CITY OF CARMEL

2015 and 2018 Inventories of Community and Government Operations Greenhouse Gas Emissions

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This report was prepared by Miranda Frausto, Indiana Climate Fellow at the City of Carmel (initially placed as an extern through the Indiana Sustainability Development Program). The author would like to thank the City of Carmel staff, Carmel community, and the Environmental Resilience Institute for providing much of the local information, expertise, and insight necessary for the completion of this report.

This GHG Inventory Report was developed using a template provided by ICLEI – Local Government for Sustainability, USA.

Letter from the Mayor

Climate change is a threat to our planet, our country and our community. It will – and in many ways already has – have negative impacts on our way of life and increased costs for our city, businesses and residents. As a co-chair of the U.S. Conference of Mayors' Climate Protection Task Force and a member of former President Obama's State, Local and Tribal Task Force on Climate Preparedness and Resilience, I've become acutely aware of what can happen if we do nothing and what we need to do, as a community, to meet this threat head on.

At this time, overwhelming evidence indicates human activities are increasing the amount of greenhouse gases found in our atmosphere. We have already begun taking steps to combat this crisis. In 2017, the Carmel City Council unanimously passed the Climate Recovery and Resiliency Resolution to put on record our dedication to do all we can to lessen our city's impact on the environment. Carmel has made infrastructure and policy updates to help our environment, such as building more than 138 roundabouts to significantly reduce harmful emissions by eliminating long lines of idling traffic. We have improved the walkability and bikeability of our city by expanding our trail system and making connections with regional communities. We are moving the city's vehicle fleet to hybrids, including our police department. While these changes can and will help, we need to do much more with the development of a Climate Action Plan.

Before we start on a plan, it is imperative that we determine how much greenhouse gas emissions we are emitting because measurement is key to our success. If we don't measure, we can't understand our impact. That is why this Green House Gas inventory is the foundation upon which we will build our Climate Action Plan. What we do in Carmel, Indiana, can have impacts worldwide.

There are many benefits to the city and its residents from becoming better stewards of our community. Many of these projects will save the city money which will be passed on to future generations through lower taxes. Some of the ways in which we reduce our CO2 emissions can also save consumers and business owners money through lower energy bills, better built homes and job creation. Our residents can also make meaningful changes such a considering energy efficient appliances, turning off unused lights, watching your furnace settings, using a bicycle instead of a car for local errands, and considering an electric vehicle to replace purely gasoline powered ones.

We would like to thank Indiana University's Environmental Resilience Institute for their assistance in the process.

Jim Brainard

Jim Brainard – Mayor, City of Carmel

Executive Summary

The City of Carmel recognizes that greenhouse gas (GHG) emissions from human activity are catalyzing profound climate change, the consequences of which pose substantial risks to the future health, wellbeing, and prosperity of our community. Furthermore, Carmel has multiple opportunities to benefit by acting quickly to reduce GHG emissions. Reducing emissions is correlated with a plethora of benefits such as reducing energy and associated costs, creating green jobs, and improving quality of life and overall health.

In February of 2017, the Carmel Common Council unanimously voted to pass the Climate Recovery and Resiliency Resolution (CRRR) which aims to reduce emissions and ensure the well-being of Carmel residents from now and into the future. In 2019, Carmel completed the city's first ever GHG emissions inventory – the first step in meeting the targets of the CRRR and climate leadership commitment. Figure 1 is a visual depiction of the steps cities like Carmel can take in committing to actionable steps towards reducing GHG emissions. This report represents the completion of ICLEI's Climate Mitigation Milestone One and provides a foundation for future work to reduce greenhouse gas emissions in Carmel.

Figure 1

Climate Leadership Commitment Cycle

This report documents the importance and findings of Carmel's first ever Community and Local Government Inventories for the reporting years of 2015 and 2018. In total, four inventories were conducted that accounted for the emissions released in those respective years (i.e., 2015 Community, 2015 Local Government, 2018 Community, and 2018 Local Government). The Community Inventories aim to gauge emissions from all community sources and activities from residents, commercial entities, and industries. The Local Government Inventories focus on the emissions that a city government has control over, such as a city-owned wastewater treatment facility (i.e. Carmel Utilities). A Community Inventory includes Local Government emissions, but a Local Government Inventory is based on the emissions attributable to city-controlled processes alone. The main sectors assessed are energy, transportation, solid waste, and water + wastewater.

The following information in Table 1 is the overall emissions for each inventory in Metric Tons of Carbon Dioxide Equivalent (MT CO2e). MT CO2e is the standard unit of measurement of emissions that converts the global warming potential of all emitted GHGs into carbon dioxide. More information about GHGs can be found in the following section titled *"Climate Change Background".*

Table 1

Total Metric Tons of Carbon Dioxide Equivalent for Each Inventory to Date

2015 Community	1,257,697
2018 Community	1,260,419
2015 Local Government	29,881
2018 Local Government	30,916

The following sections recount more details about the importance, methodologies, and results of the inventories.

