North Central Texas 12-County Metropolitan Planning Area 2019 Inventory of Community Greenhouse Gas Emissions

North Central Texas Council of Governments

Developed by the North Central Texas Council of Governments with Assistance from ICLEI - Local Governments for Sustainability USA –
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Executive Summary

The North Central Texas Council of Governments (NCTCOG) recognizes that changes in climate are occurring, and that global anthropological activities are an attributable factor. NCTCOG works in cooperation with federal, state, and local partners to achieve comprehensive air quality improvements throughout Dallas-Fort Worth across multiple transportation and emission sectors. Air quality in North Central Texas has long been a concern since the region is classified as being nonattainment under two National Ambient Air Quality Standards (NAAQS) for the pollutant ozone. Due to its harmful effects on the health of humans and the environment, ground-level ozone is monitored and targeted for emission reductions.

Development of a state-wide air quality plan, known as the State Implementation Plan (SIP), is required for all nonattainment areas to demonstrate how ozone will be reduced to levels compliant with the NAAQS. NCTCOG is dedicated to continuing the pursuit to attain federal compliance for both ozone NAAQS for the Dallas-Fort Worth region and contribute to a better quality of life for all North Texans. NCTCOG's primary goal in air quality is to reach and maintain federal attainment for criteria pollutants, and many air quality efforts reduce particulate matter, greenhouse gas, and ozone precursor emissions though supporting efforts to improve air quality comprehensively. This multipollutant approach is centered around emission reductions within the 12-county region to mitigate regional airshed pollutants that may pose substantial risks to the future health, wellbeing, and prosperity of the Dallas-Fort Worth area.

NCTCOG provided cities in the North Central Texas 12-County Metropolitan Planning Area (MPA) access to an emission inventorying software tool through participation in an emission inventory cohort. Participating cohort cities leveraged the emission inventory tool to produce their own city-wide greenhouse gas emission inventories, with ICLEI and NCTCOG support. These reports facilitate city planning and can be used as a baseline to support policy/technical decisions along with allowing a means of benchmarking actions that take place.

The following report provides quantitative estimates of greenhouse gas emissions resulting from anthropological activities within the North Central Texas 12-county MPA during calendar year 2019.

Key Findings

Figure 1 shows communitywide emissions by sector. The largest contributor is the Energy sector, with 53% of regional emissions. The next largest contributors are the Transportation & Mobile Sources (43%) sector and the Solid Waste (4%) sector. The water and wastewater sectors, when combined, were responsible for the remaining less than 1% of emissions. As a continuation of NCTCOG's dedication to advancing regional air quality and public health, emission reduction strategies from all sectors are necessary. The largest contributing sectors, of course, will have the largest amount of targeted emission reductions in the ongoing future through subsequent planning, advancements, and developments.

Figure 2 shows the emissions apportionment of the transportation sector. As the Metropolitan Planning Organization (MPO) for the region, NCTCOG works closely with local, state, and federal partners to plan and recommend transportation projects that will improve the transportation sector and encourage more efficient land use, all while minimizing the overall impact on the region's air quality. As the second largest contributing sector, emission reduction strategies in the transportation sector will be an integral part in any climate action plans developed by NCTCOG in the future.

The Inventory Results section of this report provides a detailed profile of emissions sources within the North Central Texas 12-county MPA. These results are not only pivotal as key information to guiding emission reduction efforts, but also provide a baseline against which the region will be able to compare future performance and demonstrate emission reduction progress.

Figure 1: Community-wide DFW 12-County 2019 Annual CO_2e Emissions by Sector

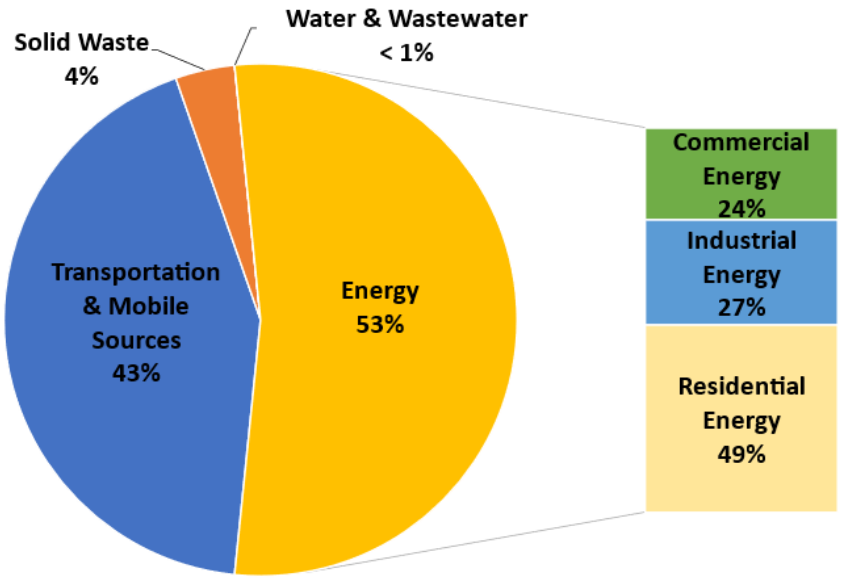
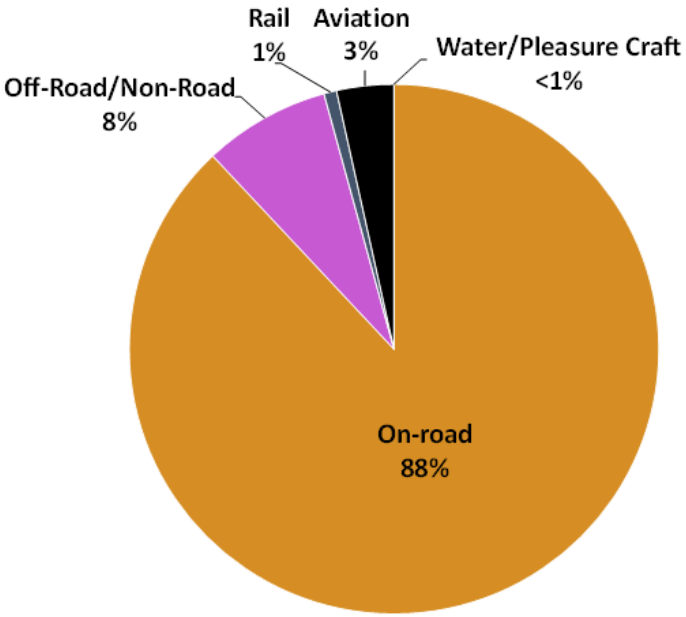


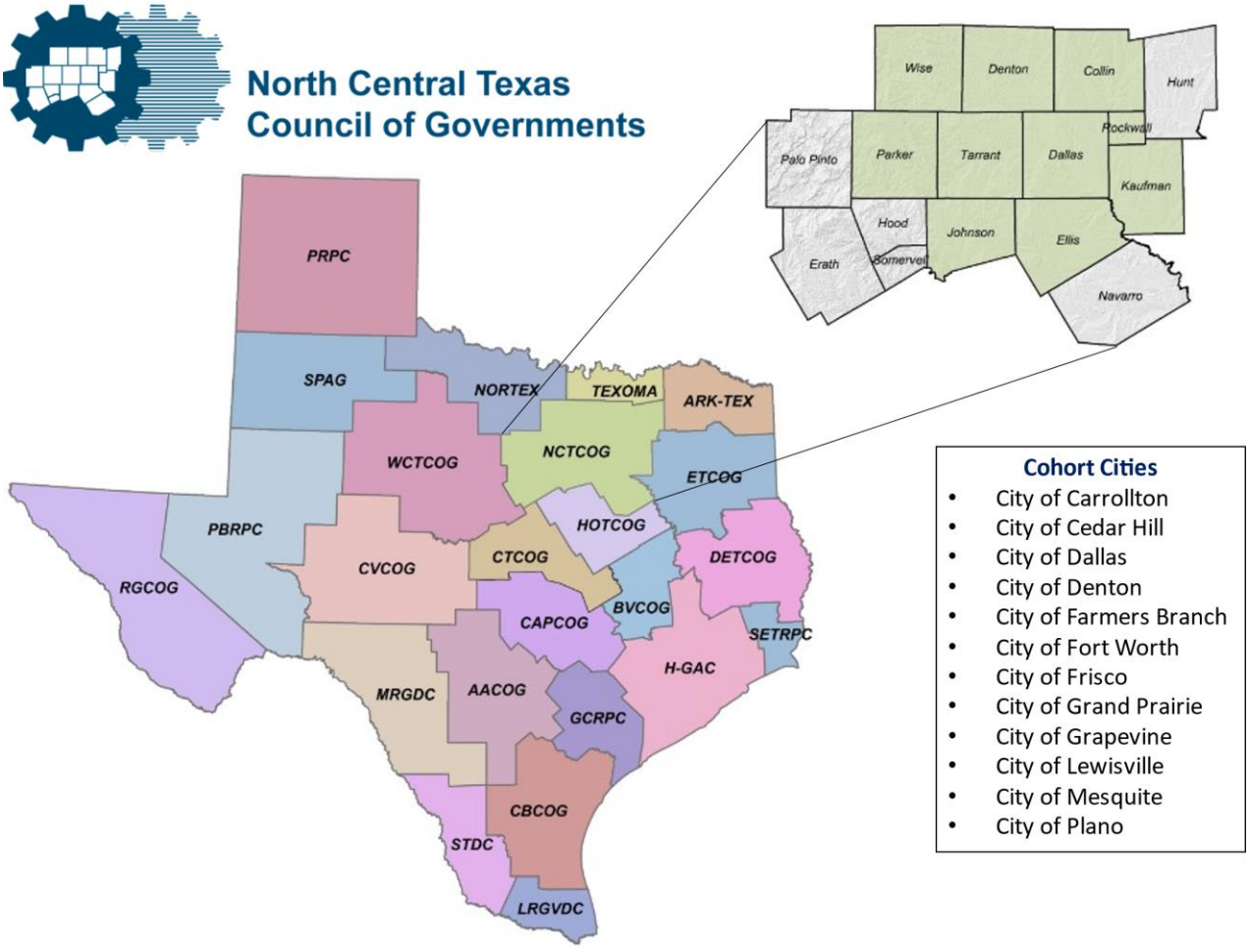
Figure 2: Community-wide DFW 12-County 2019 Annual CO_2e Transportation & Mobile Sources Emissions



