustion | scf/day | 108,960 | 2019 Orange Water And Sewer Authority (OWASA) |
| Digester Gas Flaring | cubic feet/day | 54,480 | 2019 Orange Water And Sewer Authority (OWASA) |
| Wastewater Natural Gas | Therms | 36,890 | 2019 Orange Water And Sewer Authority (OWASA) |
| Potable Water Electricity | kWh | 5,722,491 | 2019 Orange Water And Sewer Authority (OWASA) |

# Appendix A.2: Detailed Methodology

## *COMMUNITY INVENTORY*

### ELECTRICITY

Residential, commercial, and industrial electricity usage data for 2019 was furnished by Duke Energy and Piedmont Electric Cooperative. The process of determining emissions involved multiplying electricity usage by the emissions factor relevant to the jurisdiction where the electricity was generated. ICLEI: Local Governments for Sustainability[16] provided emission factors for local jurisdictions, which is based on data from the EPA Emissions Hub for SERC Virginia/Carolina (SRVC) eGRID 2019. The specific emission factors are as follows: the CO2 emission factor is 0.089765 MT/MMBtu, the CH4 emission factor is $7.7084 \times 10^{-6}$ MT/MMBtu, and the N2O emission factor is $1.0632 \times 10^{-6}$ MT/MMBtu. When these are added to carbon emissions the result is CO2e which represents the total Global Warming Potential.

Duke Energy's recent billing modifications resulted in the loss of certain emission data for 2019. This prompted us to estimate emissions using the growth rate of Orange County from 2010-2020 using census data. The County experienced an average annual growth rate of 1.1%, which we used as the basis for our electricity usage estimations. For example, in 2017, residential electricity usage from Duke amounted to 467,602,240 kWh. After applying the growth factor, we estimated that Duke's residential electricity for 2019 would be around 477,946,069 kWh. We used the same method to estimate commercial electricity usage growth from 776,643,905 kWh to 793,824,044.8 kWh. We also estimated that Duke's industrial energy usage would rise from 57,245,643 kWh to 58,511,973.87 kWh.

### NATURAL GAS

Data on residential and commercial natural gas was provided by Dominion Energy. The calculation of natural gas emissions involves multiplying the usage data by an emission factor provided by the US Community Protocol BE.1.1.[17] The respective emission factors are 53.02 kg/MMBtu CO2, 0.005 kg/MMBtu for CH4, and 1 xE-4 for N2O. The full methodology is detailed in the U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions Appendix C: Built Environment Emission Activities and Sources.

### LPG AND DISTILLATE FUEL OIL NO.2

These categories are calculated using data from the United States Census Bureau information[18] and methodologies from the US Community Protocol.[19] The Census Bureau tracks statewide residential non-utility fuel usage. To determine the proportion of fuel usage in Orange County, we compared the number of households in the County using

[16] U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions Appendix C: Built Environment Emission Activities and Sources.

[17] U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions Appendix C: Built Environment Emission Activities and Sources

[18] https://data.census.gov

[19] U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions Appendix C: Built Environment Emission Activities and Sources

each type of fuel to the total number of households in the entire state using the same fuel type. In Orange County, 6,078 households use bottled, tank, or LP gas, and 445 use fuel oil, kerosene, or similar fuels. Statewide, 256,257 households use bottled, tank, or LP gas, and 91,569 use fuel oil, kerosene, etc. The proportion of households in Orange County using bottled, tank, or LP gas is 0.0237, while the proportion using fuel oil, kerosene, etc., is 0.0486. To calculate the County's share of energy consumption, we multiply these proportions by the statewide energy use. According to data from the US Energy Information Administration,[20] North Carolina consumes 17.6 trillion Btu of Hydrocarbon Gas Liquids (HGL, which includes LPG) and 4.1 trillion Btu of Distillate Fuel Oil. After converting these figures from trillion Btu to MMBtu and applying Orange County's proportions, we estimate that the County's consumption of LPG is 417,443 MMBtu and its consumption of Distillate Fuel Oil #2 is 19,925 MMBtu. These estimates are calculated to carbon equivalencies using the US Community Protocol in ICLEI, applying emission factors of 62.98 kg/MMBtu for CO2, 0.01087 kg/MMBtu for CH4, and 0.0010870 kg/MMBtu for N2O.

