Borough of Carlisle
Workshop Meeting Minutes
March 4, 2020

Present at the meeting: Councilors Crampsie, Fulham-Winston, Hicks, Landis, Deputy Mayor Shultz, Mayor Scott and Stuby. Also present were: Borough Manger Armstrong, Assistant Borough Manager Snyder, Police Chief Landis, Water Resources Director Malarich, Community Development Manager Skelly, Parks & Recreation Director Crouse, Fire Chief Snyder, Public Information Coordinator Taylor, Solicitor Brenneman, Dickinson Student Ambassador Smith, Dickinson Law Student Ambassador Speer and Borough Secretary Stone.

I. Call to Order & Pledge of Allegiance

Mayor Scott called the Workshop Meeting to order at 6:00 p.m.

II. Presentation:

A. Green House Gas Inventory Project:

Professor Neil Leary explained the PA Department of Environmental Protection invited municipalities across the state to participate in a program to estimate the emissions of Greenhouse gases in their towns. The first phase in collecting data is complete. The second phase will consist of developing a Climate Action Plan to bring back to Borough Council for approval. The information regarding the study is attached to these minutes.

III. Citizens to be Heard:

A. Proposed Parent Pathways Model:

Mr. Tim Whelan, Executive Director of the Housing and Redevelopment Authorities presented a program concept "Parent Pathways: Model for Single Parents pursuing Postsecondary Education". This program would provide multi-faceted support to low-income, single, parents with the opportunity to pursue a post-secondary education. Mr. Whelan explained the program would be a grant, funded through the PA Department of Human Services and overseen by the Housing Authority.

Ms. Jill Bartoli expressed enthusiasm regarding this program and the need for this type of support in the Carlisle community.

There was consensus or Council to move forward with a letter of support for the program.

IV. Meeting Minutes:

A. Borough Council unanimously approved the February 5, 2020 Workshop Meeting Minutes.

IV. Economic Development Committee:

A. Carlisle Borough Shopsteading Loan Request, Transformation Training and Fitness, 117 North Hanover Street :

Ms. Rebecca Yearick with the Cumberland County Redevelopment Authority provided an overview of the loan request from the owner of Transformation Training and Fitness, Kirk Ream. The request is for a $35,000 CDBG loan to be used to expand his business to a second location at 117 North Hanover Street. The money would be used for purchasing equipment and capital to relocate and expand the business.

V. Community Planning/Smart Growth Committee:

A. Institutional District Proposed Text Amendment:

Deputy Mayor Shultz stated the reason for the text amendment is to allow growth but protect the character of the neighborhood. He recommended:

- Reassessing the intended goal and craft an amendment that is minimally invasive to the community.
- Address the residential areas that may be in conflict with an expansion of an institutional development.
- Conditional use could be based on developing distance conditions for building requests.

There was consensus among Council that the previous version limited growth and the ordinance should be review for fairness.

Dr. Phillip Niederer, 228 Wilson Street, Carlisle Pennsylvania, President of Masland Associates, expressed concern that the Medical Arts Building may be restricted from future growth.

Mr. Ken Shultes spoke on behalf of Dickinson College stating they were pleased to hear there was the opportunity for amendments to the institutional district ordinance. There was concern by the college that all permitted uses would be stripped in the INS District.

Ms. Christine Spielbauer, Superintendent for the Carlisle School District, expressed concern the text amendment would constrict building and renovations needed for growth in the school district. She noted 43% percent of the district's tax base are Borough residents. Ms. Spielbauer offered to collaborate with the borough regarding what is best with the Carlisle community.

Mr. Steve Jones, Solicitor for the Carlisle School District, explained there is a limited amount of time to complete a project in regard to the school year. He noted this amendment would increase the approval time process and could delay projects that need completed in the summer time.

Ms. Becca Raley, Executive Director for Partnership for Better Health, expressed that members of the organization's finance committee have concerns about the ordinance. She stated the ordinance as now written creates institutions as second-class citizens of the Borough. Ms. Raley thanked council for their careful consideration stepping back to rethink the ordinance.

Councilor Crampsie thanked staff for working with stakeholders and to keep communication going.

VI. Public Works Committee:

A. Carlisle Connectivity Project:

Mark Malarich, Water Resources Director provided a construction update on the Tiger Project and Project I.

<u>Tiger Project:</u>

- The contractors sent out letters to property owners to conduct preconstruction inspections.
- Public outreach meetings were held with citizens in the construction areas to provide an overview of the project scope and timeline.
- Upon the completion of the preconstruction inspections, the first phase will immediately begin with the replacement of water mains at the Norfolk Southern railroad track to Fairground Avenue then to N. College Street.
- The second phase is expected to begin in May on Factory to B Street

Project I:

- Bids will be sent out in May
- Future outreach meetings will be held with those resident directly impacted
- Meeting will be advertised on the website
- General information meeting will be held with all residents

B. LED Street Lighting "Phase II":

Mark Malarich, Water Resources Director, stated PPL converted 379 streetlights to LED lights in 2019. This resulted in a savings of $5000 per year in electrical cost to the Borough. He noted shields were placed on a few lights at the request of residents to reduce amount of light shining into their houses. Mr. Malarich explained there are 650 PPL owned lights that have been identified for the next phase of LED conversion. These lights will be converted at no cost to the Borough.

Councilor Landis requested to see a map of the future light conversions placement prior to the implementations of the next phase to ensure lights are evenly distributed in the neighborhoods.

Borough Manager Armstrong explained that PPL's program is geared to lights that are 10 years or older and noted there is no cost to the Borough to convert.

Councilor Stuby asked for the cost savings information be shared with the citizens.

Borough Council voted 7-0 to approve Phase II of the LED Street Lighting Project with PPL. (Fulham-Winston/Landis)

C. Section 902 Recycling Grant Application:

Mark Malarich, Water Resources Director, explained the potential for receiving a 902 recycling grant through DEP. The grant will provide a 90% distribution with a 10 % local match and several years to implement the use of the monies. He noted staff has discussed using the grant money to purchase a leaf vacuum truck for use of curbside leaf collection in the borough. Mr. Malarich stated this is a very competitive grant among municipalities. Discussion ensued among Council and resulted in consensus to submit the grant application.

Borough Council voted 7-0 to approve the submission of a 902 recycling grant application. (Fulham-Winston/Landis)

VIII. Mayor's Report:

A. YWCA – Year 3 "Paint the Town Teal":

Borough Council voted 7-0 to approve the YWCA's request to tie teal colored ribbons to Borough lampposts as a sign of solidarity for Sexual Assault Awareness Month contingent upon the following:

- Ribbons shall be hung from downtown Borough lampposts beginning April 1 through April 30, 2020 and removed by May 1, 2020;
- Ribbons shall be secured tightly and at a height that will prevent them from being easily removed by pedestrians or inclement weather; and,
- Area shall be inspected periodically to ensure that ribbons remain secure and in good condition. (Scott/Shultz)

B. Hope Station Letter of Support Request:

Borough Council voted 7-0 to authorize a letter of support for a proposed re-entry program that is to be initiated by Hope Station. (Scott/Shultz)

C. Mayor Scott stated he is a member of an advisory board with the National League of Cities that has initiated a project, "Cities Vote Initiative". The project is to complete a 30-second video encouraging residents to vote with the theme that every voice is heard. Mayor Scott received endorsement from Council for this project.

ADJOURNMENT

There being no further business or public comment, the meeting adjourned at 7:30 p.m.

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Timothy A. Scott
Mayor

_____
Joyce E. Stone
Borough Secretary

Carlisle Greenhouse Gas Inventory, 2017

March 3, 2020

Mark Frenzel-Sulyok, Olivia Kubaska, Sam Lavine and Neil Leary, Dickinson College*

Introduction

The Borough of Carlisle is one of twenty municipalities planning for climate change as part of the *Local Government Climate Action Assistance Program* of the Pennsylvania Department of Environmental Protection (DEP). As a participant in the program, Carlisle is receiving assistance from DEP, ICLEI Local Governments for Sustainability and Dickinson College to develop a local climate action plan that will benefit the Carlisle community while helping advance goals of Pennsylvania's Climate Action Plan (PA DEP, 2018).

In the first phase of the planning process, begun in September 2019 and completed in February 2020, greenhouse gas emission inventories were calculated for Carlisle for the years 2016 and 2017. The inventories provide estimates of the quantities of greenhouse gas emissions that are produced by Carlisle residents, businesses, government offices and other entities located in the Borough. Emissions in the two years are very similar and this report focuses on 2017 emissions, the most recent year for which complete data is available. The inventory can serve as a baseline of information to assist the Borough in identifying and prioritizing emission sources for action, developing strategies for reducing emissions and setting goals.

Greenhouse gases such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) are emitted by a variety of activities, the largest contributor being the burning of fossil fuels for heat, electric power generation and transportation. The gases accumulate in the atmosphere where they amplify the capacity of the atmosphere to absorb and retain thermal energy and cause the climate to warm and change in other ways. Emissions of each type of greenhouse gas are estimated by weight, converted into an equivalent weight of carbon dioxide, added up and reported in metric tons of carbon dioxide equivalent ($MTCO_2e$).

Activity data were collected for residential and non-residential energy use; passenger vehicle, truck, transit, rail and local airport transportation; municipal solid waste generation; drinking water distribution; and wastewater treatment. The collected activity data were input to ClearPath, an online tool developed by ICLEI for calculating greenhouse gas emissions using average emission factors for each activity (ICLEI, 2014). The emission calculations performed by ClearPath are consistent with the U.S. Community Protocol for greenhouse gas inventories (ICLEI, 2012).

Estimated greenhouse gas emissions for Carlisle totaled nearly 239,000 $MTCO_2e$ in 2017, or 12.5 $MTCO_2e$ per resident (Figure 1). The largest source of emissions in Carlisle is non-residential energy use, accounting for 47.5 percent of Carlisle's total emissions. Transportation accounts for 29.7 percent, residential energy use for 19.3 percent, solid waste 2.8 percent and treatment of water and wastewater account for 0.6 percent.

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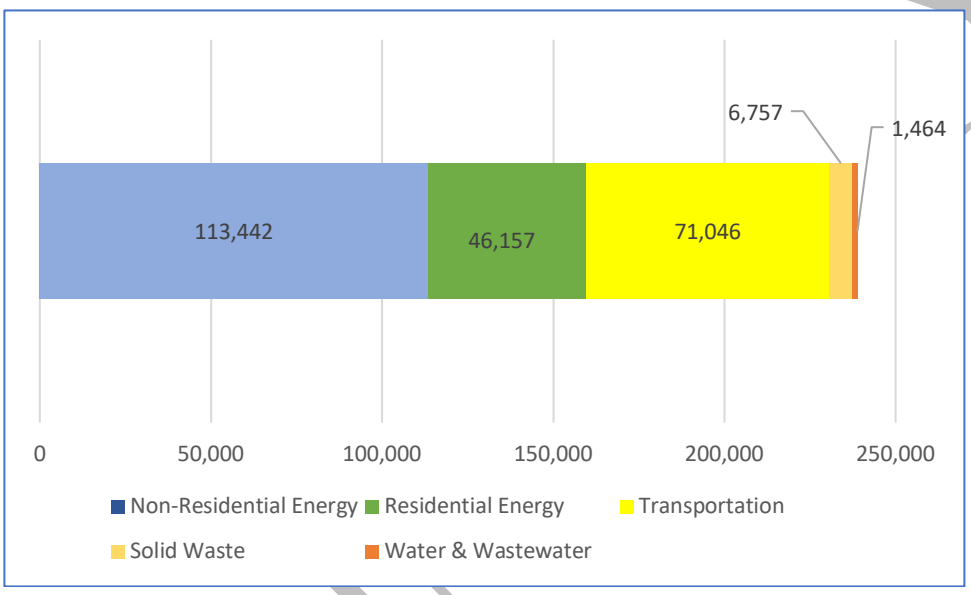
* Thanks are owed to numerous collaborators. Borough Council members Sean Shultz and Joel Hicks oversaw the project and Heidi Kunka, PA Department of Environmental Protection, and Calyn Hart, ICLEI, provided technical support. Susan Armstrong, Borough of Carlisle, Kathryn Frazier, PPL Electric Utilities, Dusty Hilbert, Advanced Disposal, Mark Malarich, Borough of Carlisle, Brian Meilinger, UGI Utilities, Justin Miller, Cumberland County Recycling and Waste Authority, Sean Shultz, Borough of Carlisle, Jeff Smith, Carlisle Airport, and Dan Szekeres, Michael Baker International provided data for the project. Funding was provided by the Borough of Carlisle and by the PA Department of Environmental Protection.

The inventory captures most of the emissions for which Carlisle residents, businesses and institutions are responsible, but not all. Not included, to give one example, are emissions that are generated by producing goods and services outside of Carlisle that are transported to Carlisle for our consumption. Another example are emissions generated by Carlisle residents' air travel to and from airports other than the Carlisle airport.

The Borough is now in a phase of consultation and information gathering as it considers next steps for developing a climate action plan for Carlisle.