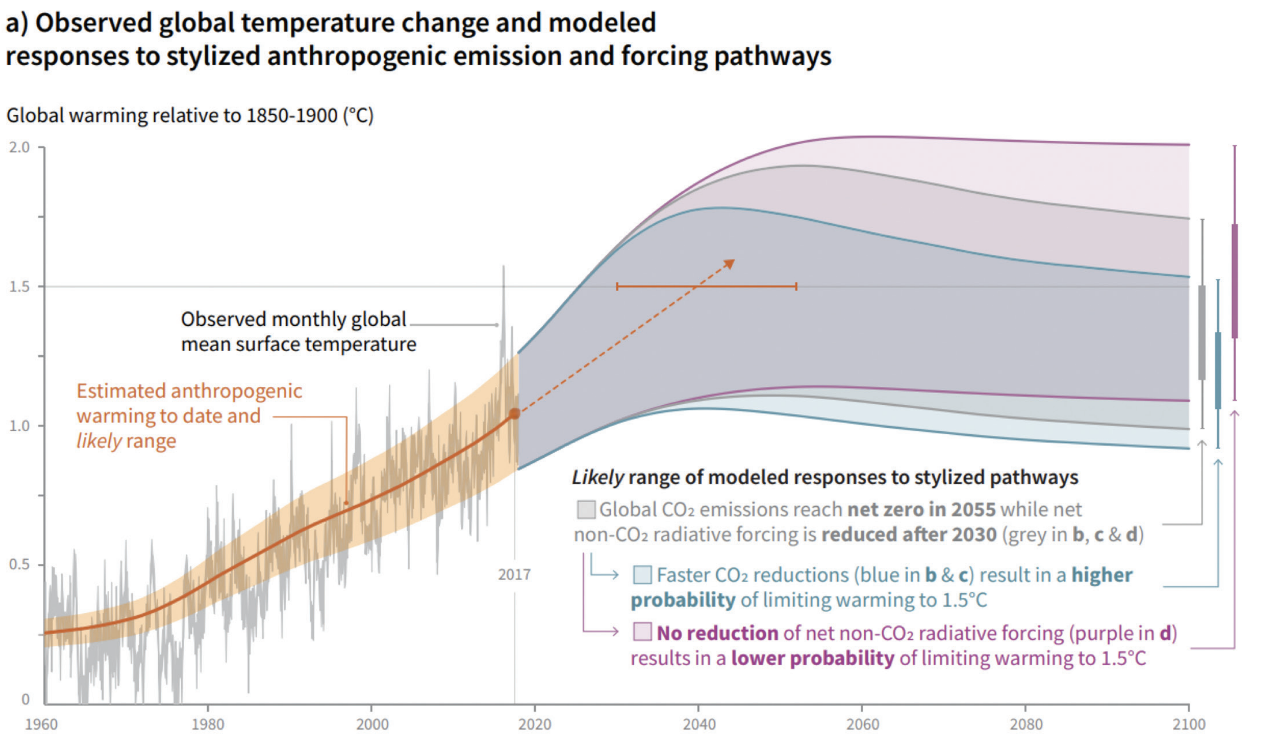
Naturally occurring gases dispersed in the atmosphere determine the Earth's climate by trapping solar radiation (energy from the sun). This phenomenon is known as the greenhouse effect. The greenhouse effect is key in regulating Earth's temperature naturally. However, overwhelming evidence shows that human activities are increasing the concentration of greenhouse gases, which tampers with the naturally-occurring greenhouse effect, resulting in a changing global climate. In other words, the equilibrium of naturally-occurring greenhouse gases in the atmosphere is being disrupted by a drastic input of GHG emissions by human activity. The most significant contributor is the burning of fossil fuels, like coal and natural gas, for transportation, electricity generation and other purposes. These activities introduce large amounts of carbon dioxide and other greenhouse gases into the atmosphere. Collectively, these gases intensify the naturally-occurring greenhouse effect, causing global average (surface and lower atmospheric) temperatures to rise.

Evidence of Human-Caused Climate Change

The Intergovernmental Panel on Climate Change (IPCC) is the United Nations body for assessing climate-related science and the international authority on the subject. In the IPCC's "Special Report: Global Warming of 1.5°C", their estimates signal that human, or anthropogenic, activities have contributed to the 1°C of global warming above pre-industrial levels[1]. This is to say that it is very unlikely that the 1°C of warming was caused by anything that was not human activity (I.e. burning of fossil fuels since the Industrial Revolution). Additionally, if emissions continue at their current rate, the IPCC warns of warming of 1.5°C between 2030 and 20521. Although 1 and 1.5°C of warming do not seem significant initially, this level of warming has, and will continue to, harm both natural and human systems. This is especially the case if current emissions trends continue. In Figure 2, one can see the global temperature warming associated with different emissions reduction targets being met, including if no reductions are made. To date, the global effects of climate change have included atmospheric and ocean warming, reduced amounts of snow and ice, and rising sea levels, to name a few[2]. It is important to consider other effects of climate change beyond from the environmental standpoint, such as social and economic concerns. For example, it is often the most vulnerable and disadvantaged populations that suffer greatly, and disproportionately, from climate change. Additionally, the effects of climate change can lead to costly repairs, such as infrastructure renovations as a result of increased flooding[2].

Figure 2

Observed Global Temperature Change and Modeled Responses to Stylized Anthropogenic Emission and Forcing Pathways[1]



How Climate Change is Impacting Indiana

The Purdue Climate Change Research Center (PCCRC) is a renowned interdisciplinary climate change research and education center based in Indiana through Purdue University. The PCCRC has documented how climate change has, and will continue to, impact Hoosiers. For example, annual rainfall, intense rain and flooding events are all expected to increase, which stimulates issues regarding human health[3]. These issues include an increase in injuries, waterborne diseases, allergen issues, asthma, and toxic algae growth, to name a few. Extremely hot days are also expected to increase, which exposes Hoosiers to heat-related illnesses (and the associated medical costs), as well as increased utility bills as a result of the higher demand of cooling[3]. To the same effect, the cold season is expected to decrease in intensity, which signifies the likelihood of disease-carrying insect prevalence for longer durations throughout the year[3].

ICLEI Climate Pathways Program

In response to the problem of climate change, many communities in the United States are taking responsibility for addressing emissions at the local level. Since many of the major sources of greenhouse gas emissions are directly or indirectly controlled through local policies, local governments have a strong role to play in reducing greenhouse gas emissions within their boundaries. Through proactive measures around land use patterns, transportation demand management, energy efficiency, green building, waste diversion, and more, local governments can dramatically reduce emissions in their communities. In addition, local governments are primarily responsible for the provision of emergency services and the mitigation of natural disaster impacts.

ICLEI's Climate Pathways program provides a framework, methodology, and comprehensive assistance for local governments to identify and reduce greenhouse gas emissions. The program is organized along the Five Milestones transcribed below.

1. Conduct an inventory and forecast of local greenhouse gas emissions;
2. Establish a greenhouse gas emissions reduction target;
3. Develop a climate action plan for achieving the emissions reduction target;
4. Implement the climate action plan; and,
5. Monitor and report on progress.

Sustainability & Climate Change Mitigation Activities in Carmel

Carmel has recognized the need to take action on sustainability, and has implemented programs that have led to ancillary benefits in the form of energy conservation and greenhouse gas mitigation. Some examples are the following:

- Formal commitments to Resilient Communities for America, the Mayors National Climate Action Agenda, and the Global Covenant of Mayors
- First city in Indiana to pass a youth-led climate resolution
- Mayor Jim Brainard served on President Obama's Task Force on Climate Preparedness and Resilience and currently serves as co-chair for the US Conference of Mayor's Energy Independence & Climate Protection Committee
- Proven commitment to reducing emissions from vehicular sources by expanding Carmel's bicycle network and installing over 100 round-a-bouts
- Design of a mixed-use and walkable downtown city center
- City-wide recycling available to all residents and small businesses
- Hybridization of Carmel government vehicle fleet
- Award-winning Wastewater Treatment Plant due to sustainable initiatives

The next step for the City of Carmel is to follow through with the milestones outlined by ICLEI. The following milestone is to create a Climate Action Plan for the City.