Regional Collaboration

In partnership with the Regional Integration of Sustainability Efforts (RISE) Coalition, and with the generous contribution from Burlington-Northern Santa Fe (BNSF) railroad, NCTCOG provided cities in the North Central Texas 12-county Metropolitan Planning Area (MPA) access to the Local Governments for Sustainability, formally known as the International Council for Local Environmental Initiatives (ICLEI), ClearPath software tool at no cost through a regional emissions inventory cohort. The cities that participated in the cohort leveraged ClearPath to produce their own city-wide Greenhouse Gas emission inventories, with ICLEI and NCTCOG support.

Figure 3: Texas MPOs, DFW 12-county Region, and Cohort Cities



Understanding the Greenhouse Gas Emissions Inventory

The first step toward achieving tangible emission reductions requires identifying baseline emissions levels and sources and activities generating emissions in the region. This report presents an assessment of anthropological emissions from the 12-county MPA, including local government operations. The government operations inventory is mostly a subset of the community inventory, as shown in Figure 4. The emissions from local government operations are included in the community emissions to create a wholistic report on emissions within a larger area, whereas a government operations inventory is the subset of emissions attributed to any local government from their operations. For example, data on commercial energy use by the community includes energy consumed by municipal buildings, and community vehicle-miles-traveled estimates include miles driven by municipal fleet vehicles.

As local governments continue to join the climate protection movement, the need for a standardized approach to quantify GHG emissions has proven essential. This inventory uses the approach and methods provided by the U.S. Community Protocol for Accounting and Reporting Greenhouse Gas Emissions (Community Protocol) and the Local Government Operations Protocol for Accounting and Reporting Greenhouse Gas Emissions (LGO Protocol) to quantify regional emission estimates, both of which are described below.

Figure 4: Relationship of Community and Government Operations Inventories

Three greenhouse gases are included in this inventory: carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Many of the charts in this report represent emissions in "carbon dioxide equivalent" (CO_2e) values, calculated using the Global Warming Potentials (GWP) for methane and nitrous oxide from the IPCC 5th Assessment Report:

Greenhouse Gas	Global Warming Potential
Carbon Dioxide (CO_2)	1
Methane (CH_4)	28
Nitrous Oxide (N_2O)	265

Inventory Methodology

The ICLEI Community Emissions Protocol

Version 1.2 of the U.S. Community Protocol for Accounting and Reporting GHG Emissions[1] was released by ICLEI in 2019 as a nationally recognized standard in guidance to help U.S. local governments develop effective community GHG emission inventories by establishing reporting requirements for all community GHG emissions inventories, providing detailed accounting guidance for quantifying GHG emissions associated with a range of emission sources and community activities, and providing numerous optional reporting frameworks to help local governments customize their community GHG emissions inventory reports based on their local goals and capacities.

The community inventory in this report includes emissions from the five Basic Emissions Generating Activities required by the Community Protocol:

- Use of electricity by the community
- Use of fuel in residential and commercial stationary combustion equipment
- On-road passenger and freight motor vehicle travel
- Use of energy in potable water and wastewater treatment and distribution
- Generation of solid waste by the community

The 2019 regional inventory also includes the following activities to be more comprehensive:

- Wastewater processing
- Off-road and non-road sectors
- Airport and aviation emissions
- Water/Pleasure Craft emissions

The ICLEI Local Government Operations (LGO) Protocol

In 2010, ICLEI, the California Air Resources Board (CARB), and the California Climate Action Registry (CCAR) released Version 1.1 of the LGO Protocol.[2] The LGO Protocol serves as the national standard for quantifying and reporting greenhouse emissions from local government operations. The purpose of the LGO Protocol is to provide the principles, approach, methodology, and procedures needed to develop a local government operations greenhouse gas emissions inventory.

[1] ICLEI. 2012. US Community Protocol for Accounting and Reporting Greenhouse Gas Emissions. Retrieved from http://www.icleiusa.org/tools/ghg-protocol/community-protocol

[2] ICLEI. 2008. Local Government Operations Protocol for Accounting and Reporting Greenhouse Gas Emissions. Retrieved from http://www.icleiusa.org/programs/climate/ghg-protocol/ghg-protocol

The following activities are included in the LGO inventory:

- Energy and natural gas consumption from buildings & facilities
- Wastewater treatment processes
- On-road transportation from employee commute and vehicle fleet

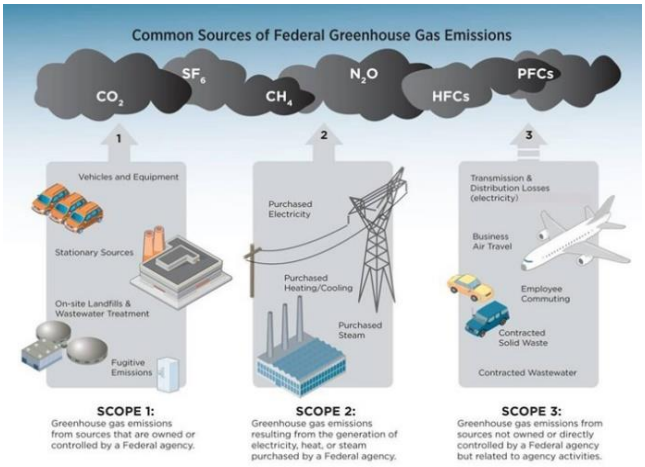
Sources and Activities

Communities contribute to greenhouse gas (GHG) emissions in many ways. Two central categorizations of emissions are used in the community inventory: 1) GHG emissions that are produced by "sources" located within the community boundary, and 2) GHG emissions produced as a consequence of community "activities".

Table 1: Source and Activity Definitions Comparison

Source	Activity
Any physical process inside the jurisdictional boundary that releases GHG emissions into the atmosphere	The use of energy, materials, and/or services by members of the community that results in the creation of GHG emissions.

By reporting on both GHG emissions sources and activities, local governments can develop and promote a deeper understanding of GHG emissions associated with their communities. A purely source-based emissions inventory could be summed up to estimate total emissions released within the community's jurisdictional boundary. In contrast, a purely activity-based emissions inventory could provide perspective on the efficiency of the community, even when the associated emissions occur outside the jurisdictional boundary. The division of emissions into sources and activities replaces the scopes framework that is used in government operations inventories, but that does not have a clear definition for application to community inventories.



Source: EPA

Quantifying Greenhouse Gas Emissions

Emissions Quantification Methods

Greenhouse gas emissions can be quantified in two ways:

- Measurement-based methodologies refer to the direct measurement of greenhouse gas emissions (from a monitoring system) emitted from a flue of a power plant, wastewater treatment plant, landfill, or industrial facility.
- Calculation-based methodologies calculate emissions using activity data and emission factors. To calculate emissions accordingly, the basic equation below is used:

Activity Data x Emission Factor = Emissions

Most emissions sources in this inventory are quantified using calculation-based methodologies. Activity data refer to the relevant measurement of energy use or other greenhouse gas-generating processes such as fuel consumption by fuel type, metered annual electricity consumption, and annual vehicle miles traveled. Please see appendices for a detailed listing of the activity data used to compose this inventory.

Known emission factors are used to convert energy usage or other activity data into associated quantities of emissions. Emissions factors are usually expressed in terms of emissions per unit of activity data (e.g., lbs CO2/kWh of electricity). For this inventory, the calculations are in Carbon Dioxide Equivalent Emissions in Metric Tons ($MTCO_2e$).

Base Year

The inventory process requires the selection of a base year with which to compare current emissions. NCTCOG's regional community greenhouse gas emissions inventory utilizes 2019 as its baseline year, because it is the most recent year for which the necessary data is available that also best represents normative regional operations.