Figure 1. Greenhouse Gas Emissions by Sector ($MTCO_2e$)



Non-Residential Energy

Non-residential energy use is the largest source of greenhouse gas emissions in Carlisle. Within the non-residential sector, electricity is the biggest contributor to emissions. Carlisle's commercial and industrial establishments used nearly 223 million kWh of electricity in 2017. The electricity delivered to Carlisle's establishments by PPL is generated using fossil fuels, which emit greenhouse gases when combusted, as well as renewable and nuclear energy sources, which do not emit greenhouse gases. Electric utilities emitted nearly 77,000 $MTCO_2e$ of greenhouse gases to generate the electricity used by Carlisle establishments in 2017 (Table 1 and Figure 2). Emissions from electricity depend on the mix of fossil, renewable and nuclear energy sources used to generate the electricity delivered to a market area. Emissions for electricity delivered to Carlisle users are estimated using average emission factors for the RFC East region from the USEPA's 2016 eGRID database.

In addition to electricity, non-residential sector establishments directly use and combust natural gas, fuel oil and propane. Natural gas is the second largest source of greenhouse gas emissions by non-residential energy users in Carlisle. The sector's direct use of natural gas totaled 546 billion Btus, which put 29,000 $MTCO_2e$ of greenhouse gases into the atmosphere. Fuel oil and propane use by Carlisle's commercial and industrial establishments are relatively small at approximately 89 billion Btus and 18 billion Btus

respectively, accounting for emissions of roughly 6,600 and 1,100 $MTCO_2e$. Adding up the emissions from each energy type for the non-residential sector totals 113,443 $MTCO_2e$.

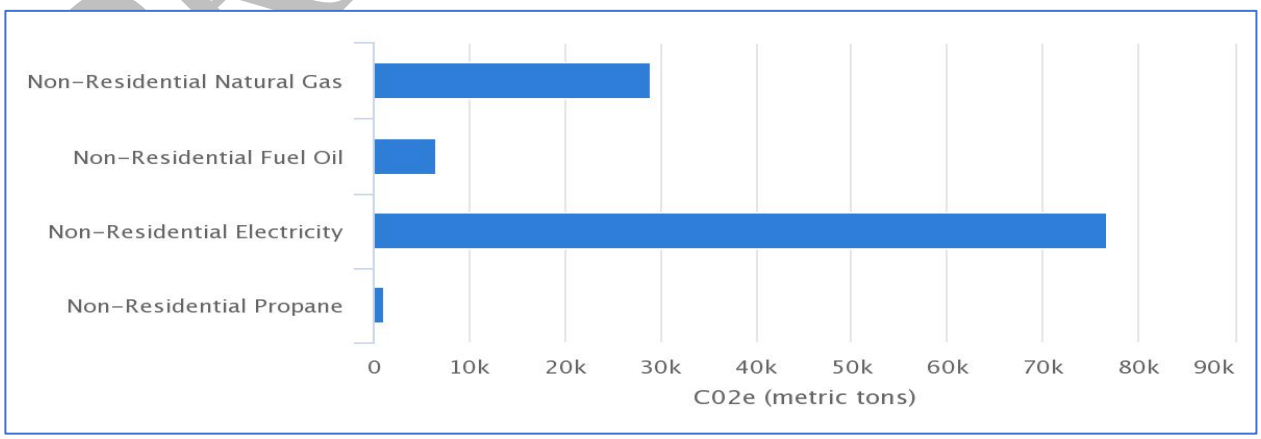
Table 1. Non-Residential Energy Use and Emissions, 2017

Energy Type	Usage	Usage Units	GHG Emissions (MTCO2e)	Emissions per Unit Energy Use (MTCO2e/MMBtu)
Electricity	222,977,998	kilowatt hours	76,683	0.101
Natural Gas	545,656	millions Btu	29,015	0.053
Fuel Oil	89,184	millions Btu	6,640	0.074
Propane	17,798	millions Btu	1,105	0.062
Total	1,413,471	millions Btu	113,443	0.080

Electricity use by commercial and industrial users in the 17013 zip code service area was provided by PPL. The percentage of employees in the 17013 service area who work in Carlisle, 59.5 percent, is used to estimate Carlisle's non-residential electricity use. UGI provided natural gas use for commercial and industrial users in Carlisle. Use of fuel oil and propane by non-residential users in Carlisle had to be estimated using state level data from the U.S. Energy Information Agency. A portion of the consumption of fuel oil and propane in Pennsylvania was allocated to Carlisle using Carlisle's percentage of the value of sales, shipments, receipts, revenue and business in Pennsylvania from the U.S. Census Bureau, which is 0.15 percent.

The different energy types have different rates of emission of greenhouse gases per unit of energy use (Table 1). Of the energy types most commonly used by Carlisle's commercial and industrial establishments, natural gas has the lowest emission rate per unit of energy use, although there are questions about whether the calculations fully account for leakages of gas during production and distribution. Electricity has the highest rate of emissions per unit of energy use. But it is worth noting that there is significant potential for the emission rate to decrease by substituting electricity produced with zero-emission renewable energy sources for electricity produced with fossil energy.

Figure 2. Non-Residential Energy Emissions, 2017



Residential Energy

Carlisle residences used 82 million kilowatt hours (kWh) of electricity in 2017 for lighting, powering appliances and, for 38 percent of Carlisle households, heating their homes. Average emission factors from the USEPA for the RFC East Region are used to estimate greenhouse gas emissions from residential electricity use. Electric utilities emitted an estimated 28,250 $MTCO_2e$ of greenhouse gases to generate the electricity used by Carlisle residences, making electricity the largest source of emissions in the residential energy sector (Table 2).

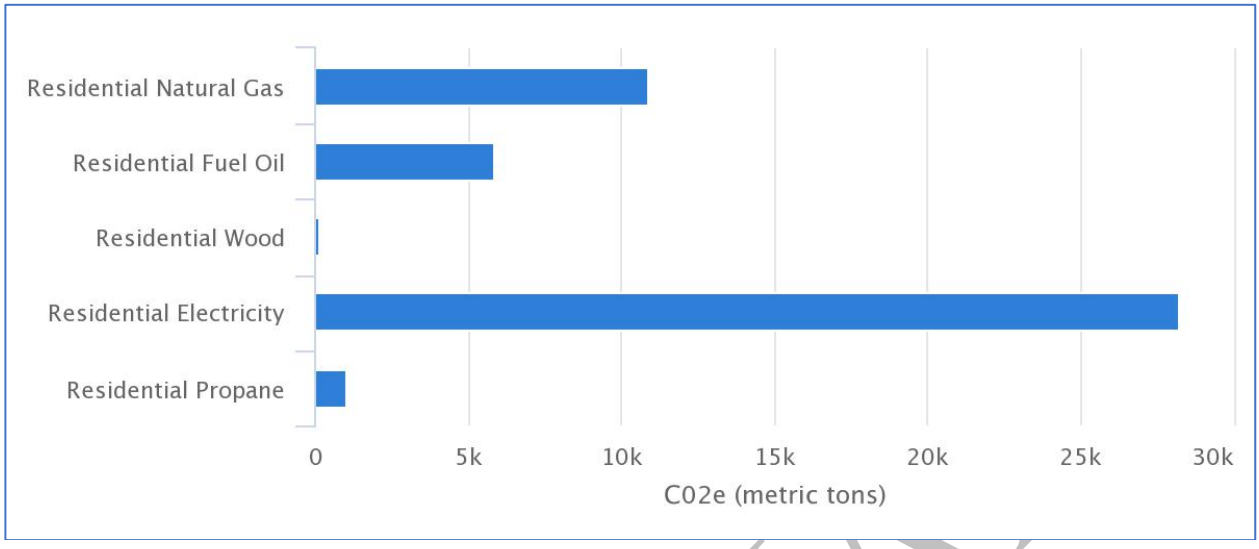
Carlisle residences also directly combusted a variety of fuel types, mostly to heat their homes. Of Carlisle's 7,475 occupied households, 45 percent used natural gas in 2017 as their primary heating fuel, 12 percent used distillate fuel oil, nearly 3 percent used propane and 1 percent used wood. More than 300 billion Btus of these fuels are estimated to have been burned by Carlisle households in 2017, resulting in almost 18,000 $MTCO_2e$ greenhouse gas emissions (Figure 3). Natural gas is the largest source of emissions after electricity in the residential sector, followed by fuel oil.

Table 2. Residential Energy Use and Emissions, 2017

Energy Type	No. Households Using Energy Type for Heat	Usage	Usage Units	GHG Emissions (MTCO2e)	Emissions per Unit Energy Use (MTCO2e/MMBtu)
Electricity	2,865	82,145,847	kilowatt hours	28,250	0.101
Natural Gas	3,366	204,514	millions Btu	10,875	0.053
Fuel oil	902	77,212	millions Btu	5,845	0.076
Propane	201	16,991	millions Btu	1,054	0.062
Wood	73	14,517	millions Btu	133	0.009
Total	7,475	593,527	millions Btu	46,157	0.078

Electricity use by residential users in the 17013 zip code service area was provided by PPL. The percentage of population in the 17013 service area who live in Carlisle, 53.4 percent, is used to estimate Carlisle's residential electricity use. UGI provided natural gas use for residential users in Carlisle. Data for use of fuel oil, propane and wood by Carlisle residences are not directly available and have to be estimated. Use of these fuels by residences in Carlisle are estimated from data on total residential energy use in Pennsylvania by fuel type, the number of households in Pennsylvania using each fuel as a heating source and their average fuel use per household, and the number of households in Carlisle using each fuel as a heating source.

Figure 3. Residential Energy Emissions (MTCO2e)



Transportation

Greenhouse gas emissions from transportation are estimated for on-road travel by passenger vehicles and commercial freight trucks, public transit and paratransit buses, rail transportation and air travel. Each of these modes of transportation burn gasoline, diesel or, in the case of air travel, jet fuel, and emit greenhouse gases in the process. While electric vehicles have the potential to substantially reduce emissions in the future, at present they are a very small portion of Carlisle's travel miles. Emissions of greenhouse gases for most transportation modes are calculated from estimates of vehicle miles traveled within Carlisle for different vehicle and fuel types, fuel efficiencies, and average emissions per gallon of fuel or per mile traveled.

Carlisle's emissions of greenhouse from transportation in 2017 are estimated at approximately 71,000 $MTCO_2e$ (Table 3). Passenger vehicles and light trucks were driven 84 million miles, used 3.5 million gallons of fuel and produced roughly 31,000 $MTCO_2e$ that year. Commercial freight trucks are driven far fewer miles than passenger vehicles in Carlisle, 21.7 million miles, but consumed about the same amount of fuel, 3.6 million gallons, and produced nearly the same amount of emissions, 30,500 $MTCO_2e$, because heavy trucks are much less fuel efficient than passenger vehicles. Public transit and paratransit bus revenue miles and fuel use in Carlisle are much smaller in comparison and they contributed less than 300 $MTCO_2e$. Rail added a bit more than 3,000 $MTCO_2e$ and fuel use at Carlisle Airport added close to 450 $MTCO_2e$.

Estimates of on-road vehicle miles traveled for passenger and commercial freight vehicles by fuel type were provided by Michael Baker International. The estimates are derived from data available from PennDOT and estimates of trip origins and destinations from the South-Central Travel Demand Model used by the Harrisburg Metropolitan Planning Organization. The estimates include 100 percent of miles for trips that start and end in Carlisle and 50 percent of miles for trips that either start or end in Carlisle. Vehicles traveling I-81 and other throughways that neither start or stop in Carlisle are excluded.

Vehicle revenue miles and fuel use for public transit services provided by Capital Area Transit and 'on demand' paratransit services provided by Rabittransit for their entire service areas were obtained from the 2017 Annual Agency Profile of the Cumberland Dauphin-Harrisburg Transit Authority. Miles and fuel

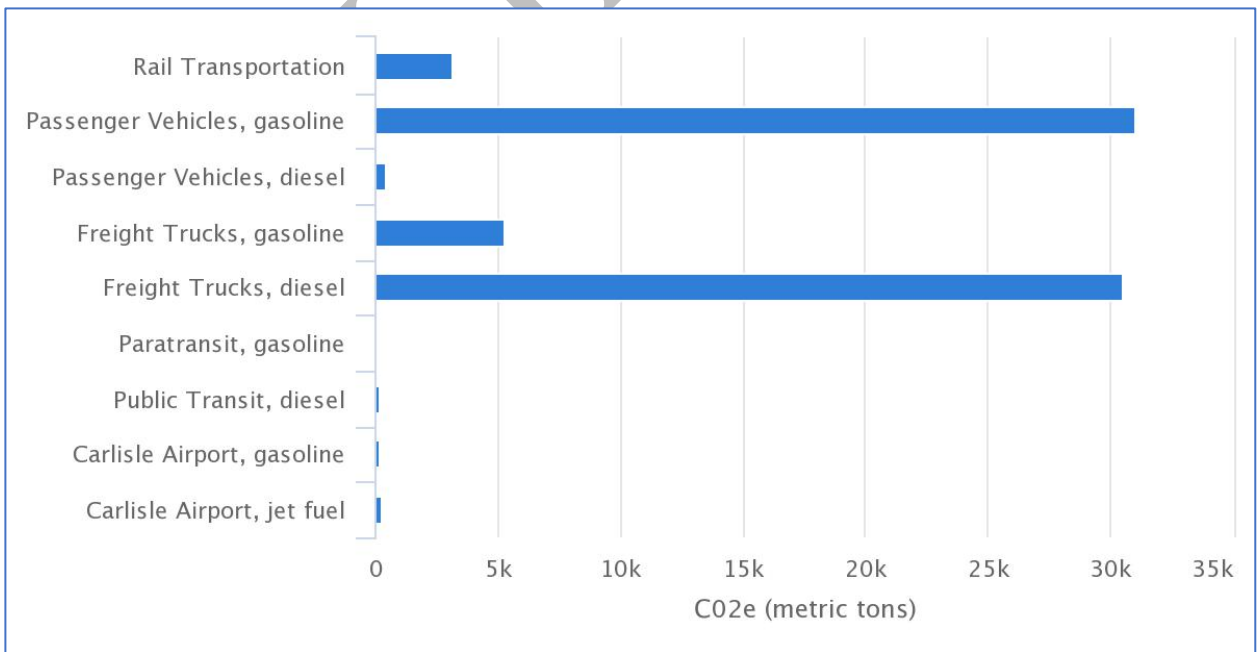
use attributable to Carlisle were estimated using Carlisle's population as a percentage of the total population served by Transit Authority, 3.73 percent.