Understanding a Greenhouse Gas Emissions Inventory

The first step toward achieving tangible greenhouse gas emission reductions requires identifying baseline emissions levels and the sources and activities generating emissions in the community. This report presents emissions from both the Carmel community as a whole, and from operations of the Carmel government. The government operations inventory is a subset of the community inventory, as shown in Figure 3. The local government inventory includes emissions solely from government operations, but these emissions are included as part of the community. For reference, all residential, commercial, and industrial sources and activities within Carmel's boundaries that yield emissions make up the community inventory (thus the larger portion of the figure below). However, the local government assesses the activities that the City of Carmel owns and operates, such as the energy used for City Hall and street lights.

Figure 3

Relationship of Community and Government Operations Inventories

As local governments have continued to join the climate protection movement, the need for a standardized approach to quantify GHG emissions has proven essential. The inventories conducted for the City of Carmel use the approach and methods provided by the Community Greenhouse Gas Emissions Protocol (Community Protocol) and the Local Government Operations Protocol (LGO Protocol), both of which are described below.

Community Emissions Protocol

The Community Protocol was released by ICLEI in October 2012, and represents a new national standard in guidance to help U.S. local governments develop effective community GHG emissions inventories. It establishes reporting requirements for all community GHG emissions inventories, provides detailed accounting guidance for quantifying GHG emissions associated with a range of emission sources and community activities, and provides a number of optional reporting frameworks to help local governments customize their community GHG emissions inventory reports based on their local goals and capacities. The State of California Governor's Office of Planning and Research recommends that California local governments follow the Community Protocol when undertaking their greenhouse gas emissions inventories.

Local Government Operations Protocol

In 2008, ICLEI, the California Air Resources Board (CARB), and the California Climate Action Registry (CCAR) released the LGO Protocol. 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.

Quantifying Greenhouse Gas Emissions

Sources and Activities

Communities contribute to greenhouse gas 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".

SOURCE	ACTIVITY
Any physical process inside the jurisdictional boundary that releases GHG emissions into the atmosphere Example: In-Boundary Transportation (i.e. trips beginning in Carmel and ending in Carmel).	**The use of energy, materials, and/or services by members of the community that result in the creation of GHG emissions.** Example: Waste generated by Carmel residents is an activity since the waste is landfilled out-of-boundary, thus creating emissions (attributable to our activities) outside of Carmel's boundaries.

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 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.

Emissions Scopes

For the government operations inventory, emissions are categorized by scope, rather than into sources and activities. Using the scopes framework helps prevent double counting. There are three emissions scopes for government operations emissions:

Scope 1: All direct emissions from a facility or piece of equipment operated by the local government. Examples include tailpipe emissions from local government, and emissions from a furnace in a local government building.

Scope 2: Indirect emissions associated with the consumption of purchased or acquired electricity, steam, heating, and cooling.

Scope 3: All other indirect or embodied emissions not covered in Scope 2. Examples include contracted services, embodied emissions in goods purchased by the local government, and emissions associated with disposal of government generated waste.

Scope 1 and Scope 2 emissions are the most essential components of a government operations greenhouse gas analysis as they are the most easily affected by local policy making.

Base Year

The inventory process requires the selection of a base year with which to compare current emissions. Carmel's community and local government inventories utilize 2015 as its base year. The year 2015 was chosen because it was the year with the earliest (yet quality) data. The 2018 inventories that proceeded were used as a metric of measuring changes between 2015 and 2018 for both the Carmel community and local government.

Quantification Methods

Emissions sources in this inventory are quantified using calculation-based methodologies. 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**. 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.

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 CO_2/kWh of electricity). For this inventory, calculations were made using the ICLEI Clearpath Tool.

Community Profile

To put emissions inventory data in context, it is helpful to have some basic information about the community such as population and number of households. This information is provided in Table 2. Please note that in both years the boundaries for Clay Township were used to ensure accuracy across both inventories given that the City of Carmel officially incorporated Clay Township in 2017.

Estimated 2015 Population	92, 747
Estimated 2015 Households	36, 471
Estimated 2018 Population	98, 347
Estimated 2018 Households	39, 415

Table 2:
Carmel/Clay Township Community Indicators[4]

Carmel Community Emissions

The City of Carmel utilized the Global Protocol for Community Scale Greenhouse Gas Emissions Inventories (GPC) to gauge community emissions. The main emissions sectors accounted for were the following: Energy (Residential, Commercial, and Industrial), Transportation and Mobile Sources, Water & Wastewater, and Solid Waste. Figure 4 and 5 summarize the emissions associated with each record for community data. Energy is the electricity and natural gas used in the residential, commercial, and industrial spheres (i.e. kWh consumed in a given inventory year). Transportation and Mobile Sources assess the emissions associated from the vehicle miles traveled in a given inventory year via gasoline and diesel vehicles. Water & wastewater calculates the emissions associated with the treatment, transportation, and general process of water and wastewater services. Lastly, solid waste quantifies the emissions associated with landfill disposal by how many tons are disposed of in an inventory year, primarily by the residential and commercial communities.

Figure 4 showcases the proportion of emissions sectors overall for 2015. Figure 5 does the same for 2018. In the 2015 Community Emissions figure, on both sides of the orange solid waste section, are industrial energy (0.8%) and Water & Wastewater Treatment (0.07%). In 2018, the proportion for Industrial Energy was (0.6%) and Water & Wastewater was (0.08%).