### COAL

Emissions data from the coal cogeneration boilers at the University of North Carolina at Chapel Hill are sourced from the 2018 Annual Air Emissions Inventory Cogeneration Facility report, prepared by ClimeCo Corporation in 2019.[21] Detailed information about emissions from Boiler 6 can be found on pages 31-33, while Boiler 7's emissions are documented on pages 54-56.

### TRANSPORTATION AND MOBILE SERVICES

Transportation emissions in Orange County were computed using the Google EIE transportation data,[22] a source recommended by ICLEI. The emissions factors are sourced from the US Community Protocol,[23] which are as follows:

| | |
|---|---|
| CO2 Emissions Factor | 0.07024 |
| CO2 Emissions Factor Units | MT/MMBtu |
| CH4 Emissions Factor | $1.9493 \times 10^{-8}$ |
| CH4 Emissions Factor Units | MT/mile |
| N2O Emissions Factor | $1.0608 \times 10^{-8}$ |
| N2O Emissions Factor Units | MT/mile |

[20] https://www.eia.gov/state/search

[21] 2018 Annual Air Emissions Inventory Cogeneration Facility. The University of North Carolina at Chapel Hill: Chapel Hill, North Carolina

[22] https://insights.sustainability.google/places/ChIJEejT22XdrIkRPupCdcVJt0k?hl=en-US

[23] U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions Appendix D: Transportation and Other Mobile Emission Activities and Sources

### SOLID WASTE

Due to the existence of five waste haulers in the County and the closure of the local landfill in 2013, tracking the amount of solid waste produced in Orange County proved challenging. The destination landfill was unable to provide the required data in time for this report, necessitating an estimation of total solid waste based on 2017 levels and a growth factor for two subsequent years. Emission factors were determined using the 2019 Orange County Recyclables Characterization Study[24] and the 2017 Waste Characterization study[25] conducted by Kessler Consulting. The following are the specific emission factors: Mixed MSW Emission Factor (MT CH4/wet short ton) 0.0648, Newspaper Emission Factor (MT CH4/wet short ton) 0.042, Office Paper Emission Factor (MT CH4/wet short ton) 0.1556, Corrugated Cardboard Emission Factor (MT CH4/wet short ton) 0.1048, Magazines/Third Class Mail Emission Factor (MT CH4/wet short ton) 0.0476, Food Scraps Emission Factor (MT CH4/wet short ton) 0.0648, Grass Emission Factor (MT CH4/wet short ton) 0.0228, Leaves Emission Factor (MT CH4/wet short ton) 0.026, Branches Emission Factor (MT CH4/wet short ton) 0.058. The calculation methodology was adopted from the US Community Protocol.[26]

### WATER AND WASTEWATER

Both potable water and wastewater systems consume electricity, and the emissions from this are calculated as previously outlined. Additionally, wastewater treatment processes utilize natural gas, the emissions from which are calculated using the aforementioned methods. The process of digester gas combustion is estimated using site-specific data obtained from OWASA. This information is converted into emissions data by applying emission factors from the US Community Protocols. Specifically, the Biogenic CO2 Emissions Factor is 52.07 kg/MMBtu, the CH4 Emissions Factor is 0.0032 kg/MMBtu, and the N2O Emissions Factor is 6.3 x 10-4 kg/MMBtu. Further details on digester combustion calculations can be found in US Community Protocols WW.1.A, WW2.A, and WW.3. Emissions resulting from the flaring of digester gas are also considered in this inventory. This is determined using site-specific data sourced from OWASA and adhering to the best calculation practices provided by the US Community Protocol. The CH4 Emissions Factor in this case is 1.2177 x10-7 MT CH4/scf. Daily nitrogen discharge is another factor incorporated in this inventory. Using the daily nitrogen load provided by OWASA, emissions data is calculated in line with the US Community Protocol. Here, the N2O Emissions Factor stands at 0.005 kg N2O/kg N in effluent. Additional details concerning effluent discharge can be referenced in the US Community Protocol, specifically WW.12. The final aspect of the water and wastewater analysis pertains to emissions from septic systems. While OWASA services the majority of households in

[24] ORANGE COUNTY, NORTH CAROLINA RECYCLABLES CHARACTERIZATION STUDY, Kessler Consulting, Inc.