Table 3. Transportation Emissions, 2017

Transportation Mode and Fuel Type	Vehicle Miles Traveled	Fuel Use (gals)	GHG Emissions (MTCO2e)
Passenger Vehicle, Gasoline	82,980,861	3,492,270	30,972
Passenger Vehicle, Diesel	1,007,865	42,416	433
Freight Truck, Gasoline	3,170,575	591,376	5,266
Freight Truck, Diesel	18,575,484	2,984,140	30,497
Paratransit Bus, Gasoline	52,255	10,341	92
Transit Bus, Diesel	68,543	18,981	194
Rail			3,144
Carlisle Airport, Gasoline		23,084	197
Carlisle Airport, Jet Fuel		25,979	251
Total			71,046

Norfolk Southern Railway, which owns and operates the freight rail line that passes through Carlisle, reports that 15.8 million $MTCO_2e$ of greenhouse gases were emitted by their national rail operations in 2017. Emissions attributable to Carlisle are estimated using the percentage of Norfolk Southern's route miles that lie within Carlisle, 0.02 percent. Emissions produced by flights in and out of the Carlisle airport are estimated using volumes of aviation gasoline and jet fuel that are loaded on planes at the airport.

Figure 4. Transportation Emissions, 2017



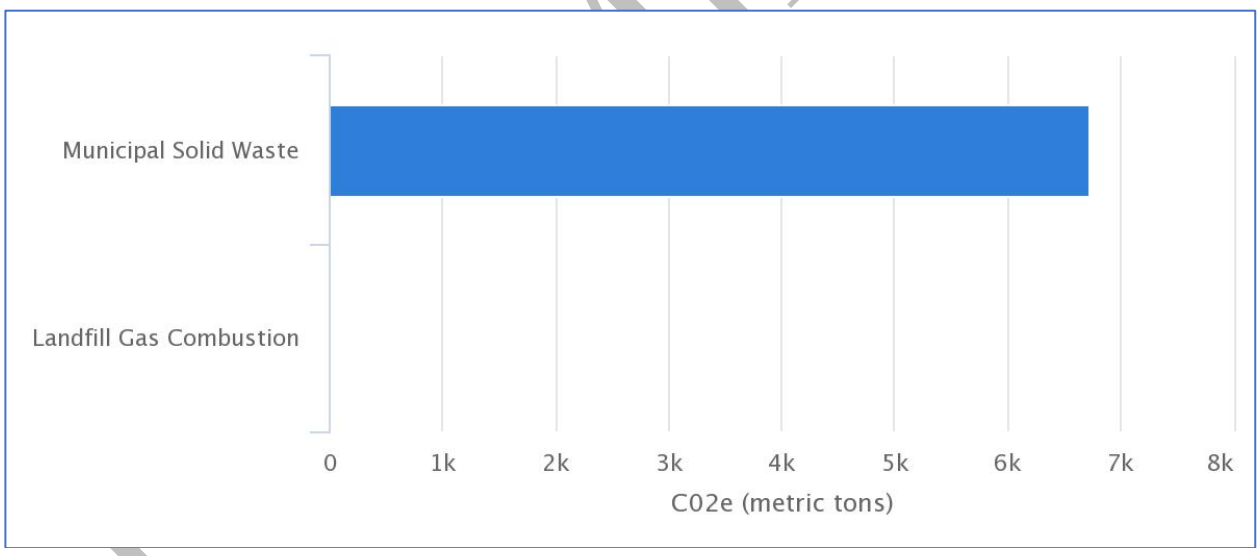
Municipal Solid Waste

Municipal solid waste generated by Carlisle residents, businesses and other establishments is collected by different haulers and taken to the Cumberland County Landfill in Newburg, PA. Organic wastes decompose in the landfill, a process the emits methane, a powerful greenhouse gas. A portion of the landfill gas, typically ranging from 40 to 60 percent, is captured and either combusted to generate electricity or flared. This reduces the amount of methane that reaches the atmosphere but produces emissions of the less powerful greenhouse gas carbon dioxide.

Waste generation is not measured directly for Carlisle but is estimated using the average weight per county resident of municipal solid waste received at the county landfill, 0.7 tons per person, and the population of Carlisle. Different types of waste emit methane at different rates. The percentage of waste by type (e.g. corrugated cardboard, newspaper, office paper, food and yard waste) were derived from a 2003 DEP study of waste composition in Pennsylvania. Quantities of landfill gas flared and combusted were provided by Advanced Disposal, the operator of the landfill.

The county landfill received nearly 167,000 tons of municipal solid waste in 2017, of which 12,772 tons are estimated to have come from Carlisle residents and establishments. Decomposition of this waste in the landfill emits methane to the atmosphere in a quantity equivalent to 6,737 metric tons of carbon dioxide. Roughly 300,000 cubic feet of the landfill gas attributed to Carlisle's waste is either flared or combusted, resulting in 21 metric tons of carbon dioxide emissions.

Figure 5. Municipal Solid Waste Emissions, 2017



Water and Wastewater

Water and wastewater represent a small share of Carlisle's greenhouse gas emissions, but they are important to report separately because the water and wastewater treatment plants are directly controlled by local government. Electricity is used to distribute and treat potable drinking water and to treat wastewater. Generation of the electricity used for these purposes produces greenhouse gas emissions, which are reported in this section and excluded from emissions reported for non-residential energy. Treatment of wastewater at the wastewater treatment plant uses a nitrification/denitrification process that

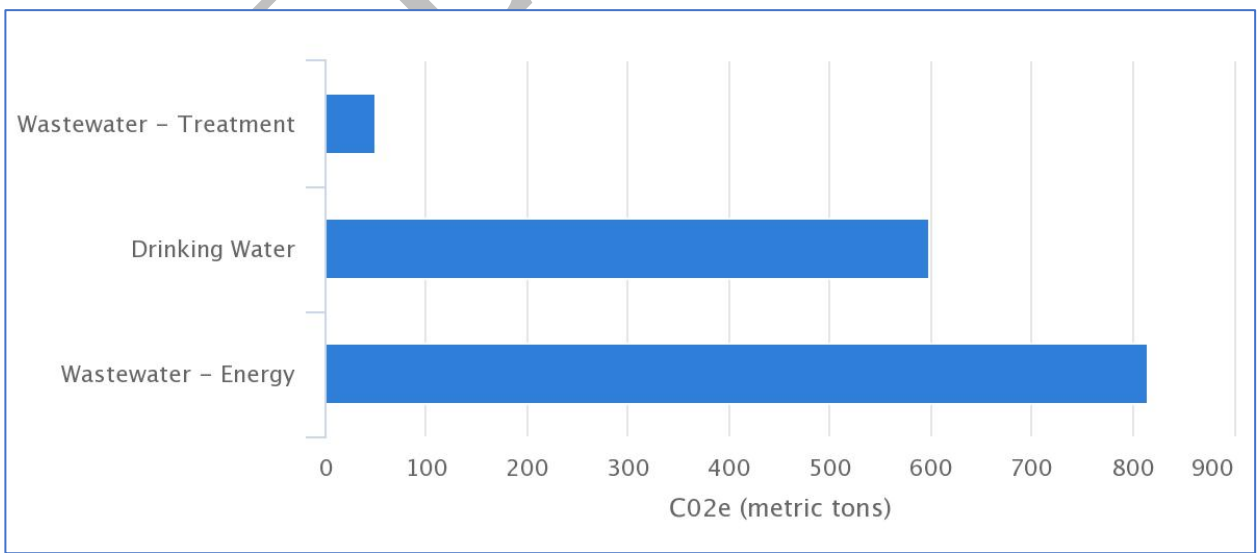
produces an estimated 7 grams of nitrous oxide per person per year. Nitrous oxide is 298 times more powerful than carbon dioxide.

Carlisle residents and establishments used 520.1 million gallons of drinking water in 2017, which is 92.5 percent of the water distributed by the Carlisle water treatment plant. 1.7 million kWh of electricity was used to treat and pump the water, producing 598 $MTCO_2e$ of emissions. 3.5 million kWh of electricity was used to operate the wastewater treatment plant, which serves a population of 28,290 people that includes Carlisle plus roughly 9,000 people who live in other jurisdictions. The share of electricity used for wastewater treatment attributable to Carlisle is estimated to be 2.4 million kWh, which produces 816 $MTCO_2e$ of emissions. Emissions from the nitrification/denitrification process to serve Carlisle's 19,190 residents is 50 $MTCO_2e$.

Table 4. Water and Wastewater Emissions, 2017

Drinking Water	
Water Use (millions gals)	520.6
Electricity Use (kWh)	1,739,224
GHG Emissions (MTCO2e)	598
Wastewater	
Population served	19,190
Electricity Use (kWh)	2,374,160
GHG Emissions from Electricity (MTCO2e)	816
GHG Emissions from Nitrification/Denitrification (MTCO2e)	50
Total Emissions (MTCO2e)	1,464

Figure 6. Water and Wastewater Emissions, 2017



References

ICLEI, 2012, U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions. ICLEI – Local Governments for Sustainability, Denver, CO. https://icleiusa.org/publications/us-community-protocol/

ICLEI, 2014, ClearPath User Guide, An ICLEI USA Tool. ICLEI – Local Governments for Sustainability, Denver, CO. https://s3.amazonaws.com/ClearPath-ICLEI/User+Guides/ClearPath+Inventory+Module+User+Guide.pdf

Pennsylvania Department of Environmental Protection, 2018, Pennsylvania Climate Action Plan, Strategies and Actions to Reduce and Adapt to Climate Change. PA Department of Environmental Protection, Harrisburg, PA. https://www.dep.pa.gov/Citizens/climate/Pages/PA-Climate-Action-Plan.aspx#:~:text=

Data Sources

Demographic Data for Carlisle

Population, number of households, household heating fuel, number of employees: US Census Bureau, American FactFinder, accessed December 21, 2019. https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml.

Residential and Non-Residential Energy

Emission factors for electricity: USEPA, 2016 *eGrid,* accessed January 20, 2020. https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid

Electricity use: PPL Electric Utilities, personal communication by email from B. Kathryn Frazier, Regulatory Affairs Manager.

Natural gas use: UGI Utilities, personal communication by email from Brian Meilinger, Manager-Energy Efficient Programs.

Pennsylvania energy consumption data: USEIA's State Energy Data System, accessed December 21, 2019. https://www.eia.gov/state/seds/seds-data-fuel-prev.php#DataFiles.

Transportation

Vehicle fuel economy:

- Passenger cars and light duty trucks: US Department of Transportation, Average Fuel Efficiency of Light Duty Vehicles, accessed January 20, 2020. https://www.bts.gov/content/average-fuel-efficiency-us-light-duty-vehicles.
- Heavy duty trucks, gasoline: U.S. Energy Information Administration, Open Data, accessed January 20, 2020. https://www.eia.gov/opendata/qb.php?category=1373322&sdid=AEO.2015.REF2015.EFI_NA_FGHT_RADS_MGS_NA_NA_MPG.A.
- Heavy duty trucks, diesel: U.S. Energy Information Administration, Open Data, accessed January 20, 2020.

https://www.eia.gov/opendata/qb.php?category=1373322&sdid=AEO.2015.REF2015.EFI_NA_FGHT_RADS_DSL_NA_NA_MPG.A.

- Transit and paratransit buses: Federal Highway Administration, Highway Statistics, accessed January 20, 2020. https://afdc.energy.gov/data/10310.

Emission factors for vehicles: USEPA, Emission Factors for Greenhouse Gas Inventories, accessed January 20, 2020. https://www.epa.gov/sites/production/files/2018-03/documents/emission-factors_mar_2018_0.pdf.

Road transportation, vehicle miles traveled, passenger vehicles and commercial trucks: Michael Baker International, personal communication by email from Dan Szekeres, Technical Manager.

Public transit, fuel consumption: Federal Transit Administration, 2017 Annual Database Energy Consumption, accessed January 20, 2020. https://www.transit.dot.gov/ntd/data-product/2017-annual-database-energy-consumption.

Public transit, vehicle revenue miles and population served: Cumberland Dauphin-Harrisburg Transit Authority DBA Capital Area Transit, 2017 Annual Agency Profile, accessed January 20, 2020. https://www.transit.dot.gov/ntd/transit-agency-profiles/cumberland-dauphin-harrisburg-transit-authority.

Rail transportation emissions: Norfolk Southern Railway, 2018 Corporate Social Responsibility Report, accessed January 20, 2020. http://www.nscorp.com/content/dam/nscorp/get-to-know-ns/about-ns/environment/ns-2018-social-responsibility-report.pdf

Carlisle Airport fuel use: Carlisle Airport, personal communication by email from Jeff Smith, Airport Manager.

Municipal Solid Waste

Municipal solid waste generation, Cumberland County and Carlisle: Cumberland County Recycling and Waste Authority, personal communication by email from Justin Miller, Recycling Coordinator.