Source: NCTCOG

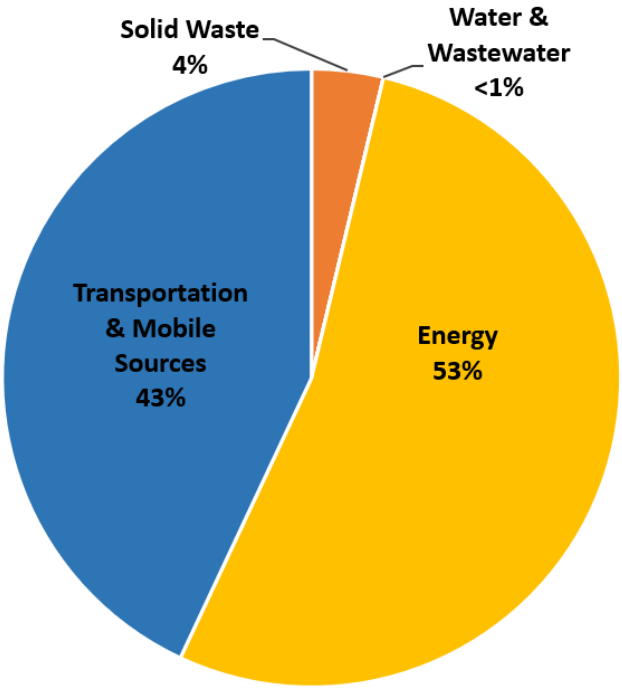
Community Emissions Inventory Results

The total community-wide Carbon Dioxide Equivalent Emissions in Metric Tons ($MTCO_2e$) for the regional 2019 inventory are shown in Table 2, and Figure 5 shows the relative distribution of community-wide emissions by sector. The Energy sector - comprised of residential, commercial, and industrial subsectors - makes up the largest portion of the regional inventory at 53%. Transportation & Mobile Sources is the second largest sector contributing to regional emissions, with the Waste and Wastewater sector making up the remaining emissions. This breakdown makes sense for Dallas-Fort Worth (DFW), with energy and transportation being the primary sources of emissions, especially since emissions from the waste & wastewater sector primarily is included in the energy sector due to energy consumption.

Table 2: Community-wide DFW 12-County 2019 Annual CO_2e Emissions

Sector	Fuel or source	2019 Usage	Usage unit	2019 Emissions ($MTCO_2e$)
Residential energy	Electricity	55,922,628	MWh	22,128,276
	Natural Gas (Utility Fuel Combustion)	81,805,347	MMBtu	4,350,940
	Kerosene and Distillate Fuel Oil (Non-utility Fuel Combustion)	1,262	MMBtu	94
	Propane (Non-utility Fuel Combustion)	3,494,597	MMBtu	216,870
	Wood (Non-utility Fuel Combustion)	333,762	MMBtu	3,324
Residential energy total				**26,699,504**
Commercial energy	Electricity	25,659,700	MWh	10,153,402
	Natural gas	47,731,979	MMBtu	2,538,696
	Kerosene and Distillate Fuel Oil (Non-utility Fuel Combustion)	4,201,094	MMBtu	312,811
	Propane (Non-utility Fuel Combustion)	2,946,261	MMBtu	182,841
	Wood (Non-utility Fuel Combustion)	117,802	MMBtu	237
Commercial energy total				**13,187,987**
Industrial energy	Electricity	17,051,836	MWh	6,747,317
	Natural gas	1,648,924	MMBtu	87,516
	Distillate Fuel Oil (Non-utility Fuel Combustion)	54,635,910	MMBtu	4,055,798
	Propane (Non-utility Fuel Combustion)	65,372,299	MMBtu	4,042,853
Industrial energy total				**14,933,484**
On-Road	Gasoline			30,507,188
	Diesel			8,498,899
Aviation	Jet A (Jet Kerosene)	-	-	1,382,747
	Aviation Gasoline	-	-	19,299
Off-Road/Non-Road	Total Off-Road/Non-Road Fuel Types			3,425,428
Pleasure craft	Diesel	-	-	94
	Gasoline	-	-	1,695
Rail	Freight Diesel	30,063,140	Gallons	309,690
	Passenger Diesel	3,312,274	Gallons	34,120
Transportation total				**44,179,160**
Solid Waste	Waste Generation	10,401,679	Tons	3,800,303
	Flaring	20,505,666,550	Cubic Feet/Year	56,010
Solid Waste total				**3,856,313**
Water and Wastewater	Effluent Nitrogen Load	183	kg N/day	139
Water and Wastewater total				**139**
Total community-wide emissions for the DFW 12-county MPA				**102,856,587 $MTCO_2e$**

Figure 5: DFW 12-County 2019 Annual CO_2e Emissions by Sector



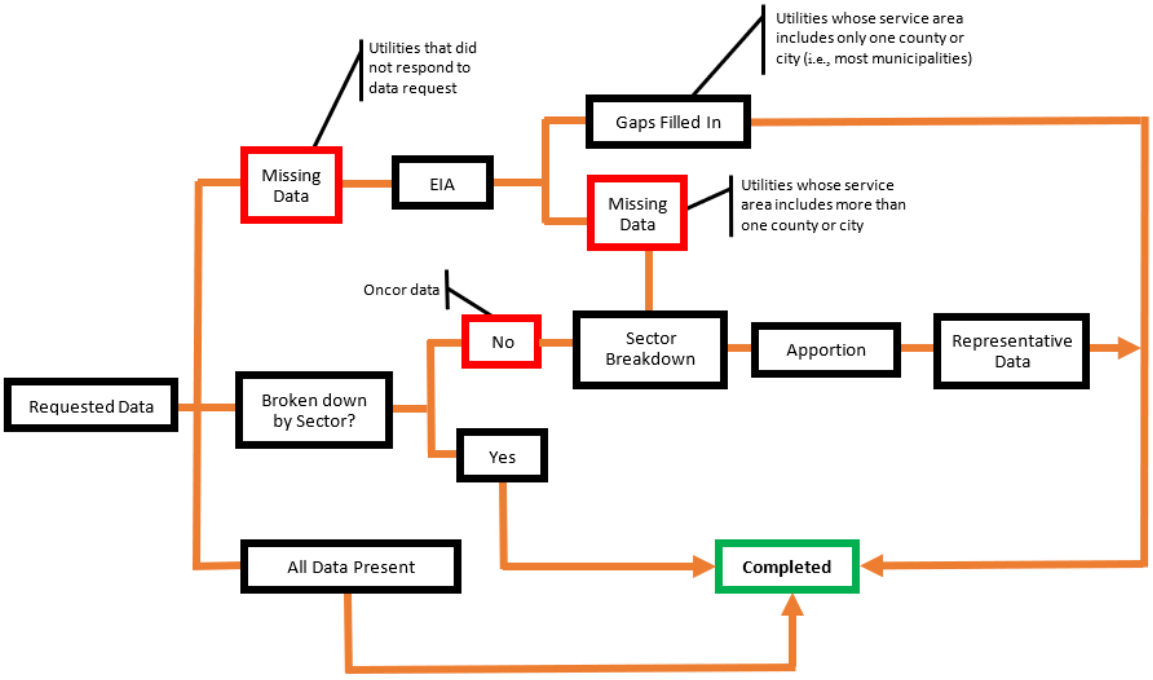
Electricity Data GHG Emissions Report and Methodology

Overview

Electricity data activity was estimated using a combination of Energy Information Administration data (EIA-861), NCTCOG GIS data, the National Land Cover Database GIS data and electricity usage data from municipal owned utilities (MOU), cooperatives (CO-OP), and electric transmission providers data requests. The data was categorized by residential, commercial, and industrial sectors for each county within the 12-county region.

Electricity usage for each county contained the summation of electricity usage from each electricity utility provider that served the county. Depicted below in Figure 6 is a process flow diagram describing the data gathering and representative data apportioning process for county electricity data. The incomplete or missing data from electricity utility providers was supplemented using EIA- 861 data and/or land-use GIS apportionment using representative data to help estimate usage.

Figure 6: County Electricity Data Methodology



Electric Utilities Operating within NCTCOG Region
City of Bridgeport, TX
City of Denton, TX
City of Farmersville, TX
City of Garland, TX
City of Granbury, TX
City of Greenville, TX
City of Sanger, TX
Cooke County Electric Coop Association
Denton County Electric Coop, Inc
Fannin County Electric Coop
Farmers Electric Coop, Inc, TX
Grayson-Collin Electric Coop, Inc
HILCO Electric Cooperative, Inc.
Navarro County Electric Coop, Inc
Tri-County Electric Coop, Inc, TX
Trinity Valley Electric Coop Inc
United Electric Coop Service Inc, TX
Weatherford Municipal Utility System
Wise Electric Coop Inc

Transmission and Distribution Utilities within NCTCOG Region
Oncor Electric
Texas New Mexico Power

Limitations
Limitations for this sector's emission inventory primarily relate to data constraints due to data availability and the level of data granularity. Some data requests were not fulfilled by electricity utility providers and EIA data was used to supplement. Oncor data was aggregated regardless of energy sector and EIA data was not at a county level, which lead to data apportionment processing.

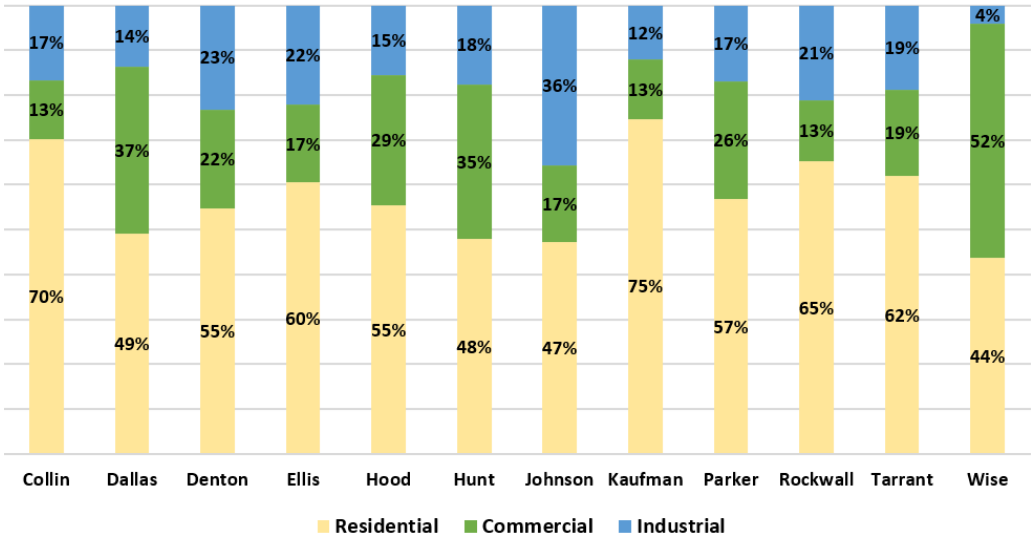
Assumptions
The following are some assumptions to complete the emissions inventory for the electricity sector.