Figure 4:

2015 Community Emissions in Metric Tons of Carbon Dioxide Equivalent

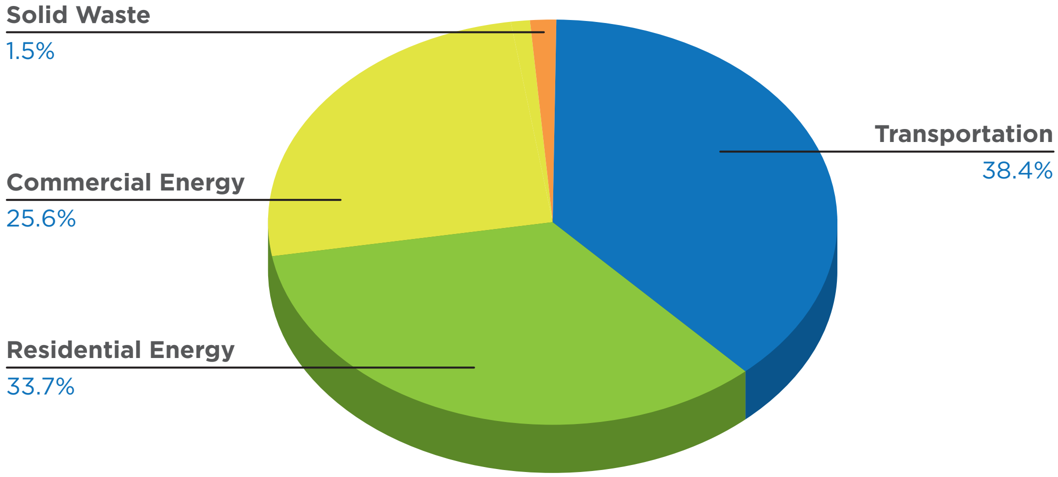
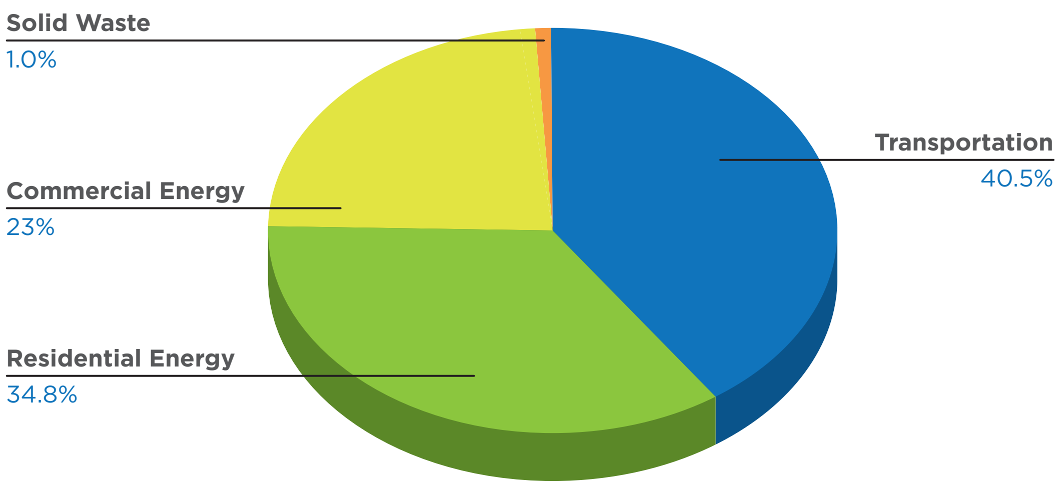


Figure 5:

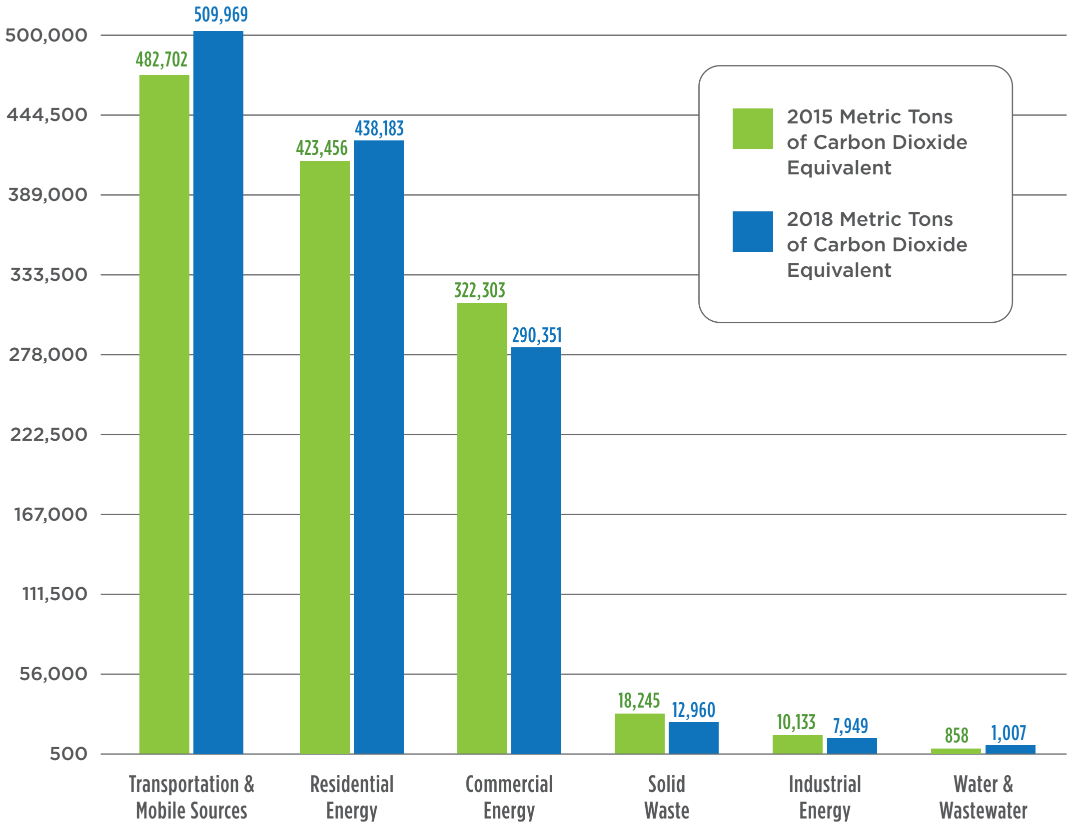
2018 Community Emissions in Metric Tons of Carbon Dioxide Equivalent



Community Emissions Inventory Results *(continued)*

Figure 6 demonstrates the changes in community emissions (in MT CO2e) between 2015 and 2018. Most sectors increased emissions, with the exception of Commercial and Industrial Energy, as well as Solid Waste.