Municipal waste composition: Pennsylvania Department of Environmental Protection, *Final Report, Statewide Waste Composition Study,* April, 2003. http://files.dep.state.pa.us/Waste/Recycling/RecyclingPortalFiles/Documents/wastecompositionstudy.pdf

Landfill gas flaring and combustion: Advanced Disposal, personal communication by email from Dusty Hilbert, General Manager.

Water and Wastewater

Water and wastewater volumes, service populations and electricity use: Borough of Carlisle, personal email communications from Susan Armstrong, Borough Manager; Mark Malarich, Director of Public Works; and Sean Shultz, Council Member

Carlisle's Greenhouse Gas Emissions

March 3, 2020

Mark Frenzel-Sulyok, Olivia Kubaska, Sam Lavine and Neil Leary, Dickinson College

Introduction

The Borough of Carlisle is one of twenty municipalities planning for climate change as part of the *Local Government Climate Action Assistance Program* of the Pennsylvania Department of Environmental Protection (DEP). Carlisle is receiving assistance from DEP, ICLEI Local Governments for Sustainability and Dickinson College to develop a local climate action plan that will benefit the Carlisle community while helping advance goals of Pennsylvania's Climate Action Plan.

In the first phase of the program, greenhouse gas emissions produced by Carlisle residents, businesses, government offices and other entities were estimated for 2017. The results are summarized in this brochure. Details of the methods and data sources are available in a companion full report.

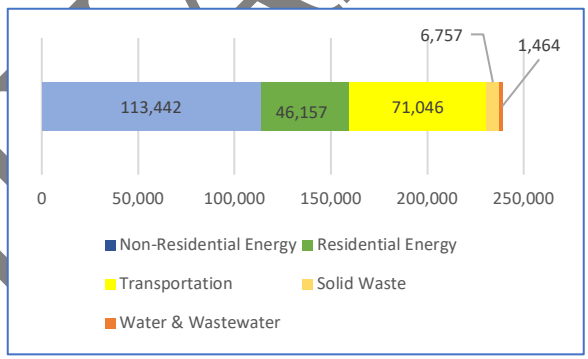
Greenhouse gases such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) are emitted by a variety of activities, the largest contributor being the burning of fossil fuels for heat, electric power generation and transportation. The gases accumulate in the atmosphere where they amplify the capacity of the atmosphere to absorb and retain thermal energy and cause the climate to warm and change in other ways.

Emissions of the different gases are estimated using average emission factors from the U.S. Environmental Protection Agency and other sources and activity data for Carlisle. Emissions of each type of greenhouse gas are converted into an equivalent weight of carbon dioxide, added up and reported in metric tons of carbon dioxide equivalent ($MTCO_2e$).

Carlisle's Greenhouse Gas Emissions

Carlisle's estimated total greenhouse gas emissions in 2017 are equivalent to nearly 239,000 metric tons of carbon dioxide ($MTCO_2e$), or 12.5 $MTCO_2e$ per resident (Figure 1). Emissions are estimated for four sectors: non-residential energy, residential energy, transportation, municipal solid waste, and water and wastewater. The sector with the greatest emissions in Carlisle is non-residential energy use, accounting for 47.5 percent of Carlisle's total emissions. Transportation accounts for 29.7 percent, residential energy use for 19.3 percent, solid waste 2.8 percent and distribution and treatment of water and wastewater account for 0.6 percent.

Figure 1. Greenhouse Gas Emissions by Sector ($MTCO_2e$)



Non-Residential Energy

Energy use by commercial and industrial establishments in Carlisle generated over 113,000 $MTCO_2e$ of emissions in 2017. Electricity use is the biggest contributor to these emissions. Nearly 223 million kWh of electricity was used by Carlisle's commercial and industrial establishments. To supply the electricity, electric utilities emitted nearly 77,000 $MTCO_2e$ of greenhouse gases. (Table 1; Figure 2)

Natural gas is the second largest source of emissions from non-residential energy use in Carlisle. The sector used 546 billion Btus of natural gas, the combustion of which put 29,000 $MTCO_2e$ of greenhouse gases into the atmosphere. Fuel oil and propane use by Carlisle's commercial and industrial establishments are relatively small at approximately 89 billion Btus and 18 billion Btus

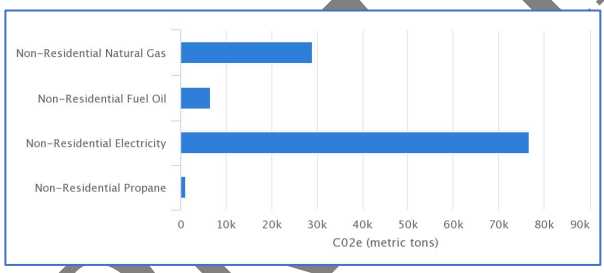
respectively, accounting for emissions of roughly 6,600 and 1,100 $MTCO_2e$.

The different energy types have different rates of emission of greenhouse gases per unit of energy use. Of the energy types most commonly used by Carlisle's commercial and industrial establishments, natural gas has the lowest emission rate per unit of energy use, although there are questions about whether the calculations fully account for leakages of gas during production and distribution. Electricity has the highest rate of emissions per unit of energy use. But it is worth noting that there is significant potential for the emission rate to decrease by substituting electricity produced with zero-emission renewable energy sources for electricity produced with fossil energy.

Table 1. Non-Residential Energy Use and Emissions, 2017

Energy Type	Usage	Usage Units	GHG Emissions (MTCO2e)	Emissions per Unit Energy Use (MTCO2e/MMBtu)
Electricity	222,977,998	kilowatt hours	76,683	0.101
Natural Gas	545,656	millions Btu	29,015	0.053
Fuel Oil	89,184	millions Btu	6,640	0.074
Propane	17,798	millions Btu	1,105	0.062
Total	1,413,471	millions Btu	113,443	0.080

Figure 2. Non-Residential Energy Emissions, 2017



Residential Energy

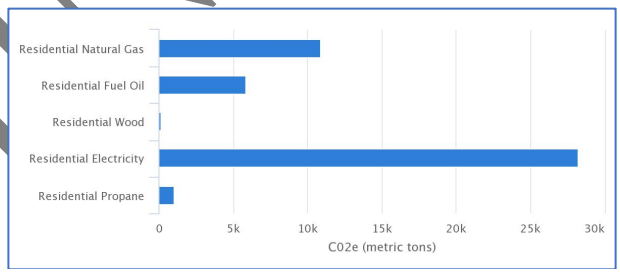
Carlisle residences used 82 million kilowatt hours (kW) of electricity in 2017 for lighting, powering appliances and, for 38 percent of Carlisle households, heating their homes. Carlisle residences also used a variety of other fuels to heat their homes. Of Carlisle's 7,475 occupied households, 45 percent used natural gas as their primary heating fuel, 12 percent used distillate fuel oil, nearly 3 percent used propane and 1 percent used wood. More than 300 billion Btus of these fuels are estimated to have been burned by Carlisle households in 2017. (Table 2)

The energy used by Carlisle's residences emitted over 46,000 $MTCO_2e$ of greenhouse gases. Electricity is the largest contributor to these emissions, followed by natural gas, fuel oil, propane and wood. (Figure 3)

Table 2. Residential Energy Use and Emissions, 2017

Energy Type	No. Households Using Energy Type for Heat	Usage	Usage Units	GHG Emissions (MTCO2e)	Emissions per Unit Energy Use (MTCO2e/MMBtu)
Electricity	2,865	82,145,847	kilowatt hours	28,250	0.101
Natural Gas	3,366	204,514	millions Btu	10,875	0.053
Fuel oil	902	77,212	millions Btu	5,845	0.076
Propane	201	16,991	millions Btu	1,054	0.062
Wood	73	14,517	millions Btu	133	0.009
Total	7,475	593,527	millions Btu	46,157	0.078

Figure 3. Residential Energy Emissions (MTCO2e)



Transportation

Carlisle's greenhouse emissions from transportation are estimated to be approximately 71,000 $MTCO_2e$. Passenger vehicles and light trucks were driven 84 million miles, used 3.5 million gallons of fuel and produced close to 31,000 $MTCO_2e$ of emissions that year. Commercial trucks were driven far fewer miles than passenger vehicles, 21.7 million miles, but consumed about the same amount of fuel, 3.6 million gallons, and produced nearly the same amount of emissions, 30,500 $MTCO_2e$. This reflects the much lower fuel economy of heavy trucks. (Table 3; Figure 4)

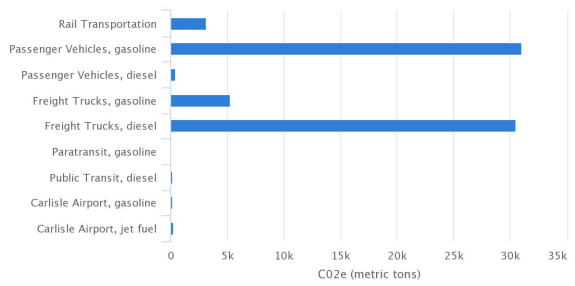
Public transit and paratransit bus revenue miles and fuel use in Carlisle are much smaller in comparison and contributed less than 300 $MTCO_2e$ to emissions. Rail added a bit more than 3,000

$MTCO_2e$ and fuel use at the Carlisle Airport added close to 450 $MTCO_2e$.

Table 3. Transportation Emissions, 2017

Transportation Mode and Fuel Type	Vehicle Miles Traveled	Fuel Use (gals)	GHG Emissions (MTCO2e)
Passenger Vehicle, Gasoline	82,980,861	3,492,270	30,972
Passenger Vehicle, Diesel	1,007,865	42,416	433
Freight Truck, Gasoline	3,170,575	591,376	5,266
Freight Truck, Diesel	18,575,484	2,984,140	30,497
Paratransit Bus, Gasoline	52,255	10,341	92
Transit Bus, Diesel	68,543	18,981	194
Rail			3,144
Carlisle Airport, Gasoline		23,084	197
Carlisle Airport, Jet Fuel		25,979	251
Total			71,046

Figure 4. Transportation Emissions, 2017



Municipal Solid Waste

Municipal solid waste generated by Carlisle residents, businesses and other establishments is taken to the Cumberland County Landfill where organic components decompose and produce methane, a greenhouse gas that is 25 times more powerful than carbon dioxide. Some of the landfill gas is captured and either combusted to generate electricity or flared. In 2017, nearly 13,000 tons of solid waste was generated in Carlisle and landfilled. Emissions of methane from the landfilled waste are estimated at roughly 6,740 $MTCO_2e$. Combustion and flaring of landfill gas are contribute an additional 21 $MTCO_2e$.

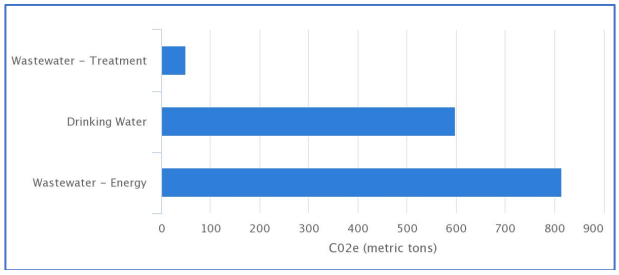
Water and Wastewater

Carlisle residents and establishments used 520 million gallons of drinking water in 2017. 1.7 million kWh of electricity was used to pump and treat the water, the generation of which produced nearly 600 $MTCO_2e$ of emissions. Treatment of wastewater also requires electricity. An estimated 2.4 million kWh of electricity was used to treat the wastewater of Carlisle's 19,190 residents. Generation of this electricity produced 816 $MTCO_2e$ of emissions. In addition, the nitrification/denitrification process used to treat the wastewater emitted nitrous oxide equivalent to 50 $MTCO_2e$.

Table 4. Water and Wastewater Emissions, 2017

Drinking Water	
Water Use (millions gals)	520.6
Electricity Use (kWh)	1,739,224
GHG Emissions (MTCO2e)	598
Wastewater	
Population served	19,190
Electricity Use (kWh)	2,374,160
GHG Emissions from Electricity (MTCO2e)	816
GHG Emissions from Nitrification/Denitrification (MTCO2e)	50
Total Emissions (MTCO2e)	1,464

Figure 6. Water and Wastewater Emissions, 2017



Acknowledgements

Borough Council members Sean Shultz and Joel Hicks oversaw the project and Heidi Kunka, PA Department of Environmental Protection, and Calyn Hart, ICLEI, provided technical support. Susan Armstrong, Borough of Carlisle, Kathryn Frazier, PPL Electric Utilities, Dusty Hilbert, Advanced Disposal, Mark Malarich, Borough of Carlisle, Brian Meilinger, UGI Utilities, Justin Miller, Cumberland County Recycling and Waste Authority, Sean Shultz, Borough of Carlisle, Jeff Smith, Carlisle Airport, and Dan Szekeres, Michael Baker International provided data for the project. Funding was provided by the Borough of Carlisle and by the PA Department of Environmental Protection.