- There is no overlap between Co-Ops and MOUs in coverage and those in a MOU area are subject to using the MOU.
- Land-Use data incorporation assumes that negligible electricity consumption occurred in areas that are not urbanized/incorporated.
- Apportioned data assumes equal amount of usage per area - counties with more urban developments, industrial or commercial sectors are likely to have fluctuating electricity usages.

Results
The energy sector is the largest contributor to CO_2e across the inventory, at 53% of regional emissions in 2019, with electricity being the bulk of the energy sector emissions – electricity from the residential, commercial, and industrial energy sub-sectors combined account for almost 38% of the regional inventory's CO_2e. Total electricity emissions for 2019 in the region were 39,028,995 metric tons of CO_2e, of which 57% (22,128,276 $MTCO_2e$) were residential, 26% (10,153,402 $MTCO_2e$) were commercial, and 17% (6,747,317 $MTCO_2e$) were industrial. Predictably, Dallas County contributed the highest amount of

CO_2e in all three sub-sectors, with Tarrant County as the second highest county. The sector percentage breakdown of the electricity consumption for each county can be seen in Figure 7.

Figure 7: DFW 12-County 2019 Annual MPA Electricity Usage by Sector



Natural Gas Data GHG Emissions Report and Methodology

Overview

Natural gas data was collected either directly from utilities or indirectly as supplemental data from the Railroad Commission of Texas (RRC). Data collected directly from utilities included division of natural gas by residential, commercial, and industrial sectors for each county and cohort city in the North Central Texas Council of Governments (NCTCOG) region. Data collected indirectly from the RRC included only residential and a combined mix of commercial and industrial sectors, which would then need to be processed and attributed to cohort cities and counties (see Figure 8).

RRC data was apportioned out to individual cohort cities and counties and used as representative data to get a wholistic view of natural gas consumption in the NCTCOG region (see Figure 9). Creating the representative data was accomplished by first identifying if a city within the NCTCOG region was serviced by more than one utility. If a city was serviced by only one utility, it could be added into the data for that county and, if applicable, the cohort city. However, if a city was serviced by more than one utility or that city existed in multiple counties, natural gas consumption data was apportioned based on that city's urban land use from the 2019 National Land Cover Database. The percentage of urban territory for each county within the service areas was then attributed to the individual county/city.

Figure 8: County Natural Gas Data Methodology

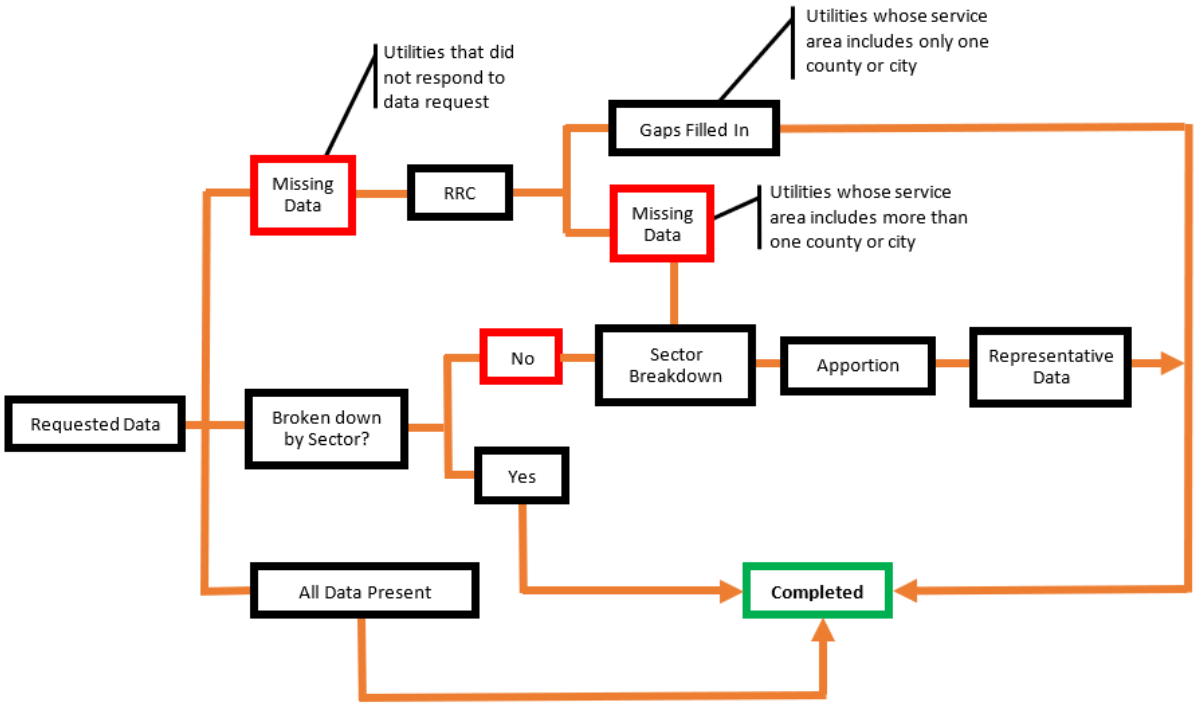
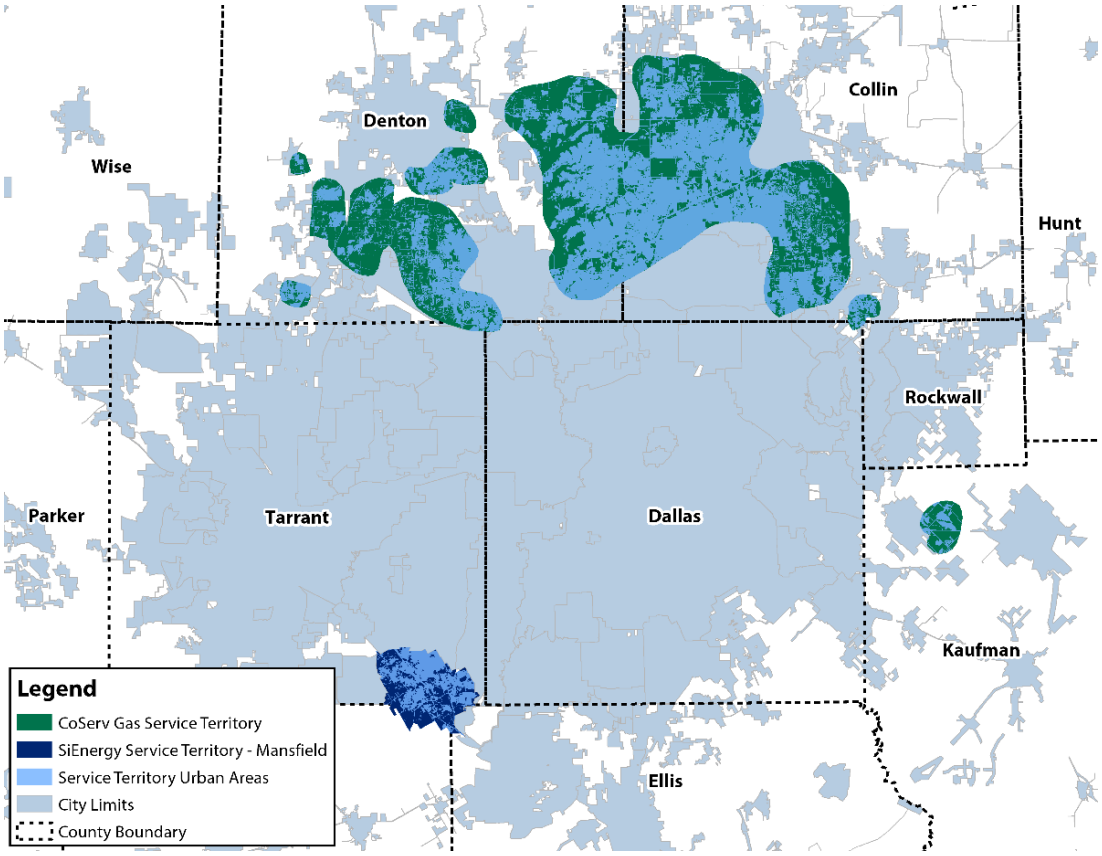


Figure 9: Natural Gas Utilities Operating within NCTCOG Region



Atmos Energy – Reported Directly
Texas Gas Service – Reported Directly
CoServ Gas – Reported Indirectly (RRC data)
SiEnergy – Reported Indirectly (RRC data)

Limitations

Limitations for this emission inventory primarily come from the use of supplemental data from the RRC. Ideally, data for natural gas consumption would have come directly from each utility that serves the NCTCOG region. The RRC receives natural gas consumption data directly from utilities. However, the structure of RRC data limits the scope of this inventory as RRC data does not include any unincorporated areas within counties and is limited to the city level. Additionally, the RRC data does not differentiate between commercial and industrial. For improvements on future emissions inventories, the facilitation of higher quality data reception from utility companies or the direct data requests to the RRC for county level data with all sectors apportioned.

