2015 Greenhouse Gas Emissions Inventory Report for the City of St. Louis & Revision Of 2005 GHG Baseline Inventory

Prepared for the
City of St. Louis Mayor's Office of Sustainability
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Contents

EXECUTIVE SUMMARY

In October 2005, former Mayor Francis G. Slay signed onto the U.S. Conference of Mayors' Climate Protection Agreement, an effort now supported by 1060 mayors nationwide. On November 13, 2015, Mayor Slay signed the Compact of Mayors and pledged to gather GHG data, set targets, identify climate hazards, assess climate risks and vulnerabilities, and develop a climate action plan to address mitigation, as well as climate adaptation plan. The Compact of Mayors has since become the Global Covenant of Mayors for Climate and Energy, an international coalition of mayors and city officials committing to reduce local greenhouse gas emissions, enhance resilience to climate change and track their progress publicly.

This greenhouse gas (GHG) inventory is part of a comprehensive approach to reducing the City's GHG emissions. Information generated during the inventory can be assessed and evaluated to identify and measure where emissions originate, establishing historical emission trends and tracking progress in reducing greenhouse gases. The 2015 Community GHG Emissions Inventory measures GHG emissions generated by the entire community within the political boundaries of the City of St. Louis, including government operations of the City of St. Louis.

In 2015, the entire community was responsible for the GHG emissions of 7.2 million metric tons of carbon dioxide equivalent (mmtCO2e). This is an 11% reduction (-862,248 mtCO2e) from the 2005 baseline year for measuring GHG emissions reductions.

This report contains a GHG emissions update for the year 2015 and a revision to the baseline year of 2005. The objective was to identify the sources and quantities of GHG emissions emitted by community activities, as well as City government operations, in the City of St. Louis in 2015 and compare to the baseline 2005 GHG emissions inventory. It allows the City to understand the scale of emissions from the various sectors within its operations and within the community over time. Periodic GHG emissions updates allow the City to track emissions trends in order to address the progress of emissions reductions. The Mayor's Office of Sustainability developed a Climate Action and Adaptation Plan in April 2017, which features mitigation strategies and policies to guide future GHG emission reduction efforts.

BACKGROUND AND METHODOLOGY OVERVIEW

Greenhouse gas emissions inventories measure emissions generated by nine sectors of the community that function within the political boundaries of the City of St. Louis, including government operations of the City of St. Louis. Although government operations constitute a subset of the overall community emissions, the government operations are studied separately because the City is considered to possess direct control over its operations, while it can only aspire to guide and influence community emissions through encouragement and policy. The Mayor's Office of Sustainability now has GHG inventories for 2005, 2010, 2013 and 2015. Emissions for the calendar year 2015 inventory are included in this update report, as well as minor revisions to the 2005 baseline inventory per the most recent GHG inventory protocols. For 2005, data was entered into emissions-calculating software, Clean Air-Climate Protection (2009) version 3.0 (CACP), a tool developed by ICLEI – Local Governments for Sustainability (ICLEI). ICLEI is an international association of local and metropolitan governments dedicated to sustainability. ICLEI has since developed an improved online emissions management software suite called ClearPath. Data for 2015 was entered and calculated using ClearPath.

Measuring Emissions: City Government Operations

The government operations portion of this inventory follows the method outlined in the *Local Governments Operations Protocol* (LGOP) (ICLEI-Local Governments for Sustainability, 2010) which serves as a national standard for quantifying and reporting greenhouse emissions from local government operations.

By convention, GHG emissions for government are categorized into three "scopes." Scope 1 emissions are direct emissions from sources that the local city government has operational control. Scopes 2 and 3 represent indirect emissions. Indirect GHG emissions are as a result of activities that take place within the organizational boundaries of the city government, but that occur at sources owned or controlled by another entity. Scope 2 consists of indirect emissions associated with the consumption of purchase or acquired electricity, steam, heating or cooling. Scope 3 emissions include all other indirect emissions not covered by Scope 2, such as from city government employee commuting, wastewater processing, or waste disposal.