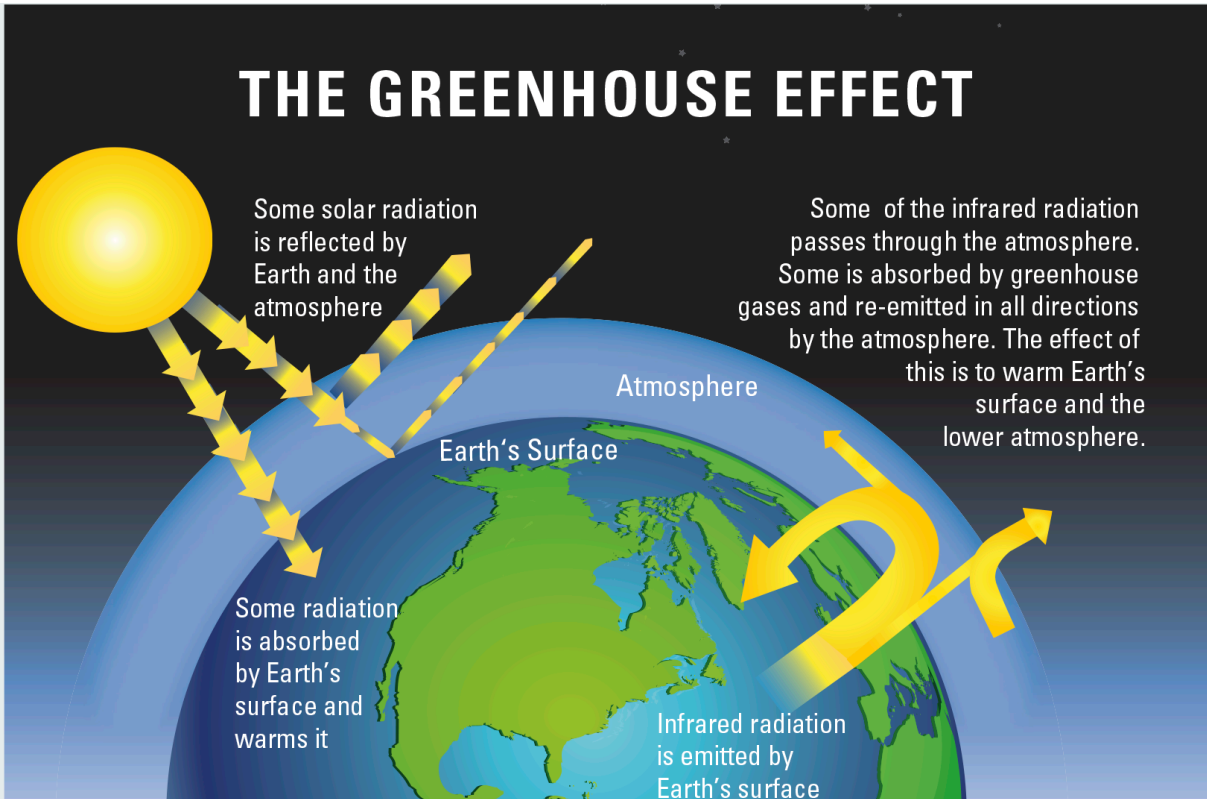
Climate Change: Evidence and Causes

Report from the U.S. National Academy of Sciences

SUMMARY: Greenhouse gases such as carbon dioxide (CO_2) absorb heat (infrared radiation) emitted from Earth's surface. Increases in the atmospheric concentrations of these gases cause Earth to warm by trapping more of this heat. Human activities – especially the burning of fossil fuels since the start of the Industrial Revolution – have increased atmospheric CO_2 concentrations by about 40%, with more than half the increase occurring since 1970. Since 1900, the global average surface temperature has increased by about 0.8 °C (1.4 °F). This has been accompanied by warming of the ocean, a rise in sea level, a strong decline in Arctic sea ice, and many other associated climate effects. Much of this warming has occurred in the last four decades. Detailed analyses have shown that the warming during this period is mainly a result of the increased concentrations of CO_2 and other greenhouse gases. Continued emissions of these gases will cause further climate change, including substantial increases in global average surface temperature and important changes in regional climate. The magnitude and timing of these changes will depend on many factors, and slowdowns and accelerations in warming lasting a decade or more will continue to occur. However, long-term climate change over many decades will depend mainly on the total amount of CO_2 and other greenhouse gases emitted as a result of human activities.

National Academy of Sciences. 2014. *Climate Change: Evidence and Causes*. Washington, DC: The National Academies Press.

The full report may be downloaded for free: https://www.nap.edu/catalog/18730/climate-change-evidence-and-causes



Carlisle Greenhouse Gas Inventory, 2017

March 2, 2020

Mark Frenzel-Sulyok, Olivia Kubaska, Sam Lavine and Neil Leary, Dickinson College*

Introduction

The Borough of Carlisle is one of twenty municipalities planning for climate change as part of the *Local Government Climate Action Assistance Program* of the Pennsylvania Department of Environmental Protection (DEP). As a participant in the program, Carlisle is receiving assistance from DEP, ICLEI Local Governments for Sustainability and Dickinson College to develop a local climate action plan that will benefit the Carlisle community while helping advance goals of Pennsylvania's Climate Action Plan (PA DEP, 2018).

In the first phase of the planning process, begun in September 2019 and completed in February 2020, greenhouse gas emission inventories were calculated for Carlisle for the years 2016 and 2017. The inventories provide estimates of the quantities of greenhouse gas emissions that are produced by Carlisle residents, businesses, government offices and other entities located in the Borough. Emissions in the two years are very similar and this report focuses on 2017 emissions, the most recent year for which complete data is available. The inventory can serve as a baseline of information to assist the Borough in identifying and prioritizing emission sources for action, developing strategies for reducing emissions and setting goals.

Greenhouse gases such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) are emitted by a variety of activities, the largest contributor being the burning of fossil fuels for heat, electric power generation and transportation. The gases accumulate in the atmosphere where they amplify the capacity of the atmosphere to absorb and retain thermal energy and cause the climate to warm and change in other ways. Emissions of each type of greenhouse gas are estimated by weight, converted into an equivalent weight of carbon dioxide, added up and reported in metric tons of carbon dioxide equivalent ($MTCO_2e$).

Activity data were collected for residential and non-residential energy use; passenger vehicle, truck, transit, rail and local airport transportation; municipal solid waste generation; drinking water distribution; and wastewater treatment. The collected activity data were input to ClearPath, an online tool developed by ICLEI for calculating greenhouse gas emissions using average emission factors for each activity (ICLEI, 2014). The emission calculations performed by ClearPath are consistent with the U.S. Community Protocol for greenhouse gas inventories (ICLEI, 2012).

Estimated greenhouse gas emissions for Carlisle totaled nearly 239,000 $MTCO_2e$ in 2017, or 12.5 $MTCO_2e$ per resident (Figure 1). The largest source of emissions in Carlisle is non-residential energy use, accounting for 47.5 percent of Carlisle's total emissions. Transportation accounts for 29.7 percent, residential energy use for 19.3 percent, solid waste 2.8 percent and treatment of water and wastewater account for 0.6 percent.

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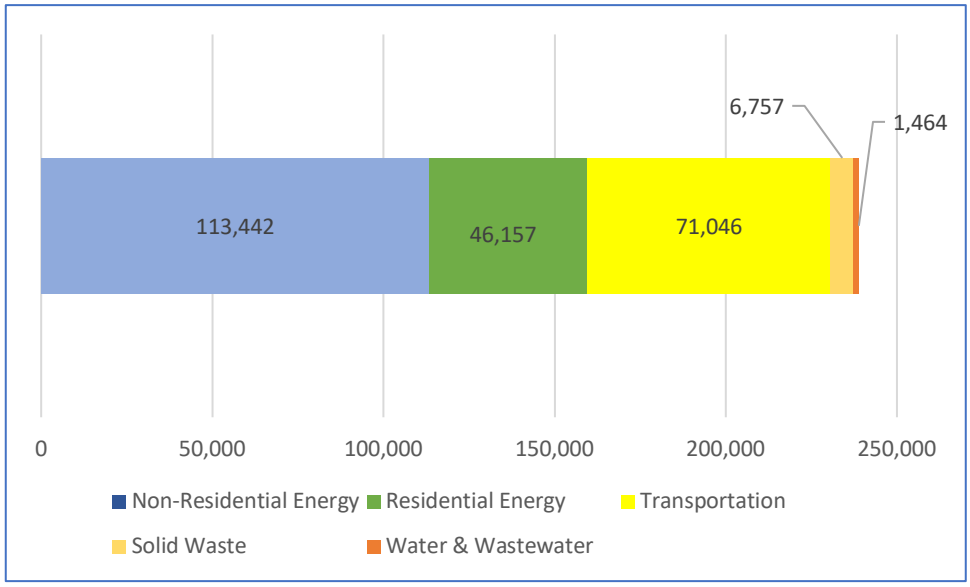
* Thanks are owed to numerous collaborators. Borough Council members Sean Shultz and Joel Hicks oversaw the project and Heidi Kunka, PA Department of Environmental Protection, and Calyn Hart, ICLEI, provided technical support. Susan Armstrong, Borough of Carlisle, Kathryn Frazier, PPL Electric Utilities, Dusty Hilbert, Advanced Disposal, Mark Malarich, Borough of Carlisle, Brian Meilinger, UGI Utilities, Justin Miller, Cumberland County Recycling and Waste Authority, Sean Shultz, Borough of Carlisle, Jeff Smith, Carlisle Airport, and Dan Szekeres, Michael Baker International provided data for the project. Funding was provided by the Borough of Carlisle and by the PA Department of Environmental Protection.

The inventory captures most of the emissions for which Carlisle residents, businesses and institutions are responsible, but not all. Not included, to give one example, are emissions that are generated by producing goods and services outside of Carlisle that are transported to Carlisle for our consumption. Another example are emissions generated by Carlisle residents' air travel to and from airports other than the Carlisle airport.

The Borough is now in a phase of consultation and information gathering as it considers next steps for developing a climate action plan for Carlisle.

Figure 1. Greenhouse Gas Emissions by Sector ($MTCO_2e$)



Non-Residential Energy

Non-residential energy use is the largest source of greenhouse gas emissions in Carlisle. Within the non-residential sector, electricity is the biggest contributor to emissions. Carlisle's commercial and industrial establishments used nearly 223 million kWh of electricity in 2017. The electricity delivered to Carlisle's establishments by PPL is generated using fossil fuels, which emit greenhouse gases when combusted, as well as renewable and nuclear energy sources, which do not emit greenhouse gases. Electric utilities emitted nearly 77,000 $MTCO_2e$ of greenhouse gases to generate the electricity used by Carlisle establishments in 2017 (Table 1 and Figure 2). Emissions from electricity depend on the mix of fossil, renewable and nuclear energy sources used to generate the electricity delivered to a market area. Emissions for electricity delivered to Carlisle users are estimated using average emission factors for the RFC East region from the USEPA's 2016 eGRID database.

In addition to electricity, non-residential sector establishments directly use and combust natural gas, fuel oil and propane. Natural gas is the second largest source of greenhouse gas emissions by non-residential energy users in Carlisle. The sector's direct use of natural gas totaled 546 billion Btus, which put 29,000 $MTCO_2e$ of greenhouse gases into the atmosphere. Fuel oil and propane use by Carlisle's commercial and industrial establishments are relatively small at approximately 89 billion Btus and 18 billion Btus

respectively, accounting for emissions of roughly 6,600 and 1,100 $MTCO_2e$. Adding up the emissions from each energy type for the non-residential sector totals 113,443 $MTCO_2e$.

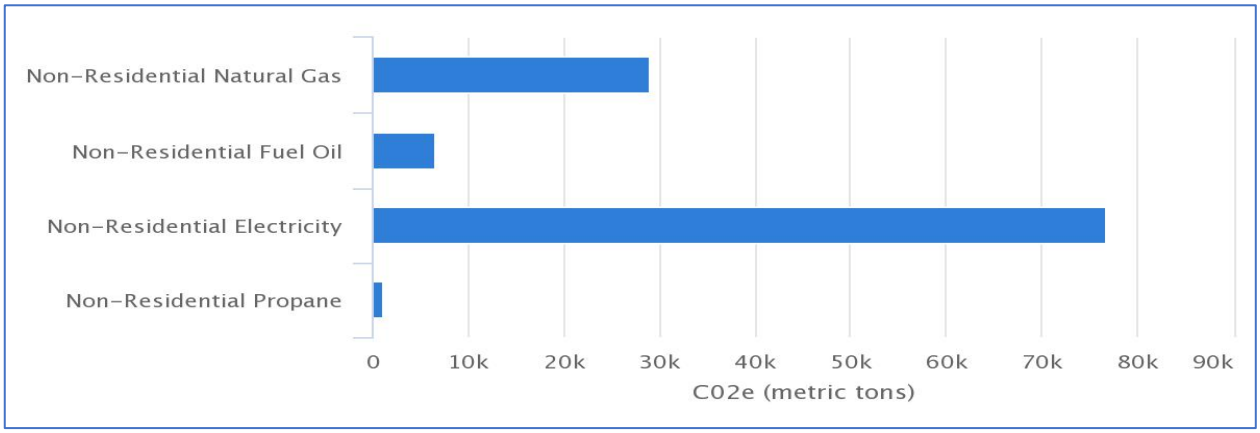
Table 1. Non-Residential Energy Use and Emissions, 2017

Energy Type	Usage	Usage Units	GHG Emissions (MTCO2e)	Emissions per Unit Energy Use (MTCO2e/MMBtu)
Electricity	222,977,998	kilowatt hours	76,683	0.101
Natural Gas	545,656	millions Btu	29,015	0.053
Fuel Oil	89,184	millions Btu	6,640	0.074
Propane	17,798	millions Btu	1,105	0.062
Total	1,413,471	millions Btu	113,443	0.080

Electricity use by commercial and industrial users in the 17013 zip code service area was provided by PPL. The percentage of employees in the 17013 service area who work in Carlisle, 59.5 percent, is used to estimate Carlisle's non-residential electricity use. UGI provided natural gas use for commercial and industrial users in Carlisle. Use of fuel oil and propane by non-residential users in Carlisle had to be estimated using state level data from the U.S. Energy Information Agency. A portion of the consumption of fuel oil and propane in Pennsylvania was allocated to Carlisle using Carlisle's percentage of the value of sales, shipments, receipts, revenue and business in Pennsylvania from the U.S. Census Bureau, which is 0.15 percent.