Assumptions

The following are assumptions that were made to get the most wholistic view of natural gas consumption for the NCTCOG region:

- Commercial and industrial sector data from the RRC would only be included as commercial in the final product. This was done since data from Atmos Energy supported a more commercial heavy natural gas consumption.
- Data from Texas Gas Service included a "Public Authority" consumption. This sector was included as commercial in the final product since it included entities such as universities and government buildings.
- Most natural gas consumption is assumed to be in urban areas to help apportion data to different counties. However, this is not entirely true as numerous other land use areas consume natural gas.

Results

Total natural gas consumption for 2019 in the region was 131,186,251 MMBtu: of which 81,805,347 MMBtu was residential, 47,731,979 MMBtu was commercial, and 1,648,924 MMBtu was industrial. Dallas County contributed the highest amount of CO_2e in both residential and commercial with 1,501,844 and 1,189,621 metric tons, respectively. In the industrial sector, Tarrant County contributed the most CO_2e with 43,359 metric tons emitted. A breakdown by natural gas consumption for each county can be seen in Table 3.

Table 3: DFW 12-County 2019 Annual Natural Gas Usage by County, per Sector

County Natural Gas Usage	Residential (MMBtu)	Commercial (MMBtu)	Industrial (MMBtu)
Collin	17,069,925	5,026,766	97,509
Dallas	28,237,312	22,366,973	278,197
Denton	11,976,048	3,947,603	20,518
Ellis	849,596	608,677	82,046
Hood	95,415	118,542	0
Hunt	484,158	452,233	151,925
Johnson	648,447	501,344	165,429
Kaufman	814,352	404,970	29,478
Parker	384,276	440,237	6,869
Rockwall	1,404,920	449,868	0
Tarrant	19,691,689	13,174,683	816,954
Wise	149,210	240,084	0
Totals	**81,805,347**	**47,731,979**	**1,648,924**

Stationary Non-Utility Fuel Combustion GHG Emissions Report and Methodology

Overview

Stationary Non-Utility Fuel Combustion is reported by each source to the U.S. EPA under 40 CFR Part 98 Subpart C – General Stationary Fuel Combustion Sources and is also collected by the US Energy Information Administration (EIA) for usage in their State Energy Data System (SEDS). Reported data was extracted for statewide usage and downscaled for each sector, with the region's industrial sector data also gathered via the EPA's Facilities Level Information on GreenHouse gases Tool (FLIGHT) for regional guidance and comparative purposes. Data was then input into ICLEI's ClearPath tool to convert total consumption into metric tons of CO_2e using an emissions factor conversion for the corresponding fuel combusted.

Limitations

Limitations for this emission inventory primarily relate to data availability for accuracy and precision. Ideally, data for stationary non-utility fuel consumption would have come directly from each utility that serves the NCTCOG region. As the threshold for the federal GHG reporting program is 25,000 MT CO_2e for any facility to appear in reporting, many smaller emitters are left out and may cumulatively be a significant number of emissions that are unaccounted for. Additionally, EIA SEDS aggregates consumption of all types of distillate fuel oil into one number for the residential and commercial sectors. Therefore, custom emissions factors appropriate for general distillate fuel oil consumption of all types were used for ClearPath entry by using the CO_2 emission factor from the EIA and the CH_4 and N_2O emission factors from EPA's emission factors in Appendix C of the US Community Protocol.

Assumptions

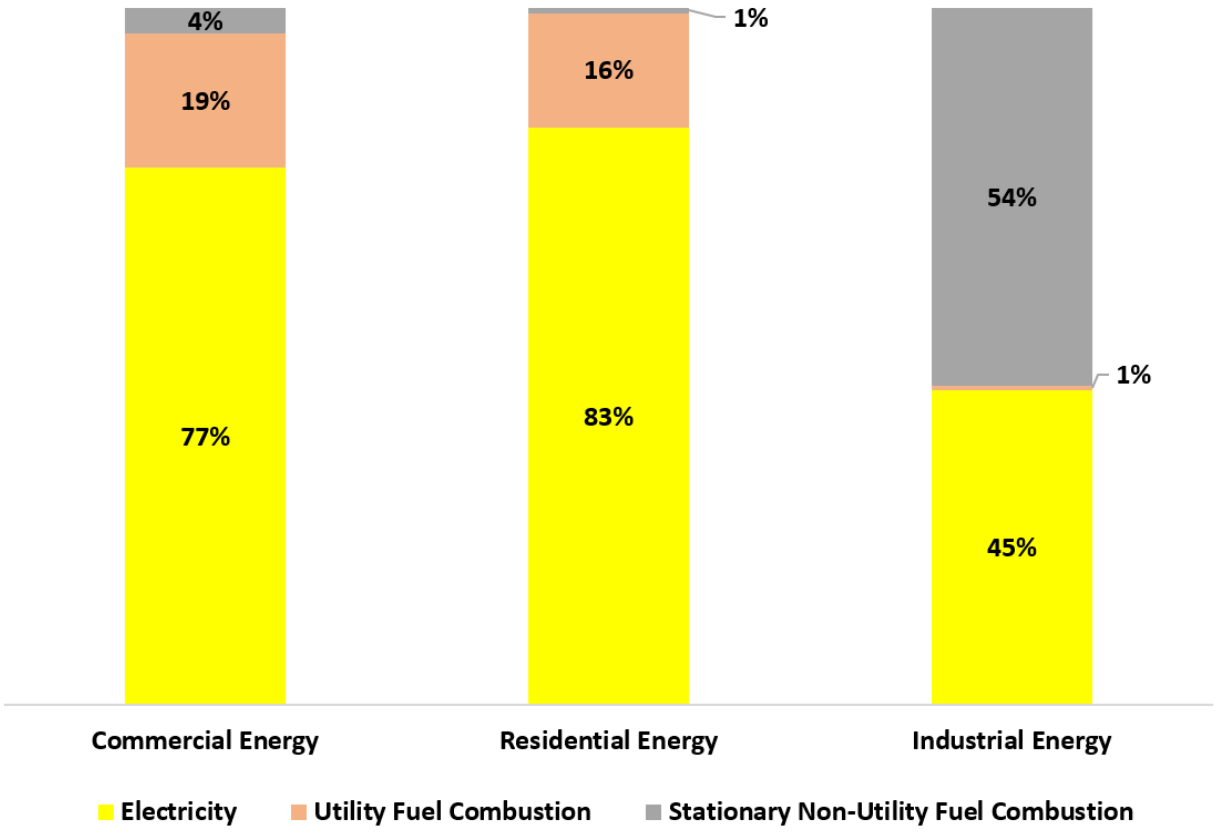
The following are assumptions that were made to get the most wholistic view of stationary non-utility Fuel consumption for the NCTCOG region:

- FLIGHT data was used to highlight what large industrial facilities exist in the region and what fuel types were consumed in 2019. This information was used as an indicator for what are likely the only fuels with widespread use throughout the region's industrial sector and therefore what fuels would also be unlikely to be used at smaller facilities in a nonnegligible amount.
- Assumed electricity, natural gas, and district heating/cooling to all be delivered by utilities and included in other sectors of this emission inventory.
- Estimations downscale the commercial and industrial sectors involved downscaling non-local (i.e., statewide) data on fuel consumption to a local level using Census job counts.
- EIA assumes statewide residential coal consumption in 2008 and beyond to be zero/negligible.

Results

Total stationary non-utility gas consumption for 2019 in the region resulted in 8,814,828 MT CO_2e of emissions: 220,288 was residential, 495,889 was commercial, and 8,098,651 was industrial. A sector-wide percentage comparison of the regional emission total can be seen in Figure 10 below.

Figure 10: DFW 12-County 2019 Annual Energy Emissions



On-road GHG Emissions Report and Methodology

Estimation of Vehicle Activity
The Dallas-Fort Worth Travel Model, Transportation Analytical Forecasting Tool (TAFT), serves as the source for forecasting vehicle miles of travel (VMT) and other travel characteristics for the North Central Texas nonattainment area. The network-based TAFT is executed in the TransCAD environment, which is a Geographic Information System-based commercial travel demand software package for transportation planning. The North Central Texas Council of Governments Transportation Department is responsible for executing TAFT and conducting various planning studies for the region. The forecasting technique of TAFT is based on a four-step sequential process designed to model travel behavior and predict the level of travel demand at regional, sub-area, or small area levels. These four steps are: Trip Generation, Trip Distribution, Mode Choice, and Roadway Assignment.