[25] https://www.orangecountync.gov/DocumentCenter/View/2826/2017-Orange-County-Waste-Characterization-Study-Final-Report-PDF

[26] U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions Appendix E: Solid Waste Emission Activities and Sources

Orange County, approximately 65,000 are not covered by the local wastewater agency. This results in widespread use of septic systems for wastewater disposal. Emissions from these systems can be calculated using a population-based method, which incorporates a CH4 Emissions Factor of 0.048213 MT CH4 per daily kg BOD5. An alternative calculation approach is documented in the US Community Protocol under reference WW.11 (alt).[27]

#### FUGITIVE EMISSIONS

Fugitive emissions were calculated by usage data summed from natural gas. This was multiplied by a leakage factor of an industry standard recommended by the U.S. Community Protocol.[28] The leakage emissions are multiplied by an emissions factor of $6.1939 \times 10^{-5}$ MT CH4/MMBtu natural gas used, and CO2 emission factor of $6.6316 \times 10^{-5}$ MT CO2/MMBtu natural gas used.

### *COUNTY OPERATIONS INVENTORY*

#### BUILDINGS AND FACILITIES

Orange County's buildings and facilities emissions were calculated using usage data obtained from the government's tracking software. This software monitors both electricity and natural gas usage data. The calculations were carried out in the same manner as those for the community inventory of natural gas and electricity.

#### VEHICLE FLEET

Fuel usage for Orange County's vehicle fleet was supplied by the County and calculated using the US Community Protocol.[29] The annual miles traveled, and annual fuel usage are tracked and multiplied by emission factors from ICLEI. These include a CO2 Emissions Factor of 0.070268 MT/MMBtu, a Biogenic CO2 Emissions Factor of 0 MT/MMBtu, a CH4 Emissions Factor of 2.153 x10-8 MT/vehicle mile, a Biofuel CH4 Emissions Factor of 0 MT/vehicle mile, a N2O Emissions Factor of 1.248 x10-8 MT/vehicle mile, and a Biofuel N2O Emissions Factor of 0 MT/vehicle mile.

#### TRANSIT FLEET

Data on Orange County's transit fleet usage was also provided by the County. This data was broken down by vehicle types, with transit fleet vehicles identified as buses within the data sheet. Emission factors for transit fleet buses include a CO2 Emissions Factor of 0.07024 MT/MMBtu, a CH4 Emissions Factor of 1.93 x 10-8 MT/vehicle mile, and a N2O Emissions Factor of 1.48 x10-8 MT/vehicle mile.[30]

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[27] U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions Appendix F: Wastewater and Water Emission Activities and Sources

[28] https://www.edf.org/sites/default/files/US-Natural-Gas-Leakage-Model-User-Guide.pdf

[29] U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions Appendix D: Transportation and Other Mobile Emission Activities and Sources

[30] U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions Appendix D: Transportation and Other Mobile Emission Activities and Sources

### EMPLOYEE COMMUTE

Data on employee commutes was provided by the 2019 commuting survey of Orange County employees. This survey asked employees about their commuting habits, and total annual Vehicle Miles Traveled (VMT) was extrapolated from the responses. While the survey results did not include total mileage, it was possible to calculate this by multiplying the average miles per commute by the average workdays per week and then calculating the yearly VMT using the average number of working weeks in a year, which is 49.[31] This yields the total annual commuting VMT for Orange County. The emissions were then calculated using the US Community Protocol emission factors of CO2 Emissions Factor 0.07024 MT/MMBtu, CH4 Emissions Factor 1.8300 x 10-8 MT/Mile, and a N2O Emissions Factor 8.3 x 10-9 MT/Mile.

### WATER AND WASTEWATER

The emissions from water and wastewater operations for Orange County's municipal activities were calculated in the same manner as in the community inventory.[32] As OWASA is a municipal operation, its emissions should be included under those from the County. The difference between the two sectors is that the municipal inventory does not include emissions from septic systems.

### FUGITIVE EMISSIONS

These are calculated in the same way as the community inventory. Fugitive emissions were calculated by usage data summed from natural gas used by the County operations. Usage was multiplied by a leakage factor of an industry standard recommended by the U.S. Community Protocol. [33] The leakage emissions are multiplied by an emissions factor of 6.1939 x $10^{-5}$ MT CH4/MMBtu natural gas used, and CO2 emission factor of 6.6316 x $10^{-5}$ MT CO2/MMBtu natural gas used.

[31] https://www.bls.gov/news.release/pdf/atus.pdf

[32] U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions Appendix F: Wastewater and Water Emission Activities and Sources

[33] https://www.edf.org/sites/default/files/US-Natural-Gas-Leakage-Model-User-Guide.pdf