Figure 6:
Community Emissions by Sector for 2015 and 2018

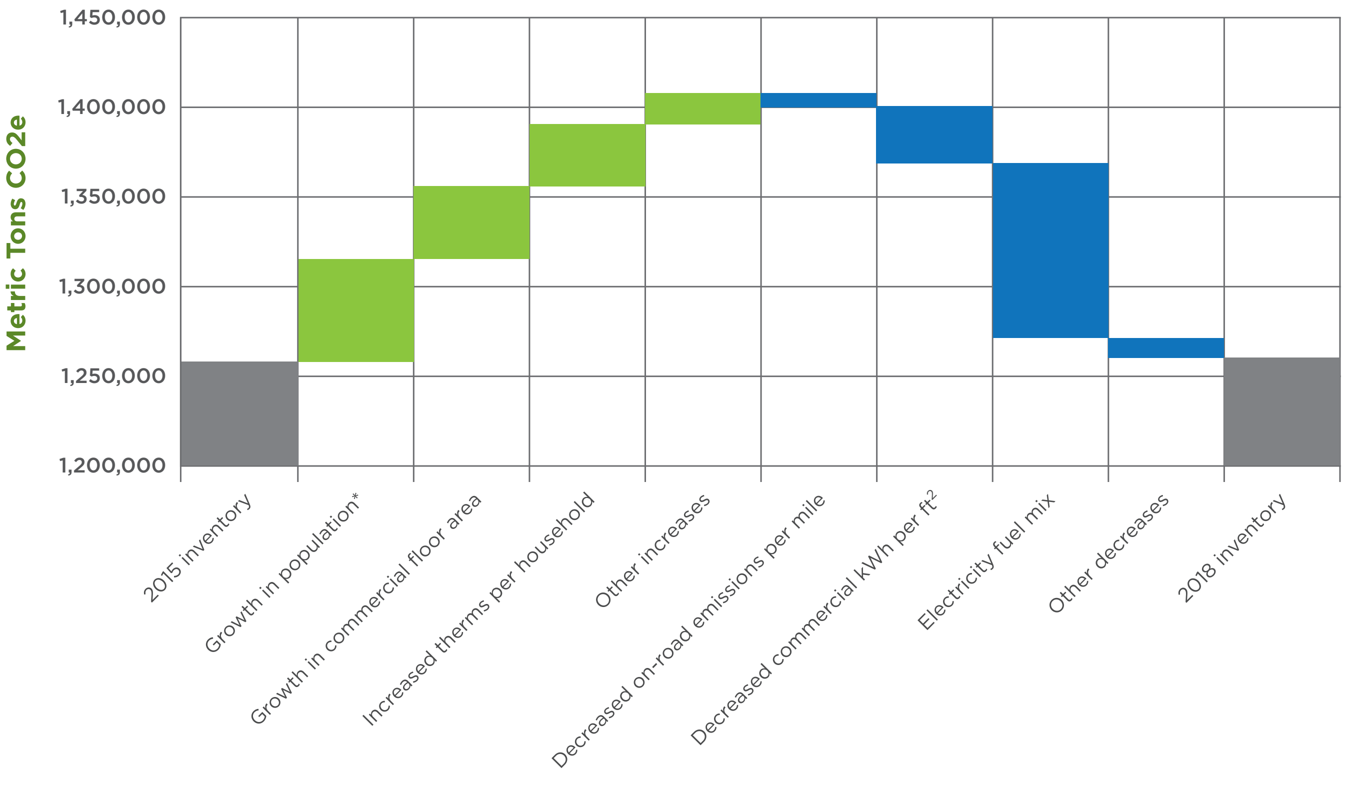


Carmel will focus on the aforementioned emissions sources and activities in developing a climate action plan. The total MT CO2e of emissions will be the baseline for setting an emissions reduction target and comparing future emissions reductions.

Contribution Analysis

A contribution analysis is used to determine what the largest contributors to emissions increases are. It was especially prudent that this be conducted for Carmel due to the population boom between 2015 and 2018 – a difference of almost +6,000 residents. The cause of the emissions increases and decreases are displayed in the Contribution Analysis "waterfall" chart below. Contribution analyses are helpful to distinguish what controllable and uncontrollable factors led to emissions reductions and increases. As one can see from the chart, the top two contributors of the escalation of emissions were population and employment development (causes of increase are shown in green on the left side of the chart). The other top contributors to the emissions increases were the increased therms (or natural gas usage) by household, and other factors. The top two contributions to emissions reductions were electricity fuel mix and decreased commercial kWh per job. It is difficult to associate why these decreases occurred within the community, but it is likely due to a diversification of energy resources and increased energy efficiency.

Figure 7: **Contribution Analysis**



Another helpful visual for community emissions is emissions per capita. Emissions per capita presents the emissions results in a more tangible manner by associating emissions by a person's individual contributions. Doing so further determines how much of a role population growth played in the inventory results. Based on the per capita metric tons emitted by person between 2015 and 2018, Carmel reduced per capita emissions by 5.9%. This indicates that although emissions increased between 2015 and 2018, had not more consideration and action been taken, the emissions increase could have been greater. Therefore, Carmel can work towards reducing overall emissions, but is on the right track considering the reductions per capita. The ultimate goal of is to reduce GHG emissions despite population growth (and other increases) when larger-scale projects and technologies are implemented (i.e. renewable energy procurement).

Table 3: **Per Capita Emissions of Carmel Residents**

Inventory Year	Per Capita Emissions (Based on Total Community Emissions and Population)
2015	13.6 MT CO2e
2018	12.8 MT CO2e

Future Projections

To illustrate the potential emissions growth based on projected trends in energy use, driving habits, job growth, and population growth from the baseline year going forward, Carmel conducted an emissions forecast for the year 2050. The forecast is applied to the activities and sources subject to local government significant influence.

Table 4: **Indicators Used in Emissions Forecast**[5]

Indicator	2018 Value	2050 Value	Compound Annual Growth Rate	Total Percent Change from 2018 to 2050
Population	100,055	147,556	1.2%	47%

Under a business-as-usual scenario, the City of Carmel's emissions will grow by approximately 47% percent by the year 2050 from 1,260,419 to 1,824,864 metric tons CO2e. Business-as-usual scenarios indicate the emissions increase in conjunction with the population with little to no action taken to reduce emissions. Table 5 below shows the results of the forecast.