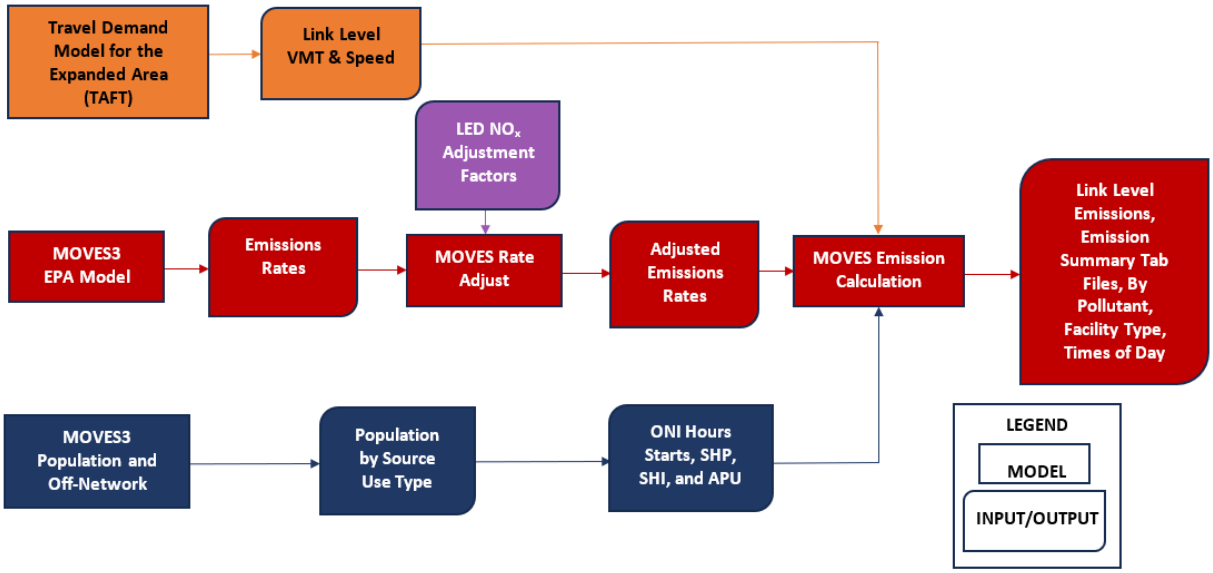
Estimation of Off-network Activity
The non-roadway-based inventory estimates (e.g., from vehicle starts, parked vehicle evaporative processes, non-roadway-based vehicle idling, hoteling activity) were calculated as the product of the amount of associated activity and the mass per unit of activity. To estimate the source hours parked (SHP) and vehicle starts activity, vehicle population estimates were needed. Hoteling activity estimates (composed largely of the emissions-producing source hours extended idling (SHEI) and diesel auxiliary power unit (APU) hours) were based on county-specific actual estimates.

The methodology provided by the Texas A&M Transportation Institute (TTI) similar to the region's transportation conformity, was used to calculate the vehicle population and off-network activity estimates.

Emissions Estimation
Emissions were calculated using the EPA's MOtor Vehicle Emission Simulator (MOVES) 3 model and the utilities developed by the Texas A&M Transportation Institute. The utilities combine vehicle and off-network activity and emission factors to create emission estimates.

Figure 11 below outlines the emission calculation modeling process used to calculate the Dallas-Fort Worth Metropolitan Planning Area emissions estimates.

Figure 11: Emissions Modeling Process



The emissions consist of link-level roadway-based modeled emissions for Collin, Dallas, Denton, Ellis, Hood, Hunt, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise counties. These emissions produced were at a summer weekday level, and a conversion factor from TxDOT's Automatic Traffic Recorder (ATR) Data was used to annualize the estimates. The on-road annual CO_2e emissions for the analysis year 2019 are listed in Table 4 below.

Table 4: DFW 12-County 2019 Annual On-road CO_2e Emissions

County	$MTCO_2e$
Collin	4,386,731
Dallas	14,642,389
Denton	3,476,454
Ellis	1,384,734
Hood	346,761
Hunt	958,525
Johnson	965,320
Kaufman	1,214,645
Parker	1,010,439
Rockwall	441,550
Tarrant	9,479,378
Wise	699,160
Total	**39,006,086**

Off-Road/Non-Road GHG Emissions Report and Methodology

The off-road/non-road emissions include emissions from various equipment such as agricultural, airport, commercial, construction and mining, industrial, lawn and garden, logging, railroad, and recreational. The emissions estimates were developed using the TexN model, a tool for estimating Texas-specific emissions from off-road/non-road sources. The Texas Commission for Environmental Quality (TCEQ) contracted with Easter Research Group (ERG) to develop the model. The TexN model uses EPA's Non-Road model to calculate emissions, as previously required by the EPA for developing emissions estimates for state implementation plan revisions, national emissions inventories, and reasonable further progress (RFP) analyses. Since TexN was developed, TCEQ has frequently updated the Texas-specific data within the tool and enhanced the tool's functionality. The recent version available, TexN 2.2, was utilized for this inventory.

The TexN 2.2 model was set to the scenario year of 2019, an annual period, and was run for all the 12 DFW MPA counties (Collin, Dallas, Denton, Ellis, Hood, Hunt, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise). The off-road/non-road annual CO_2e emissions for the analysis year 2019 are listed in Table 5 below.

Table 5: DFW 12-County 2019 Annual Off-Road/Non-Road CO_2e Emissions

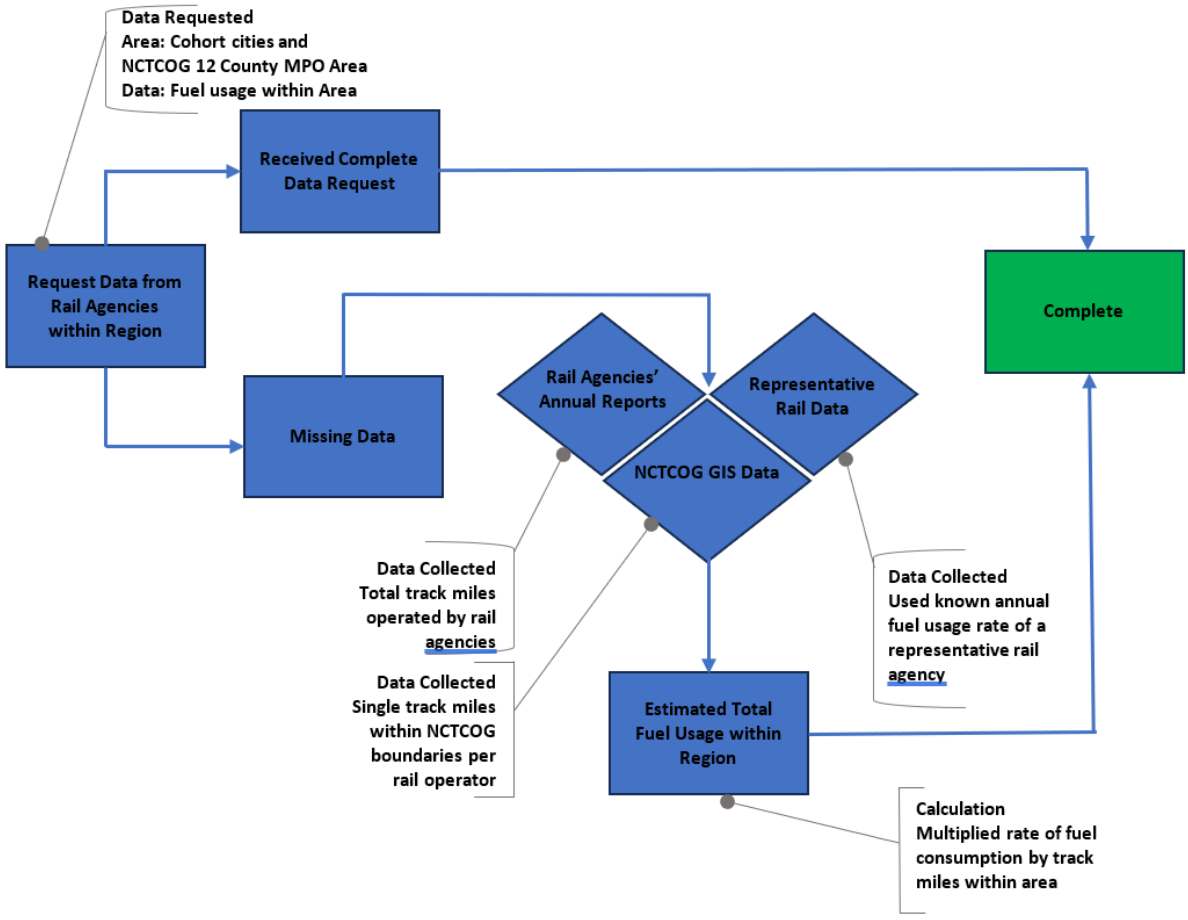
County	$MTCO_2e$
Collin	397,742
Dallas	1,418,388
Denton	290,817
Ellis	138,050
Hood	36,107
Hunt	38,465
Johnson	75,241
Kaufman	82,529
Parker	65,856
Rockwall	51,097
Tarrant	778,049
Wise	53,088
Total	**3,425,428**

Rail Data GHG Emissions Report and Methodology

Overview

Rail data was collected from a combination of fuel usage data from regional rail agencies data requests, total rail track miles and annual fuel use from rail agencies' sustainability/annual reports, representative rail data (for rail entities that had no data available), and single rail track miles operated by rail agencies within the North Central Texas Council of Governments (NCTCOG) region from NCTCOG GIS database (see Figure 12). The data was categorized as either freight (diesel), passenger (diesel), and passenger (electric).