The different energy types have different rates of emission of greenhouse gases per unit of energy use (Table 1). Of the energy types most commonly used by Carlisle's commercial and industrial establishments, natural gas has the lowest emission rate per unit of energy use, although there are questions about whether the calculations fully account for leakages of gas during production and distribution. Electricity has the highest rate of emissions per unit of energy use. But it is worth noting that there is significant potential for the emission rate to decrease by substituting electricity produced with zero-emission renewable energy sources for electricity produced with fossil energy.

Figure 2. Non-Residential Energy Emissions, 2017



Residential Energy

Carlisle residences used 82 million kilowatt hours (kWh) of electricity in 2017 for lighting, powering appliances and, for 38 percent of Carlisle households, heating their homes. Average emission factors from the USEPA for the RFC East Region are used to estimate greenhouse gas emissions from residential electricity use. Electric utilities emitted an estimated 28,250 $MTCO_2e$ of greenhouse gases to generate the electricity used by Carlisle residences, making electricity the largest source of emissions in the residential energy sector (Table 2).

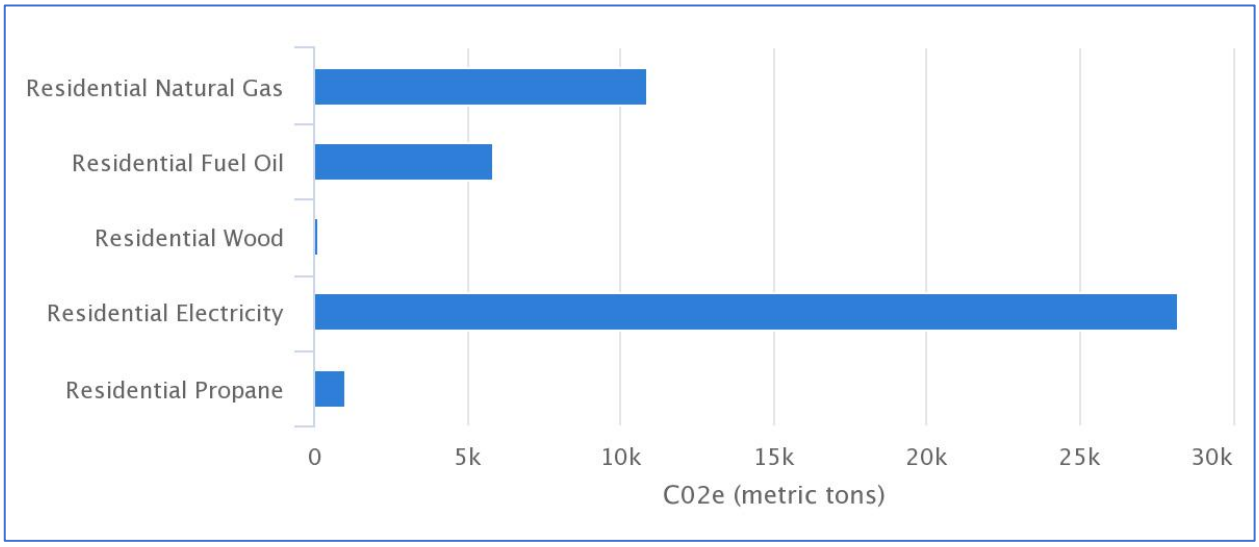
Carlisle residences also directly combusted a variety of fuel types, mostly to heat their homes. Of Carlisle's 7,475 occupied households, 45 percent used natural gas in 2017 as their primary heating fuel, 12 percent used distillate fuel oil, nearly 3 percent used propane and 1 percent used wood. More than 300 billion Btus of these fuels are estimated to have been burned by Carlisle households in 2017, resulting in almost 18,000 $MTCO_2e$ greenhouse gas emissions (Figure 3). Natural gas is the largest source of emissions after electricity in the residential sector, followed by fuel oil.

Table 2. Residential Energy Use and Emissions, 2017

Energy Type	No. Households Using Energy Type for Heat	Usage	Usage Units	GHG Emissions (MTCO2e)	Emissions per Unit Energy Use (MTCO2e/MMBtu)
Electricity	2,865	82,145,847	kilowatt hours	28,250	0.101
Natural Gas	3,366	204,514	millions Btu	10,875	0.053
Fuel oil	902	77,212	millions Btu	5,845	0.076
Propane	201	16,991	millions Btu	1,054	0.062
Wood	73	14,517	millions Btu	133	0.009
Total	7,475	593,527	millions Btu	46,157	0.078

Electricity use by residential users in the 17013 zip code service area was provided by PPL. The percentage of population in the 17013 service area who live in Carlisle, 53.4 percent, is used to estimate Carlisle's residential electricity use. UGI provided natural gas use for residential users in Carlisle. Data for use of fuel oil, propane and wood by Carlisle residences are not directly available and have to be estimated. Use of these fuels by residences in Carlisle are estimated from data on total residential energy use in Pennsylvania by fuel type, the number of households in Pennsylvania using each fuel as a heating source and their average fuel use per household, and the number of households in Carlisle using each fuel as a heating source.

Figure 3. Residential Energy Emissions (MTCO2e)



Transportation

Greenhouse gas emissions from transportation are estimated for on-road travel by passenger vehicles and commercial freight trucks, public transit and paratransit buses, rail transportation and air travel. Each of these modes of transportation burn gasoline, diesel or, in the case of air travel, jet fuel, and emit greenhouse gases in the process. While electric vehicles have the potential to substantially reduce emissions in the future, at present they are a very small portion of Carlisle's travel miles. Emissions of greenhouse gases for most transportation modes are calculated from estimates of vehicle miles traveled within Carlisle for different vehicle and fuel types, fuel efficiencies, and average emissions per gallon of fuel or per mile traveled.

Carlisle's emissions of greenhouse from transportation in 2017 are estimated at 71,000 $MTCO_2e$ (Table 3). Passenger vehicles and light trucks were driven 84 million miles, used 3.5 million gallons of fuel and produced roughly 31,000 $MTCO_2e$ that year. Commercial freight trucks are driven far fewer miles than passenger vehicles in Carlisle, 21.7 million miles, but consumed about the same amount of fuel, 3.6 million gallons, and produced nearly the same amount of emissions, 30,500 $MTCO_2e$, because heavy trucks are much less fuel efficient than passenger vehicles. Public transit and paratransit bus revenue miles and fuel use in Carlisle are much smaller in comparison and they contributed less than 300 $MTCO_2e$. Rail added a bit more than 3,000 $MTCO_2e$ and fuel use at Carlisle Airport added close to 450 $MTCO_2e$.

Estimates of on-road vehicle miles traveled for passenger and commercial freight vehicles by fuel type were provided by Michael Baker International. The estimates are derived from data available from PennDOT and estimates of trip origins and destinations from the South-Central Travel Demand Model used by the Harrisburg Metropolitan Planning Organization. The estimates include 100 percent of miles for trips that start and end in Carlisle and 50 percent of miles for trips that either start or end in Carlisle. Vehicles traveling I-81 and other throughways that neither start or stop in Carlisle are excluded.

Vehicle revenue miles and fuel use for public transit services provided by Capital Area Transit and 'on demand' paratransit services provided by Rabittransit for their entire service areas were obtained from the 2017 Annual Agency Profile of the Cumberland Dauphin-Harrisburg Transit Authority. Miles and fuel

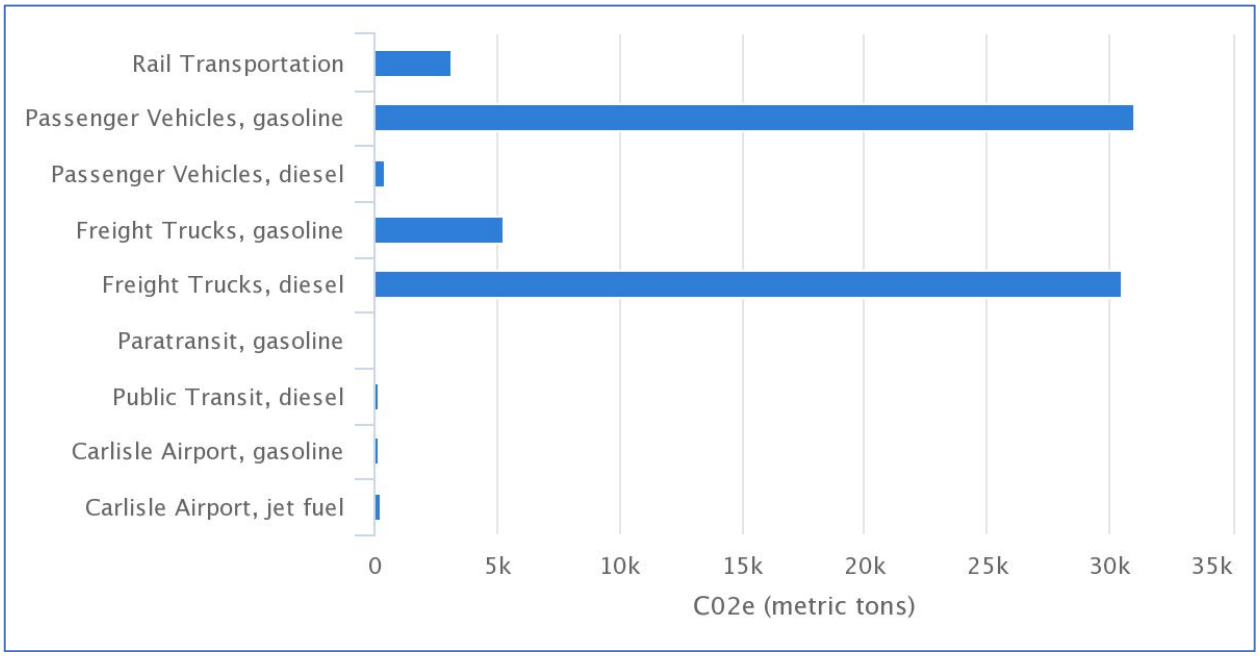
use attributable to Carlisle were estimated using Carlisle's population as a percentage of the total population served by Transit Authority, 3.73 percent.

Table 3. Transportation Emissions, 2017

Transportation Mode and Fuel Type	Vehicle Miles Traveled	Fuel Use (gals)	GHG Emissions (MTCO2e)
Passenger Vehicle, Gasoline	82,980,861	3,492,270	30,972
Passenger Vehicle, Diesel	1,007,865	42,416	433
Freight Truck, Gasoline	3,170,575	591,376	5,266
Freight Truck, Diesel	18,575,484	2,984,140	30,497
Paratransit Bus, Gasoline	52,255	10,341	92
Transit Bus, Diesel	68,543	18,981	194
Rail			3,144
Carlisle Airport, Gasoline		23,084	197
Carlisle Airport, Jet Fuel		25,979	251
Total			71,046

Norfolk Southern Railway, which owns and operates the freight rail line that passes through Carlisle, reports that 15.8 million $MTCO_2e$ of greenhouse gases were emitted by their national rail operations in 2017. Emissions attributable to Carlisle are estimated using the percentage of Norfolk Southern's route miles that lie within Carlisle, 0.02 percent. Emissions produced by flights in and out of the Carlisle airport are estimated using volumes of aviation gasoline and jet fuel that are loaded on planes at the airport.

Figure 4. Transportation Emissions, 2017



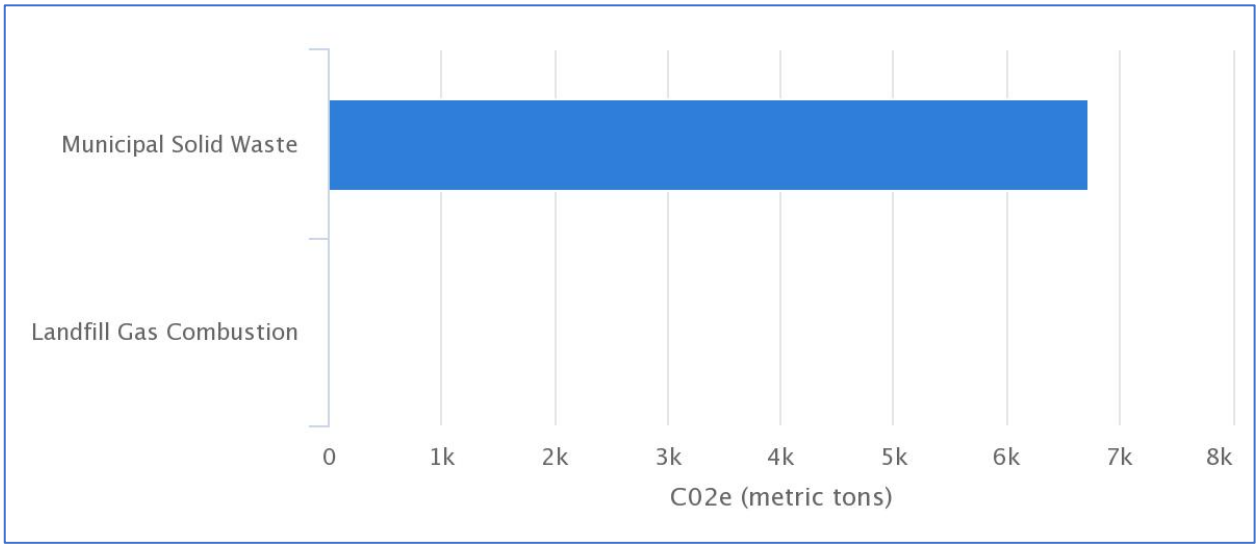
Municipal Solid Waste

Municipal solid waste generated by Carlisle residents, businesses and other establishments is collected by different haulers and taken to the Cumberland County Landfill in Newburg, PA. Organic wastes decompose in the landfill, a process the emits methane, a powerful greenhouse gas. A portion of the landfill gas, typically ranging from 40 to 60 percent, is captured and either combusted to generate electricity or flared. This reduces the amount of methane that reaches the atmosphere but produces emissions of the less powerful greenhouse gas carbon dioxide.