Measuring Emissions: Community-scale

The method for completing the community inventories followed the *Global Protocol for Community-Scale GHG Emissions Inventories: An Accounting and Reporting Standard for Cities*, collectively authored by ICLEI, World Resources Institute, and C40 Cities. The GHG emissions were generated by sources within eleven sectors of the community: commercial buildings, residential buildings, industrial facilities, vehicle miles traveled, solid waste, wastewater treatment and facilities, Metro vehicles and facilities, the Airport, rail, and ports. The St. Louis Lambert International Airport (Airport) was not previously included in the City's GHG community inventory for 2005. The 2005 baseline inventory has now been revised to include the Airport emissions.

In some instances, it is possible to measure GHG emissions directly. However, GHGs are emitted from hundreds of thousands of sources, many of which are mobile, and most of which are not directly monitored. Consequently, emissions that cannot be directly measured are estimated using other measurements, particularly energy consumption; a detailed description of the methods used in conducting this inventory is included in the Appendix.

PART I: REVISION TO BASELINE GREENHOUSE GAS EMISSIONS INVENTORY – CY 2005

Because 2005 was the year in which former Mayor Slay signed the U.S. Conference of Mayors' Climate Protection Agreement in reference to the Kyoto Protocol[1], that is the year and initial target the City established as the foundation upon which to track emission trends. Additionally, the year 2005 was selected as the baseline for forecasting, in order to assess progress of mitigation strategies and policies. This section of the report describes the revision to the City of St Louis 2005 Baseline Year Greenhouse Gas Inventory, conducted in 2011. The community portion of the 2005 inventory follows the method outlined in the *U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions* (ICLEI-Local Governments for Sustainability USA, 2013). However, the ICLEI protocol was not yet developed at the time the 2005 inventory was conducted, resulting in a revision to the emissions previously reported for that year. The primary change relates to the inclusion of Airport operations in the community inventory.

The St. Louis Airport Authority is the organization assigned to oversee the operation of the airport, however, there is also the Airport Commission which is responsible for the oversight of all planning development, management and operation of the airport. The Airport Commission currently consists of the Director of Airports, who serves as Chairman of the Airport Commission, the Comptroller of the City of St. Louis, the President of the Board of Aldermen, the Chairman of the Transportation and Commerce Committee of the Board of Aldermen, six members appointed by the Mayor, five members appointed by the St. Louis County Executive, one member appointed by St. Charles County, Missouri and one member appointed by St. Clair county, Illinois.[2] Given the Airport Commission includes members from other counties, and the Airport leases space to many vendors serving a community greater than the City of St. Louis, Airport emissions are not completely under operational control of the City or Airport Authority. The original 2005 inventory, reported all GHG emissions for the Airport under the City of St. Louis government operations inventory, and excluded them from the community inventory. In following the most up-to-date protocol, Airport emissions for 2005 have been properly redistributed between those the Airport Authority has operational control over, and those which they do not. The update in Airport emissions has resulted in an increase in the apparent 2005 community emissions and a reduction in apparent 2005 emissions attributed to government operations. The changes made align with current protocol and allow for direct comparison to the 2015 and future inventories.

COMMUNITY EMISSIONS INVENTORY – CY 2005 BASELINE REVISION

In 2005, the community GHG emissions originally calculated and reported for the City of St. Louis totaled 7,996,469 $mtCO_2e$, or 24.6 $mtCO_2e$ per person. The revised baseline for 2005 of 8,081,418 $mtCO_2e$, or 24.9 $mtCO_2e$ per person, is due to the Airport now being included in the community inventory. The emissions totals do not include those for flights or vendors of the airport, only the operation of the Airport's buildings, vehicles and waste generation overseen by the Airport Authority.

Summary of Community Emissions by Sector

Commercial buildings accounted for the largest percentage of emissions followed by residential buildings, and vehicle miles traveled (cars and trucks). The Airport emissions of 84,949 $mtCO_2e$,

[1] In 1997, 160 nations met in Kyoto, Japan to negotiate reductions in greenhouse gas emissions pursuant to the
[2] https://www.flystl.com/about-us/leadership