Table 5: **Business-As-Usual Emissions Increase Scenario**

Sector	2018 Emissions	2050 Emissions	Compound Annual Growth Rate
Residential Electricity	289,652	419,250	1.2%
Commercial Electricity	270,525	391,564	1.2%
Industrial Electricity	7,950	11,507	1.2%
Residential Natural Gas	148,531	214,988	1.2%
Commercial Natural Gas	19,826	28,697	1.2%
On-Road Transportation (Gasoline)	301,152	435,994	1.2%
On-Road Transportation (Diesel)	112,127	162,296	1.2%
Solid Waste Generation	12,960	19,299	1.2%
Water and Wastewater Treatment (Not Including Energy Use)	1,008	1,458	1.2%
Miscellaneous	96,688	139,811	1.2%
Total	**1,260,419**	**1,824,864**	**1.2%**

Future Projections *(continued)*

The data used to create the forecasting figures was obtained from the population forecasting figures provided by the Carmel Planning and Zoning Office. In this instance, it is assumed that Building Permit Issuance is correlated with community growth. Population growth is used as a metric for a "business-as-usual" emissions scenario in which emissions increase along with population. The purpose of forecasting a Business-As-Usual scenario is to avoid the increase in emissions that often grows in tandem with population growth by taking proper action.

The following forecast metric is an optimal emissions reductions scenario based on the sustainability goals of one of Carmel's largest energy suppliers, Duke Energy. Duke Energy has selected the ultimate emissions reduction goal of net zero emissions by 2050 based on 2005 levels, an initiative they have already made significant progress on[6]. This reduction target is in line with the Paris Climate Accord and will be accomplished by converting to renewable energy and increasing energy efficiency. The City of Carmel is also using these reduction goals to dictate emissions reductions and the community Climate Action Plan. Not only are these goals the global standard, but given the stake that energy consumption plays in Carmel's emissions, our emissions also rely on the initiative of our utility providers (and our collaboration with them to ensure success). Please note that a "Best Case Scenario Emissions Forecast" indicates that the net zero reduction target is met by 2050. Additionally, net zero means that emissions are significantly lowered and as close to zero as possible given different considerations. To achieve net zero emissions, any emissions still produced must be offset by carbon sequestration activities, such as tree plantings that remove carbon from the atmosphere. This is why the forecast below is not an exact zero.

Table 6: **Best Case Scenario Emissions Forecast**

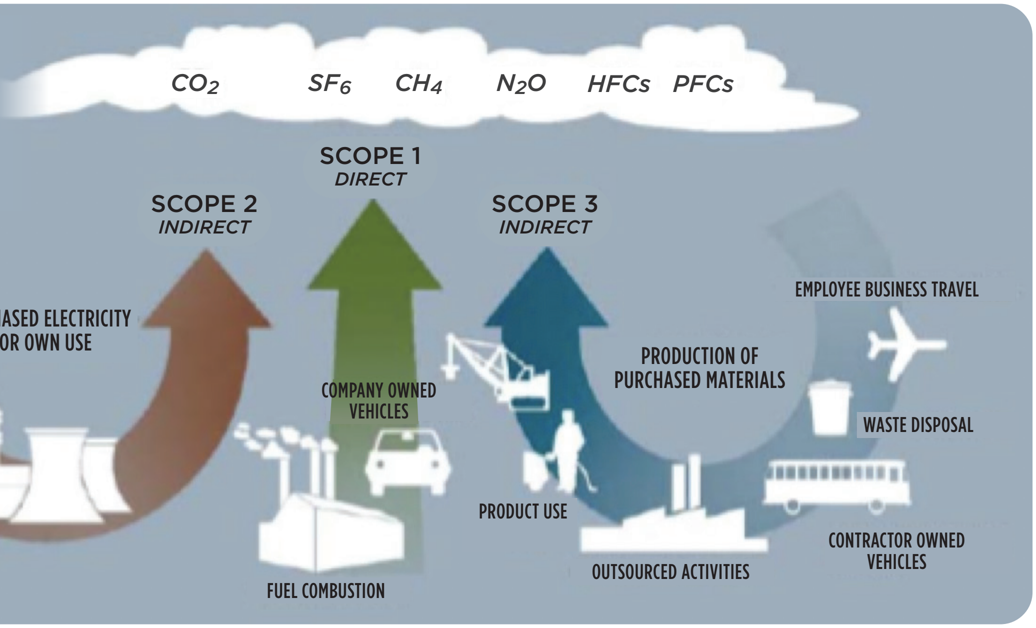
Sector	2018 Emissions	2050 Emissions	Compound Annual Growth Rate
Residential Electricity	289,652	322	-19.1%
Commercial Electricity	270,525	300	-19.1%
Industrial Electricity	7,950	9	-19.1%
Residential Natural Gas	148,531	215	-19.1%
Commercial Natural Gas	19,826	29	-19.1%
On-Road Transportation (Gasoline)	301,152	3,023	-6.9%
On-Road Transportation (Diesel)	112,127	837	-14.2%
Solid Waste Generation	12,960	151	-13.0%
Water and Wastewater Treatment (Not Including Energy Use)	1,008	12	-12.9%
Miscellaneous	96,688	375	-15.9%
Total	**1,260,419**	**5,273**	**-15.7%**

The scenario depicted above is possible if Carmel 1) reduces emissions sources within the boundary via city/community initiatives and 2) collaborates with utility providers to promote more sustainable technologies to reduce emissions from Carmel's activities.

Emissions by Scope

Scopes are used to keep track of emissions in order to avoid double counting within and between entities. Scope 1 emissions come from fuel use in government facilities and vehicles; Scope 2 emissions come from electricity use, and Scope 3 are other indirect emissions. See Figure 8 for more reference.

Figure 8
Emissions Source by Scope[7]