Waste generation is not measured directly for Carlisle but is estimated using the average weight per county resident of municipal solid waste received at the county landfill, 0.7 tons per person, and the population of Carlisle. Different types of waste emit methane at different rates. The percentage of waste by type (e.g. corrugated cardboard, newspaper, office paper, food and yard waste) were derived from a 2003 DEP study of waste composition in Pennsylvania. Quantities of landfill gas flared and combusted were provided by Advanced Disposal, the operator of the landfill.

The county landfill received nearly 167,000 tons of municipal solid waste in 2017, of which 12,772 tons are estimated to have come from Carlisle residents and establishments. Decomposition of this waste in the landfill emits methane to the atmosphere in a quantity equivalent to 6,737 metric tons of carbon dioxide. Roughly 300,000 cubic feet of the landfill gas attributed to Carlisle's waste is either flared or combusted, resulting in 21 metric tons of carbon dioxide emissions.

Figure 5. Municipal Solid Waste Emissions, 2017



Water and Wastewater

Water and wastewater represent a small share of Carlisle's greenhouse gas emissions, but they are important to report separately because the water and wastewater treatment plants are directly controlled by local government. Electricity is used to distribute and treat potable drinking water and to treat wastewater. Generation of the electricity used for these purposes produces greenhouse gas emissions, which are reported in this section and excluded from emissions reported for non-residential energy. Treatment of wastewater at the wastewater treatment plant uses a nitrification/denitrification process that

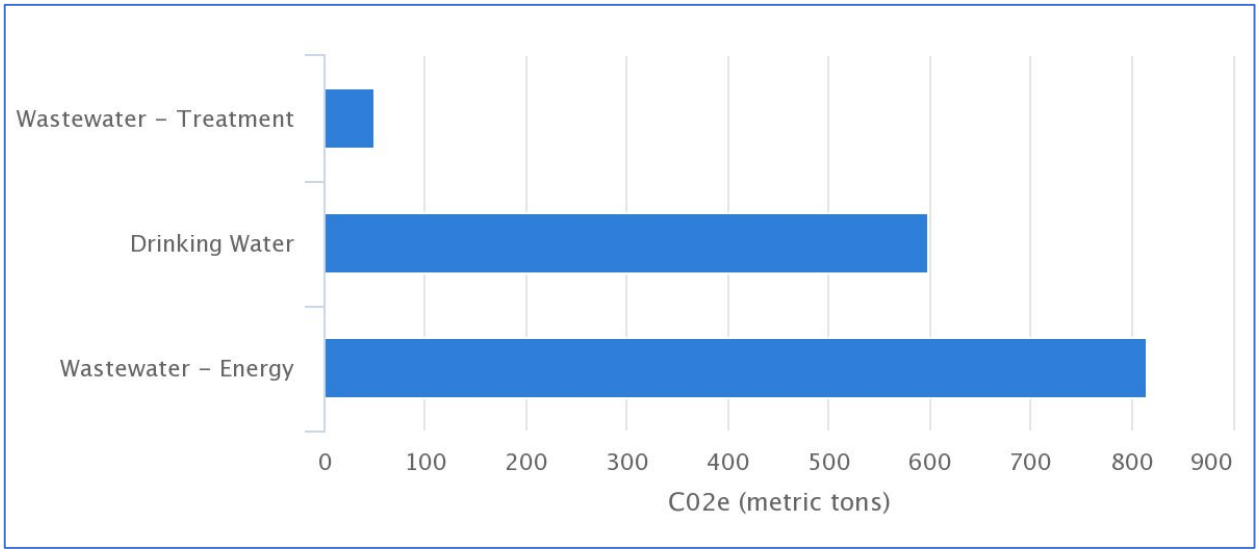
produces an estimated 7 grams of nitrous oxide per person per year. Nitrous oxide is 298 times more powerful than carbon dioxide.

Carlisle residents and establishments used 520.1 million gallons of drinking water in 2017, which is 92.5 percent of the water distributed by the Carlisle water treatment plant. 1.7 million kWh of electricity was used to treat and pump the water, producing 598 $MTCO_2e$ of emissions. 3.5 million kWh of electricity was used to operate the wastewater treatment plant, which serves a population of 28,290 people that includes Carlisle plus roughly 9,000 people who live in other jurisdictions. The share of electricity used for wastewater treatment attributable to Carlisle is estimated to be 2.4 million kWh, which produces 816 $MTCO_2e$ of emissions. Emissions from the nitrification/denitrification process to serve Carlisle's 19,190 residents is 50 $MTCO_2e$.

Table 4. Water and Wastewater Emissions, 2017

Drinking Water	
Water Use (millions gals)	520.6
Electricity Use (kWh)	1,739,224
GHG Emissions (MTCO2e)	598
Wastewater	
Population served	19,190
Electricity Use (kWh)	2,374,160
GHG Emissions from Electricity (MTCO2e)	816
GHG Emissions from Nitrification/Denitrification (MTCO2e)	50
Total Emissions (MTCO2e)	1,464

Figure 6. Water and Wastewater Emissions, 2017



References

ICLEI, 2012, U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions. ICLEI – Local Governments for Sustainability, Denver, CO. https://icleiusa.org/publications/us-community-protocol/

ICLEI, 2014, ClearPath User Guide, An ICLEI USA Tool. ICLEI – Local Governments for Sustainability, Denver, CO. https://s3.amazonaws.com/ClearPath-ICLEI/User+Guides/ClearPath+Inventory+Module+User+Guide.pdf

Pennsylvania Department of Environmental Protection, 2018, Pennsylvania Climate Action Plan, Strategies and Actions to Reduce and Adapt to Climate Change. PA Department of Environmental Protection, Harrisburg, PA. https://www.dep.pa.gov/Citizens/climate/Pages/PA-Climate-Action-Plan.aspx#:~:text=

Data Sources

Demographic Data for Carlisle

Population, number of households, household heating fuel, number of employees: US Census Bureau, American FactFinder, accessed December 21, 2019. https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml.

Residential and Non-Residential Energy

Emission factors for electricity: USEPA, 2016 *eGrid,* accessed January 20, 2020. https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid

Electricity use: PPL Electric Utilities, personal communication by email from B. Kathryn Frazier, Regulatory Affairs Manager.

Natural gas use: UGI Utilities, personal communication by email from Brian Meilinger, Manager-Energy Efficient Programs.

Pennsylvania energy consumption data: USEIA's State Energy Data System, accessed December 21, 2019. https://www.eia.gov/state/seds/seds-data-fuel-prev.php#DataFiles.

Transportation

Vehicle fuel economy:

- Passenger cars and light duty trucks: US Department of Transportation, Average Fuel Efficiency of Light Duty Vehicles, accessed January 20, 2020. https://www.bts.gov/content/average-fuel-efficiency-us-light-duty-vehicles.
- Heavy duty trucks, gasoline: U.S. Energy Information Administration, Open Data, accessed January 20, 2020. https://www.eia.gov/opendata/qb.php?category=1373322&sdid=AEO.2015.REF2015.EFI_NA_FGHT_RADS_MGS_NA_NA_MPG.A.
- Heavy duty trucks, diesel: U.S. Energy Information Administration, Open Data, accessed January 20, 2020.

https://www.eia.gov/opendata/qb.php?category=1373322&sdid=AEO.2015.REF2015.EFI_NA_FGHT_RADS_DSL_NA_NA_MPG.A.

- Transit and paratransit buses: Federal Highway Administration, Highway Statistics, accessed January 20, 2020. https://afdc.energy.gov/data/10310.

Emission factors for vehicles: USEPA, Emission Factors for Greenhouse Gas Inventories, accessed January 20, 2020. https://www.epa.gov/sites/production/files/2018-03/documents/emission-factors_mar_2018_0.pdf.

Road transportation, vehicle miles traveled, passenger vehicles and commercial trucks: Michael Baker International, personal communication by email from Dan Szekeres, Technical Manager.

Public transit, fuel consumption: Federal Transit Administration, 2017 Annual Database Energy Consumption, accessed January 20, 2020. https://www.transit.dot.gov/ntd/data-product/2017-annual-database-energy-consumption.

Public transit, vehicle revenue miles and population served: Cumberland Dauphin-Harrisburg Transit Authority DBA Capital Area Transit, 2017 Annual Agency Profile, accessed January 20, 2020. https://www.transit.dot.gov/ntd/transit-agency-profiles/cumberland-dauphin-harrisburg-transit-authority.

Rail transportation emissions: Norfolk Southern Railway, 2018 Corporate Social Responsibility Report, accessed January 20, 2020. http://www.nscorp.com/content/dam/nscorp/get-to-know-ns/about-ns/environment/ns-2018-social-responsibility-report.pdf

Carlisle Airport fuel use: Carlisle Airport, personal communication by email from Jeff Smith, Airport Manager.

Municipal Solid Waste

Municipal solid waste generation, Cumberland County and Carlisle: Cumberland County Recycling and Waste Authority, personal communication by email from Justin Miller, Recycling Coordinator.

Municipal waste composition: Pennsylvania Department of Environmental Protection, *Final Report, Statewide Waste Composition Study,* April, 2003. http://files.dep.state.pa.us/Waste/Recycling/RecyclingPortalFiles/Documents/wastecompositionstudy.pdf

Landfill gas flaring and combustion: Advanced Disposal, personal communication by email from Dusty Hilbert, General Manager.

Water and Wastewater

Water and wastewater volumes, service populations and electricity use: Borough of Carlisle, personal email communications from Susan Armstrong, Borough Manager; Mark Malarich, Director of Public Works; and Sean Shultz, Council Member

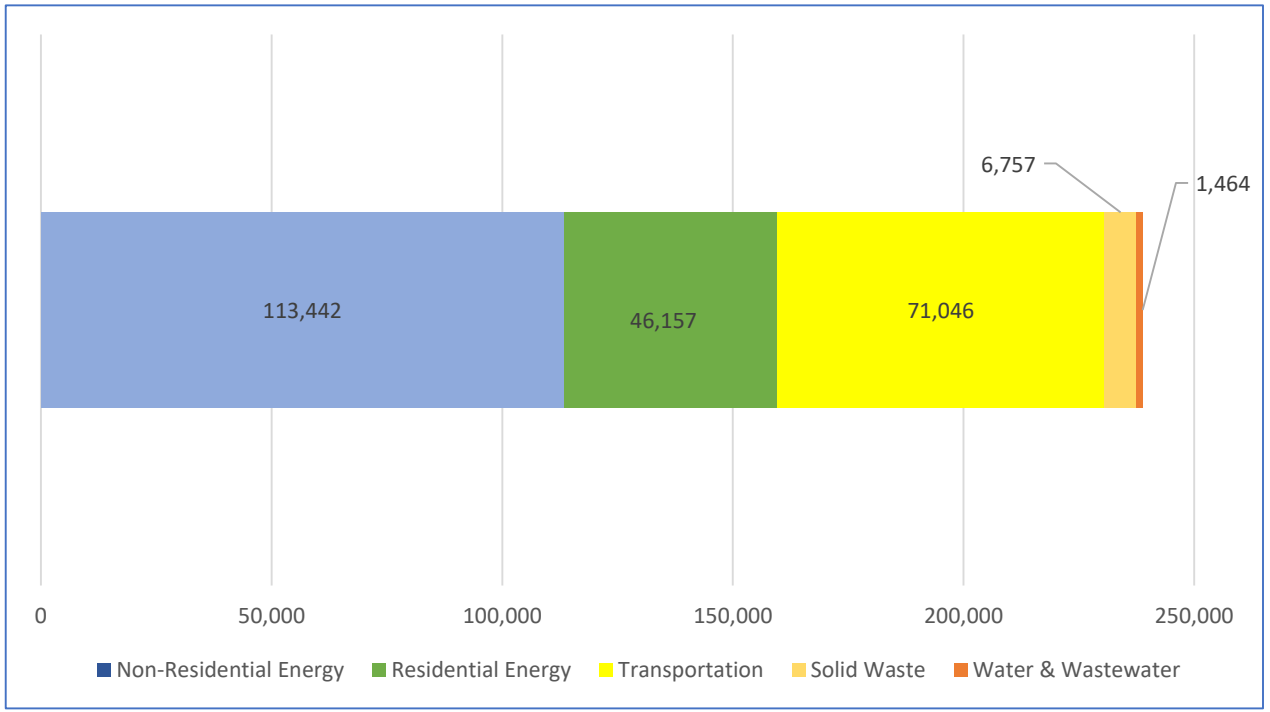
Local Government Climate Action Assistance Program