Figure 12: County Rail Data Methodology



Rail emissions were estimated by calculating the rate of fuel consumption per single track mile for each rail agency and applying that rate to the number of single-track miles within the NCTCOG region.

$$Fuel\ Consumption_{Regional} = \frac{Fuel\ Consumption_{Total}}{Single\ Track\ Mile_{Total}} \times Single\ Track\ Mile_{Regional}$$
$$Emissions_{Regional} = Fuel\ Consumption_{Regional} \times ERCOT\ eGRID\ emission\ factor$$

Rail Agencies Operating within NCTCOG Region
Burlington Northern and Santa Fe Railway (BNSF)
Dallas Area Rapid Transit (DART)
Denton County Transportation Authority (DCTA)
Dallas, Garland & Northeastern Railroad (DGNO)
Fort Worth Western Railroad (FWWR)
Kansas City Southern (KCS)
Northeast Texas Rural Rail Transportation District (NETEX)
Trinity Metro
Union Pacific (UP)

Limitations
For this emissions inventory, the assumption that each track mile had the same emission rate was used to calculate emissions. Unless the rail agency solely operated within the NCTCOG region and provided their total fuel usage, this assumption did not account for the number of trips or number of locomotives for each track which would invariably over or underestimate the emissions per track mile. Additionally, ICLEI's ClearPath tool used only the Emissions & Generation Resource Integrated Database (eGRID) for the rail transportation factor set. "The eGRID is a comprehensive source of data from EPA's Clean Air Markets Division on the environmental characteristics of almost all electric power generated in the United States."[3]. However, eGRID may not accurately estimate the emissions from rail diesel as its focus is related to electricity generation and those associated emissions. This would work for electric rail transportation but may not as accurately calculate emissions for diesel rail transportation.

The following suggestions could be used to improve future emissions inventories:
- Obtain fuel usage data from FWWR.
- Know the number of locomotives that are used per trip within NCTCOG region.
- Know the number of trips per track mile.
- Consider including rail yard emissions in addition to goods and people movement.
- Identify a factor set that more specifically relates to rail diesel consumption.

It is understood that some of these suggestions may not be easily feasible, however they would help provide better accuracy and data quality.

Assumptions
The following are some assumptions that were made to complete the emissions inventory for the rail sector:
- Each track mile was assumed to have the same emission rate for all rail agencies.
- Fuel consumption from the Trinity Rail Express (TRE) was estimated using fuel consumption rates from DART and Trinity Metro because both operate part of the TRE.
- There was no fuel consumption attributed to NETEX because no trains were likely to run on the tracks located within our region.

[3] www.epa.gov/egrid

- The rate of fuel consumption for DGNO was used to estimate FWWR fuel consumption because no fuel data was available for FWWR and DGNO was a known representative data source.
- DART Light Rail electricity consumption is already accounted for in the electricity emissions inventory.

Results

The total CO_2e region associated with the rail sector in the region for 2019 was 343,810 metric tons, with a total fuel usage of 39,483,834 gallons of diesel. Tarrant County freight rail is shown to have contributed the highest amount of carbon dioxide equivalent (CO_2e) with 68,507 metric tons followed by Dallas County freight rail with 54,697 metric tons of CO_2e. There were 119,096,142 kilowatt hours associated to passenger rail and no electric freight rail usage. The electricity use associated to the rail sector is already accounted for in the electricity sector in the emissions inventory.

Table 6: DFW 12-County 2019 Annual Rail Sector Fuel Usage by County, per Sector

County Fuel Usage	Passenger Electric (kWh)	Passenger Diesel (gallons)	Freight Diesel (gallons)
Collin	4,889,483	0	1,978,636
Dallas	117,048,019	1,405,857	5,309,742
Denton	0	122,821	4,041,918
Ellis	0	0	3,699,674
Hood	0	0	144,798
Hunt	0	0	991,295
Johnson	0	0	3,177,038
Kaufman	0	0	563,801
Parker	0	0	640,404
Rockwall	0	0	64,782
Tarrant	2,048,123	1,783,597	6,650,288
Wise	0	0	2,800,763
Totals	**123,985,625**	**3,312,274**	**30,063,140**

Table 7 : DFW 12-County 2019 Annual Rail Sector CO_2e Emissions

County	$MTCO_2e$
Collin	20,383
Dallas	69,179
Denton	42,902
Ellis	38,111
Hood	1,492
Hunt	10,212
Johnson	32,728
Kaufman	5,808
Parker	6,597
Rockwall	667
Tarrant	86,880
Wise	28,851
Total	**343,810**

Pleasure-craft Data GHG Emissions Report and Methodology

Overview

Pleasure craft data was provided as a regional annual estimate based on data from the Texas Parks and Wildlife (TPW) Boat Registration inventory. The pleasure craft inventory was filtered down to the boats in the 12-county MPA that were built by 2019 and fuel description was processed to count all pleasure craft that may use diesel or gasoline. Pleasure craft emissions were estimated by establishing hours of pleasure craft operation and applying the number of boats in each speciated category against a conservative estimate for annual hours of boating per pleasure craft, then applying the hours against the corresponding emission factors from EPA's MOVES 3 model.

The EPA's MOVES 3 emission factors were for the scenario year of 2019, for all the 12 DFW MPA counties (Collin, Dallas, Denton, Ellis, Hood, Hunt, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise). The estimated regional pleasure craft CO_2e emissions for the analysis year 2019 are listed in the Table 8 below.

Limitations

Limitations for this section of the emission inventory include having to rely on TPW boat registration data accuracy. Fuel description was a vital column for being able to fully speciate pleasure craft emissions, and inconsistencies generally required manual edits for dataset manipulation. An additional limitation pertains to the location of pleasure craft usage and the number of hours operated, which were estimated using data on registered boats in Texas from the 2012 National Recreational Boating Survey and the corresponding exposure hours. There are also limitations on emission quantification due to the usage of summer weekday averages for each class of craft for emission rates.

Table 8: DFW 12-County 2019 Annual Pleasure Craft CO_2e Emissions

County	$MTCO_2e$
Collin	229
Dallas	360
Denton	296
Ellis	65
Hood	87
Hunt	30
Johnson	67
Kaufman	52
Parker	95
Rockwall	49
Tarrant	419
Wise	41
Total	**1,789**

Assumptions

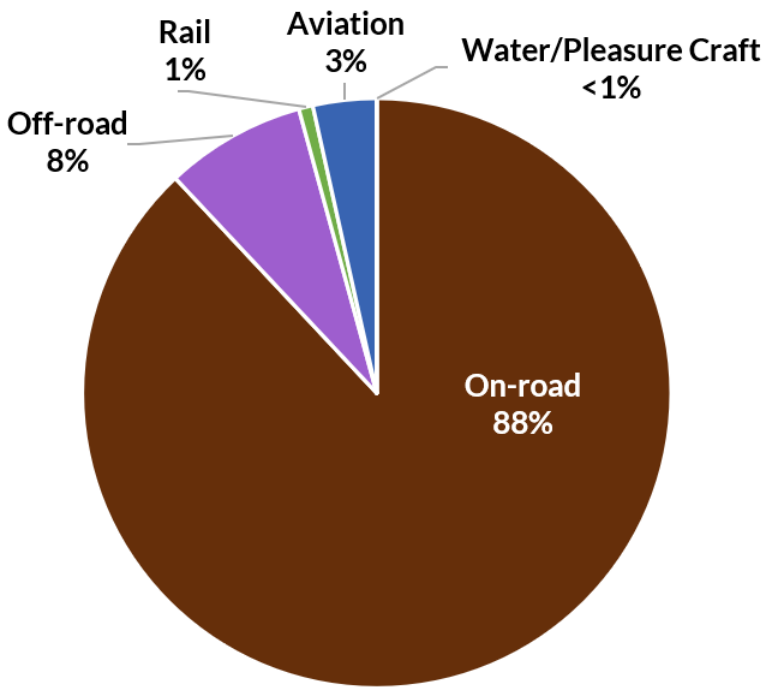
The following are some assumptions that were made to complete the emissions inventory for regional pleasure craft emissions:

- Pleasure craft registered within the 12-county region that also had a year built of 2019 or earlier were included in estimates.
- All pleasure craft were assumed to operate, and to operate an equal amount within the region.
- TPW data post-processing occurred to superimpose corresponding fuel descriptions and emission factors. The following occurred:
    - Boats registered as sail propulsion that did not have an engine or Fuel Description were superimposed as "NONE/NA" Fuel description.
    - Boats registered as sail propulsion that did not have an engine but were listed with a diesel fuel description were assumed to be inboard/sterndrive as a conservative estimate.
    - Fuel Description "NONE/NA" was not included for emission estimates.
    - Fuel Description as electric were not included for emission estimates to avoid potential double counting.
    - Fuel description "OTHER" that also had no engine were not included for emission estimates.
    - Pleasure craft with a blank fuel description and no engine were not included for emission estimates.
    - Combined Engine Types of NONE/NA, OTHER, (Blanks), & POD DRIVE were assumed to use the most conservative gasoline emission factor.
    - Summer Weekday activity is consistent across the region and representative of activity levels.

Results

Total pleasure craft estimated emissions for the 12-county MPA for 2019 resulted in 1,972 MT CO_2e of emissions, which is less than 1% of the emissions within the transportation sector. This is depicted below in Figure 13.

Figure 13 : DFW 12-County 2019 Annual CO_2e Transportation & Mobile Sources Emissions



Aviation Data GHG Emissions Report and Methodology

Overview

To maintain consistency with the state, regional aviation data emissions were sourced from the 2019 and 2020 data used in development of the SIP through a recent airport emission inventory ("2020 Texas Statewide Airport Emissions Inventory and 2011 through 2050 Trend Inventories") provided by the Texas Transportation Institute (TTI) for the TCEQ. The report is required every three years by the EPA to fulfill Air Emissions Reporting Requirements (AERR) for usage in the EPA's National Emissions Inventory (NEI).

The emissions estimates were modeled using average summer weekday emissions from airport (auxiliary power unit [APU], and ground support equipment) and aircraft emissions through the Federal Aviation Administration's Aviation Environmental Design Tool (AEDT). The most recent version of AEDT, AEDT 3d, was used for modeling and emission estimates are listed in Exhibit 1 below. As noted within the study, aircraft emissions were based on calculations for taxi-in, taxi-out, climb, and landing.