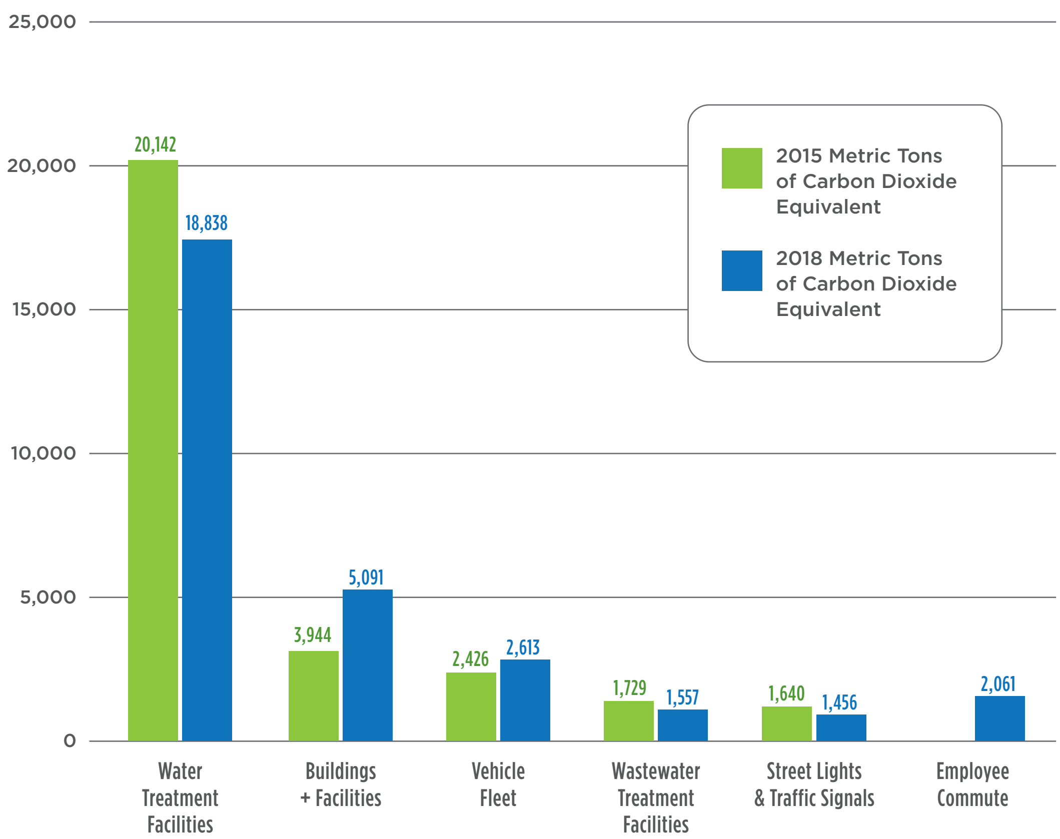
Emissions by Sector

For developing emissions reduction policies, it is often most useful to look at emissions broken down by sector, as each sector will have a particular set of strategies to reduce emissions. Table 7 and Figure 9 show Carmel's government operations emissions broken down by sector numerically and visually.

Table 7: **Government Operations Emissions by Sector and Year**

Sector	2015 metric tons CO_2e	2018 metric tons CO_2e
Water Treatment Facilities (Energy Use Included)	20,142	18,138
Buildings & Facilities	3,944	5,091
Vehicle Fleet	2,426	2,613
Wastewater Treatment Facilities (Energy Use Included)	1,721	1,557
Street Lights and Traffic Signals	1,640	1,456
Employee Commute	N/A	2,061
Totals	**29,881**	**30,916**

Figure 9: **Local Government Emissions by Sector for 2015 and 2018**



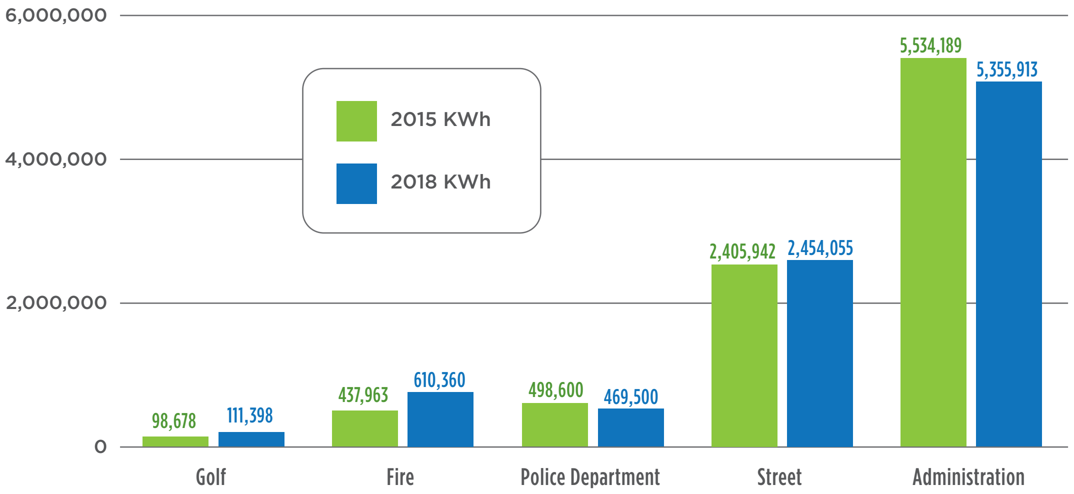
Water Treatment Facilities

The Water Treatment Facilities section is the largest sector of government operations emissions. These emissions are primarily attributable to energy use, such as the energy used for the treatment and transportation of drinking water (as well as other process emissions). It is essential to take into account the higher significance of this sector in relation to the others in the local government inventory. Thanks to the implementation of energy efficiency measures, emissions from water and wastewater treatment decreased between 2015 and 2018.

Buildings & Facilities

Buildings and facilities were the second largest sector of government operations emissions. Buildings and facilities include all energy consumption from the Administration, Fire, Golf, Police, and Street Departments. The Utilities Department was not included – these emissions are already accounted for in the Water Treatment and Wastewater Treatment sectors. Figure 10 on the following page demonstrates the proportions of energy consumption by department and by inventory year. Most departments experienced an increase in emissions, with the exception of the Administration and Police Departments (both decreased emissions between inventory years).

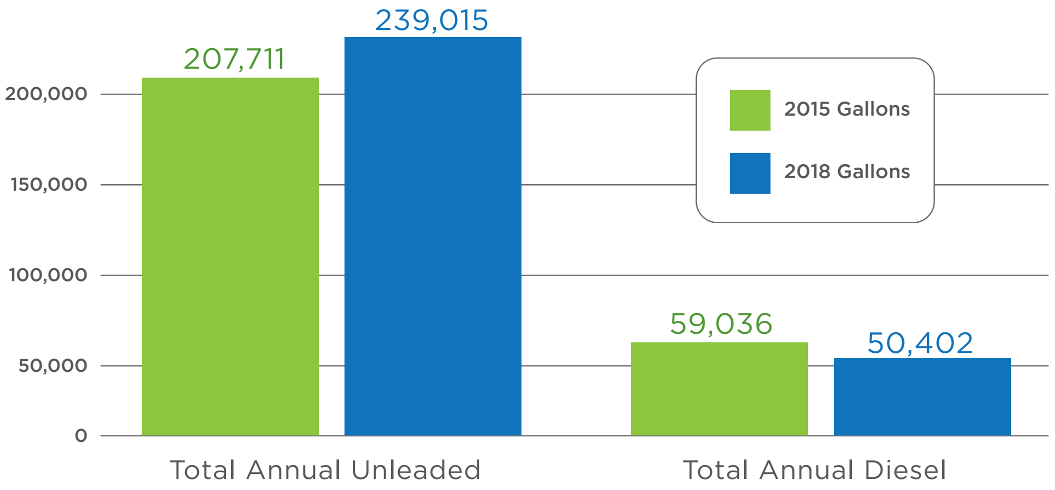
Figure 10: **Energy Usage by Department and Inventory Year**