PA Department of Environmental Protection and ICLEI Local Governments for Sustainability

- Phase I: Create a Greenhouse Gas Inventory
  - ✓ Completed
- Phase II: Develop and adopt a Climate Action Plan
  - o Underway

Carlisle's GHG Emissions, 2017

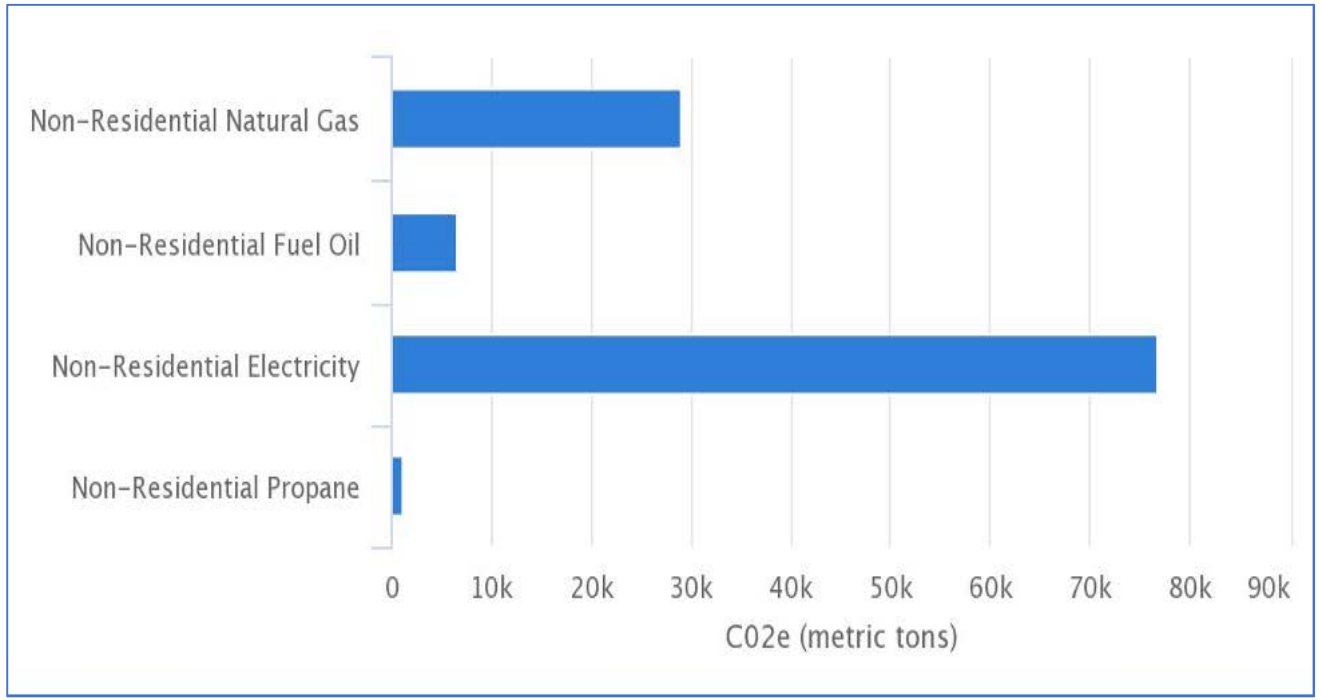
Sector	Emissions (MTCO2e)	Percent of Total
Non-Residential Energy	113,442	47.5%
Residential Energy	46,157	19.3%
Transportation	71,046	29.7%
Solid Waste	6,757	2.8%
Water & Wastewater	1,464	0.6%
TOTAL	**238,866**	100.0%



Metric Tons Carbon Dioxide Equivalent ($MTCO_2e$)

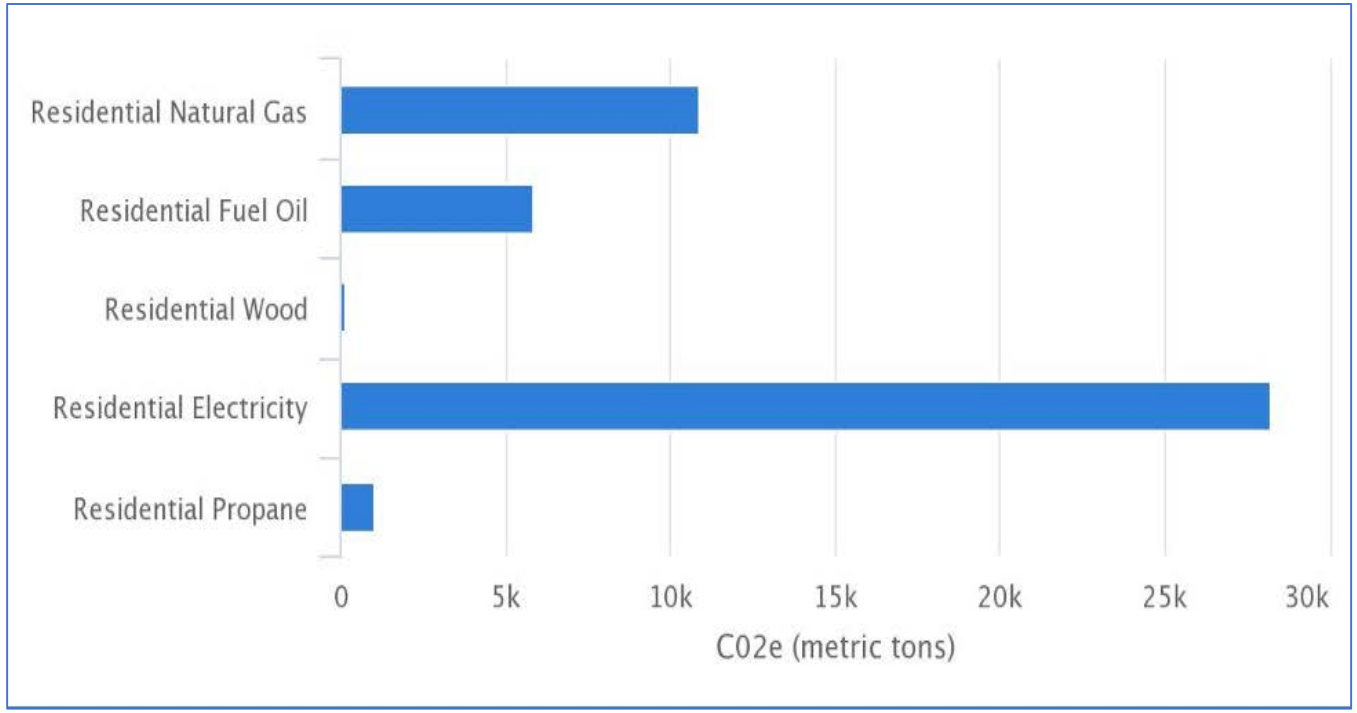
Non-residential energy

Energy Type	Usage	Usage Units	GHG Emissions (MTCO2e)	Emissions per Unit Energy Use (MTCO2e/MMBtu)
Electricity	223	Million kWh	76,683	0.101
Natural Gas	545,656	million Btu	29,015	0.053
Fuel Oil	89,184	million Btu	6,640	0.074
Propane	17,798	million Btu	1,105	0.062
Total	1,413,471	million Btu	113,443	0.080



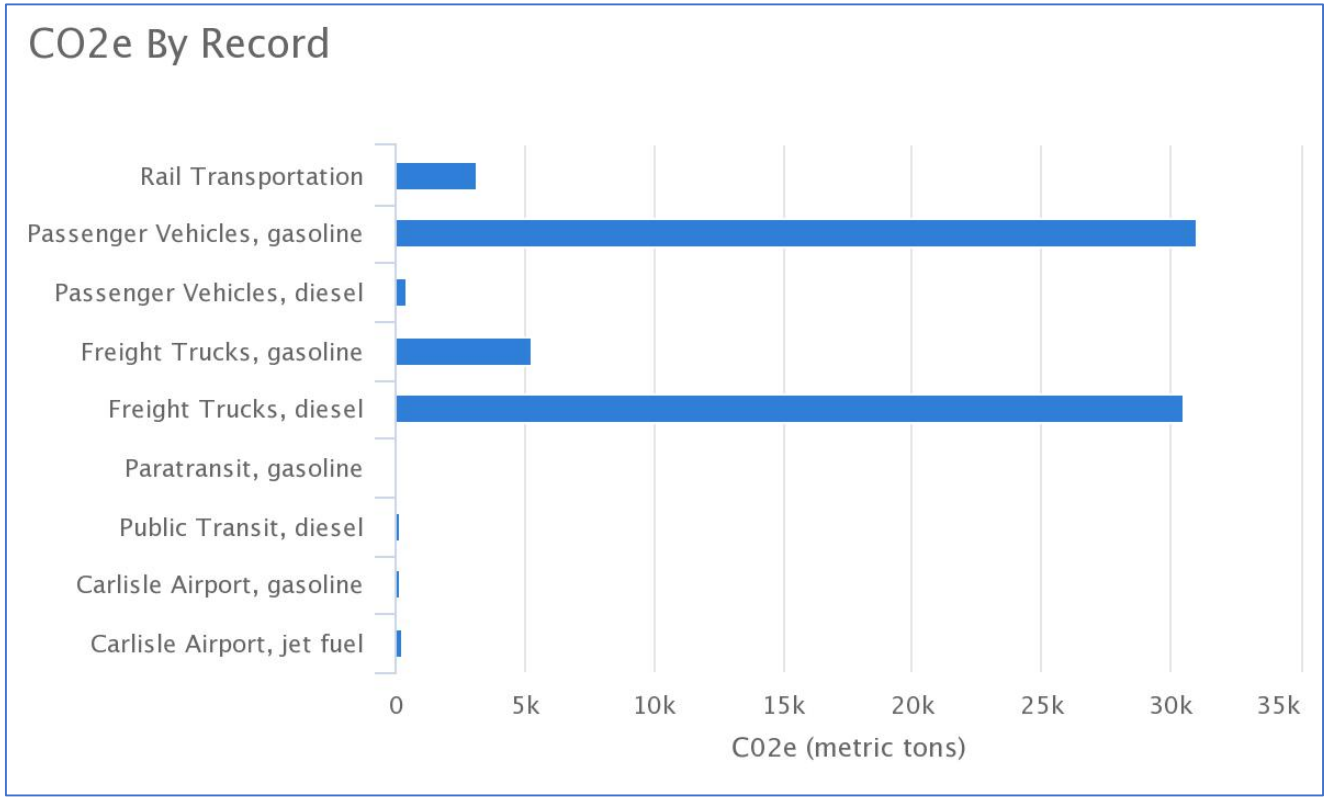
Residential energy

Energy Type	No. Households Using Energy Type for Heat	Usage	Usage Units	GHG Emissions (MTCO2e)
Electricity	2,865	82.1	million kWh	28,250
Natural Gas	3,366	204,514	million Btu	10,875
Fuel oil	902	77,212	million Btu	5,845
Propane	201	16,991	million Btu	1,054
Wood	73	14,517	million Btu	133
Total	7,475	593,527	million Btu	46,157



Transportation

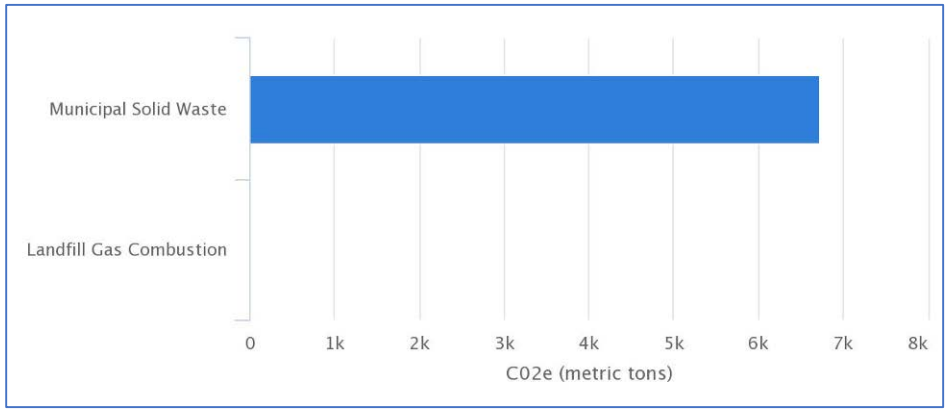
Transportation Mode and Fuel Type	Vehicle Miles Traveled	Fuel Use (gals)	GHG Emissions (MTCO2e)
Passenger Vehicle, Gasoline	82,980,861	3,492,270	30,972
Passenger Vehicle, Diesel	1,007,865	42,416	433
Freight Truck, Gasoline	3,170,575	591,376	5,266
Freight Truck, Diesel	18,575,484	2,984,140	30,497
Paratransit Bus, Gasoline	52,255	10,341	92
Transit Bus, Diesel	68,543	18,981	194
Rail			3,144
Carlisle Airport, Gasoline		23,084	197
Carlisle Airport, Jet Fuel		25,979	251
Total			71,746



Solid waste, water and wastewater

Drinking Water	
Water Use (millions gals)	520.6
Electricity Use (kWh)	1,739,224
GHG Emissions (MTCO2e)	598
Wastewater	
Population served	19,190
Electricity Use (kWh)	2,374,160
GHG Emissions from Electricity (MTCO2e)	816
GHG Emissions from Nitrification/Denitrification (MTCO2e)	50
Total Emissions (MTCO2e)	1,464

Drinking water



Wastewater