Limitations

Limitations for this emission inventory primarily come from the use of an external report. As the report is only required every three years by the AERR, there may be times that data may be unavailable or that required years may not align with desired/horizon years. Additionally, the COVID-19 pandemic may have had some impact on this study.

Assumptions

The following are assumptions that were made:

- Assumes all commercial, military, and turbine engines use Jet A (Jet Kerosene), are domestic passenger flights, and are between jurisdictions (scope 3).
- Assumes all piston engines use Aviation Gasoline, are domestic passenger flights, and are within jurisdictions (scope 1).
- The model assumes a maximum mixing height of 3,000 ft for emissions, so emissions at/above cruising altitude are not included in results.

Table 9: DFW 12-County 2019 Annual Aviation CO_2e Emissions

County	$MTCO_2e$
Collin	47,474
Dallas	213,161
Denton	24,020
Ellis	8,748
Hood	1,994
Hunt	7,529
Johnson	3,902
Kaufman	3,786
Parker	5,799
Rockwall	1,656
Tarrant	1,081,707
Wise	2,273
Total	**1,402,046**

Solid Waste, Wastewater, and Water Treatment Data & Methodology

Solid Waste

Overview

Greenhouse gas emissions from the Solid Waste sector were calculated using methane generation and flaring data from federal regulatory reporting for the 26 registered landfills within the inventory area for the year 2019. Methane is generated from the breakdown of organic material within landfills and may either be released directly into the atmosphere, captured for flaring, or converted into compressed natural gas (CNG). Flaring is the process of combusting landfill gas to reduce methane and other harmful compounds emitted.

Landfill methane generation is reported by landfills to the U.S. EPA under 40 CFR Part 98 Subpart HH – Municipal Solid Waste Landfills. This data was extracted for each landfill in the inventory area via the EPA's Facilities Level Information on GreenHouse gases Tool (FLIGHT) and totaled for the entire region. Data was input into ICLEI's ClearPath tool to convert total methane generated into metric tons of CO_2e.

Landfill gas flaring emissions data was extracted using the EPA's FLIGHT tool. Landfills are required to report the amount of landfill gas flared, the fraction of methane in the landfill gas, and the equipment destruction efficiency. The amount of gas flared was totaled for the inventory area, and averages were calculated for the fraction of methane and equipment destruction efficiency. Data was input into ICLEI's ClearPath tool to convert the total amount flared into metric tons of CO_2e.

The waste characterization factor set used was from the 2019 North Central Texas Waste Characterization Study.

Limitations

Since landfill methane is a Scope 1 emission, all methane emissions from each landfill are attributed to the county in which the landfill is located. All generation and disposal data are assumed to be from within the same county for ease of attribution. Hood, Kaufman, Rockwall, and Wise Counties have no landfills reporting through EPA FLIGHT or the Texas Commission on Environmental Quality (TCEQ). Data on emissions associated with compost facilities is not included in the Solid Waste sector as these facilities are not currently reporting emissions to EPA or TCEQ. Emissions from the collection and transportation of solid waste are included in the on-road transportation sector.

Table 10: DFW 12-County 2019 Annual Solid Waste CO_2e Emissions

Solid Waste Sector Emissions $MTCO_2e$	
Waste Generation Emissions	3,800,303
Landfill Gas Flaring Emissions	56,010
Total	**3,856,313**

Water and Wastewater

Overview

Greenhouse gas emissions from the Water Supply sector were calculated based on the total volume of water intake for water providers within the inventory area. Water intake data is reported by water providers to the Texas Water Development Board (TWDB) and published in TWDB's Water Use Survey. Total intake volume was converted to kWh of electricity usage using the ICLEI U.S. Community Protocol: Appendix F, Method WW.14 (Calculation of Upstream Emissions Associated with Water Supply, Conveyance, Treatment and Delivery). Data was input into ICLEI's ClearPath tool to convert total electricity usage into metric tons of CO_2e.

Emissions from wastewater effluent discharge were calculated based on data available through the EPA's Enforcement and Compliance History Online (ECHO). Daily nitrogen load was estimated via monthly averages reported to the EPA's National Pollutant Discharge Elimination System (NPDES) by wastewater facilities, based on nitrogen readings taken at effluent discharge sites. Daily averages are reported by facilities in lbs/day, so they were converted to kg/day. County data was averaged across the region and input into ICLEI's ClearPath tool to convert daily nitrogen load into annual metric tons CO_2e regionally. For ease of calculation and to properly assign Scope 1 emissions at the point of source, all wastewater effluent is assumed to be generated and treated in-boundary.

Limitations

Data on emissions associated with the supply of potable water is included in this report as information only. All emissions associated with water supply are related to the electricity used in water conveyance, treatment, and distribution, which is captured by the Commercial and Industrial Energy sectors.

In the absence of site-specific data, the energy intensities used in the calculations of electricity usage for each stage in the water supply process come from national averages and may have varying degrees of reliability.

Data on emissions associated with anaerobic digestion of wastewater biosolids is not included as this data is not currently reported to EPA or TCEQ. Only six of the 130 wastewater treatment facilities in the inventory area currently have onsite anaerobic digesters. There are no emissions associated with the combustion of wastewater biosolids as no wastewater treatment facilities in the inventory area engage in biosolid combustion. Process methane and nitrous oxide emissions from wastewater treatment lagoons and nitrification/denitrification are not included as this data is not currently reported to EPA or TCEQ. Emissions from septic systems are not included as there is no regional database for on-site sewage systems, so the total number of septic systems in the inventory area is unknown.

Table 11: DFW 12-County 2019 Annual Water and Wastewater CO_2e Emissions

Water and Wastewater Sector Emissions $MTCO_2e$	
Water Supply Emissions*	500,669*
Wastewater Effluent Discharge Emissions	139
Total (Emissions from Water and Wastewater Including the Emissions part of Energy Sector)	**500,808**

*Water Supply Emissions data is included in this section for information only. These emissions are included within the Commercial and Industrial Energy sector emissions.

Next Steps

This inventory is actively being utilized to focus and prioritize regional emission reduction strategies through project and policy planning and will serve as a baseline for future inventories: as a reference to gauge the effectiveness of subsequent actions targeted to reduce harmful emissions within the overall regional airshed, as well as a basis to improve upon for future inventorying efforts.

Based on 2019 emission inventory results, the following areas have the greatest potential for sector-wide emissions reductions:

- Energy
- Transportation & Mobile Sources
- Solid Waste

In concurrence of the completion of this 2019 emission inventory, NCTCOG has been awarded funding under the Climate Pollution Reduction Grant (CPRG) to continue aggressive emission reduction and inventorying pursuits for the region. As an expansion of this 12-county 2019 inventory, a progress assessment resulting from the implementation of emission reduction strategy projects and the extension of the scope to incorporate all 16 counties that the North Central Texas Council of Governments serves. As part of NCTCOG's scheduled CPRG planning initiatives the completion of this expanded 2019 emission inventory to be 16 counties will be completed by March of 2024 and an updated GHG emission inventory year will occur in the summer of 2025, with a potential update to the summer 2025 inventory in 2027.

The detailed methodology section of this report, as well as notes and attached data files in the ClearPath tool will be helpful to complete future inventories while maintaining consistency and making improvements for regional accuracy.

Conclusion

This inventory marks the completion of the first regional inventory for the NCTCOG 12-county MPA.

The Intergovernmental Panel on Climate Change (IPCC) states that to meet the Paris Agreement commitment of keeping warming below 1.5°C we must reduce global emissions by 50% by 2030 and reach climate neutrality by 2050. Equitably reducing global emissions by 50% requires that high-emitting, wealthy nations reduce their emissions by more than 50%. More than ever, it is imperative that countries, regions, and local governments set targets that are ambitious enough to slash carbon emissions between now and mid-century.

Science-based targets are calculated climate goals, in line with the latest climate science, that represent a community's fair share of the global ambition necessary to meet the Paris Agreement commitment. To achieve a science-based target, community education, involvement, and partnerships will be instrumental. The NCTCOG recognizes the need to adopt and implement achievable science-based targets that are guided by quantitative analysis and that will generate the largest emission reductions overall, and in the immediate future. Strategies that net large emission reductions across high emitting sectors will be pivotal, especially with ambitious aims to reduce overall emissions at least 50% from 2005 levels. This 12-county MPA inventory will be vital to emission reduction goals by further investigating priority emission reduction strategies and project assessments to guide the regional adoption of science-based targets. While expanding this 12-county inventory into the 16-county inventory for the baseline year 2019, the NCTCOG will formally adopt science-based targets by the completion of the next full inventory that will be completed during the summer of 2025.

In addition, NCTCOG will continue to track key energy use and emissions indicators on an on-going basis. It is recommended that communities update their inventories on a regular basis, especially as plans are implemented to ensure measurement and verification of impacts. Regular inventories also allow for "rolling averages" to provide insight into sustained changes and can help reduce the change of an anomalous year being incorrectly interpreted. This inventory shows that the energy and transportation sectors as well as communitywide transportation patterns will be particularly important to focus on. Through these efforts and others, the region can achieve environmental, economic, and social benefits beyond reducing emissions and attaining federal air quality standards.

If you would like any additional information or access to datasets used for the comprisal of this 12-county regional DFW GHG emission inventory, please contact NCTCOG staff.