Vehicle Fleet

Following buildings and facilities, vehicles were the next largest source of government operations emissions. These emissions are associated with the number of essential services provided by Carmel city government. Emissions from Vehicle Fleet were measured by gallons purchased for the use of the vehicle fleet. In Figure 11, one can see that diesel consumption decreased significantly, whereas the usage of unleaded gasoline increased greatly.

Figure 11: **Fuel Usage for Vehicle Fleet By Year and Type**



Street Lights and Traffic Signals

Like most local governments, Carmel operates a range of public lighting including traffic signals and street lighting. All of Carmel's street lights and traffic signals are operated by the Street Department. However, one should note that the emissions associated with street lights and traffic signals are dwindling due to the increase in round-a-bouts within city boundaries.

Wastewater Treatment

Wastewater collection and treatment is an essential public service provided by Carmel. Wastewater treatment processes require a significant amount of energy. In addition, as wastewater is collected, treated, and discharged, chemical processes in aerobic and anaerobic conditions lead to the creation and emission of methane and nitrous oxide. This sector also decreased between 2015 and 2018 for the same reasons listed above for Water Treatment.

Employee Commute

Employee commute emissions are not under direct operational control of Carmel, but Carmel has a variety of tools available to influence them. Total employee commute emissions were 2,016 metric tons in 2018. Emissions in 2015 were not determined due to data constraints. Carmel can influence employee commute emissions primarily by promoting alternative commute modes such as public transit and carpooling, and by offering options such as compressed workweeks and telecommuting that reduce the number of trips employees must make. Results showed that a minor fraction of employees used alternative forms of transportation (i.e. walk/bike/carpool). The majority used light truck/SUV/Pickup/Van (61%), Passenger Cars (33.3%), and Heavy Duty Trucks (5.7%). See Table 8 for more information.

Table 8: **Employee Commute Emissions**

Scope	Emission Type	Greenhouse Gas Emissions (metric tons)
SCOPE 3		CO2e
	Mobile Combustion	2,061 metric tons
INDICATORS	Vehicle Miles Traveled	3,998,912.86 miles

Government-Generated Solid Waste

Many local government operations generate solid waste, much of which is eventually sent to a landfill. Typical sources of waste in local government operations include paper and food waste from offices and facilities, construction waste from public works, and plant debris from parks departments. Due to the lack of quality data for this section, both 2015 and 2018 are represented with the same tonnages (482 tons total per year). However, the emissions are miniscule and a quantity of metric tons of CO2e could not be attributed to waste generated by Carmel local government.

Local Government Emissions Forecast

The same parameters used in the Community Forecast were utilized for Local Government as well. See below in Table 9 more details in a "Business-as-Usual" scenario and Table 10 for the application of Duke's reduction goals (i.e. Optimal Scenario).

Table 9: **Business-As-Usual Local Government Emissions**

Sector	2018 Emissions	2050 Emissions	Compound Annual Growth Rate
Water and Wastewater Treatment Facilities	19,695	28,508	1.2%
Buildings and Facilities Electricity	4,941	7,152	1.2%
Buildings and Facilities Natural Gas	150	157	1.2%
Vehicle Fleet (Gasoline)	2,099	3,037	1.2%
Vehicle Fleet (Diesel)	515	745	1.2%
Street Lights and Traffic Signals Electricity	1,255	1,817	1.2%
Street Lights and Traffic Signals Natural Gas	201	290	1.2%
Employee Commute	2,061	2,985	1.2%
Total	**30,916**	**44,691**	**1.2%**

Same as the Business-as-Usual forecast for the community inventory, the local government emissions for this forecast are based on population growth. The emissions produced by a local government are directly correlated with the services the city provides, so as the city's population grows, so do the demands placed for such services. This scenario can be avoided if the City of Carmel improves upon current climate leadership to produce emissions reductions such as the optimal scenario below:

The emissions reductions yielded in Table 10 are dependent on the work and initiative of the City of Carmel in improving the efficiency and sustainability of city-owned services and activities. This can range from improving the energy efficiency of city-operated buildings and procuring cleaner vehicles for the city fleet (i.e. electric, hybrid, etc.).

Table 10: **Best Case Scenario Local Government Emissions**

Sector	2018 Emissions	2050 Emissions	Compound Annual Growth Rate
Water and Wastewater Treatment Facilities	19,695	30	-18.35%
Buildings and Facilities Electricity	4,941	5	-19.39%
Buildings and Facilities Natural Gas	150	0	-20.43%
Vehicle Fleet (Gasoline)	2,099	2	-19.5%
Vehicle Fleet (Diesel)	515	1	-13.5%
Street Lights and Traffic Signals Electricity	1,255	1	-20.0%
Street Lights and Traffic Signals Natural Gas	201	0	-21.2%
Employee Commute	2,061	20	-13.5%
Total	**30,916**	**59**	**-17.80%**

Conclusion

This inventory marks completion of Milestone One of the Five Milestones for Climate Mitigation. The next steps are to set an emissions reduction target, and to develop a climate action plan that identifies specific quantified strategies that can cumulatively meet that target. In addition, Carmel should continue to track key energy use and emissions indicators on an on-going basis. ICLEI recommends completing a re-inventory at least every five years to measure emissions reduction progress.

Emissions reduction strategies to consider for the climate action plan include energy efficiency, renewable energy, vehicle fuel efficiency, alternative transportation, vehicle trip reduction, land use and transit planning, and waste reduction among others. This inventory shows that Energy and Transportation will be particularly important to focus on. Through these efforts and others, the City of Carmel can achieve additional benefits beyond reducing emissions, chiefly, improving the quality of life of residents.

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