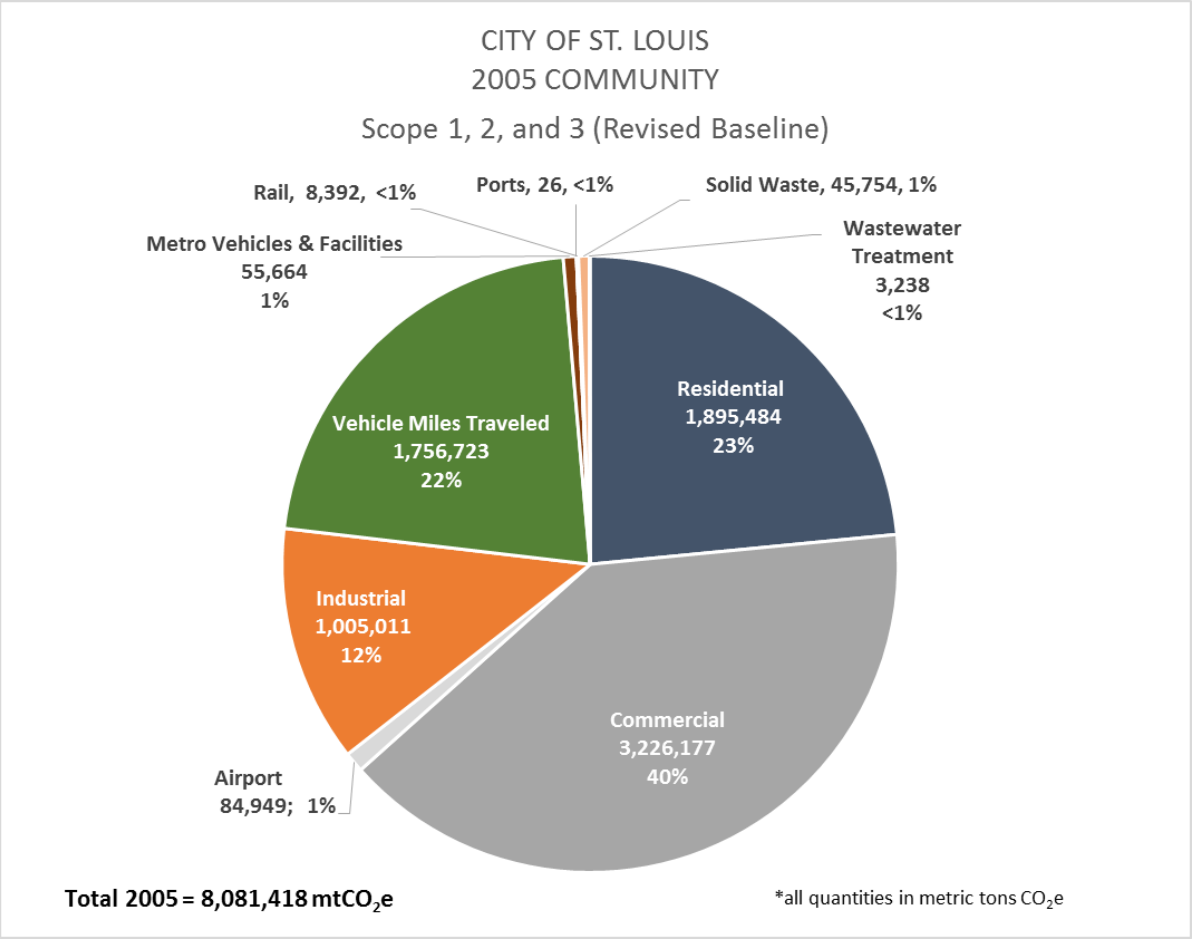
previously omitted from the community emissions, and have now been added, bringing the total community emissions to 8,081,418 $mtCO_2e$.

Table 1: Revised Community Emissions by Sector (2005)

	Emissions ($mtCO_2e$)	Percent Emissions
SCOPES 1+2		
Commercial	3,226,177	40%
Airport	**84,949**	**1%**
Residential	1,895,484	23%
Vehicle Miles Traveled	1,756,723	22%
Industrial	1,005,011	12%
Metro Transit Vehicles & Facilities	55,664	0.7%
Rail	8,392	0.1%
Ports	26	0.0003%
SCOPE 3		
Solid Waste	45,754	0.6%
Wastewater Treatment & Facilities	3,238	0.04%
OVERALL TOTAL SCOPES 1+2+3	**8,081,418**	**100%**

**Percentages may not total to 100% due to rounding*

Figure 1: Revised Community Emissions by Sector (2005)

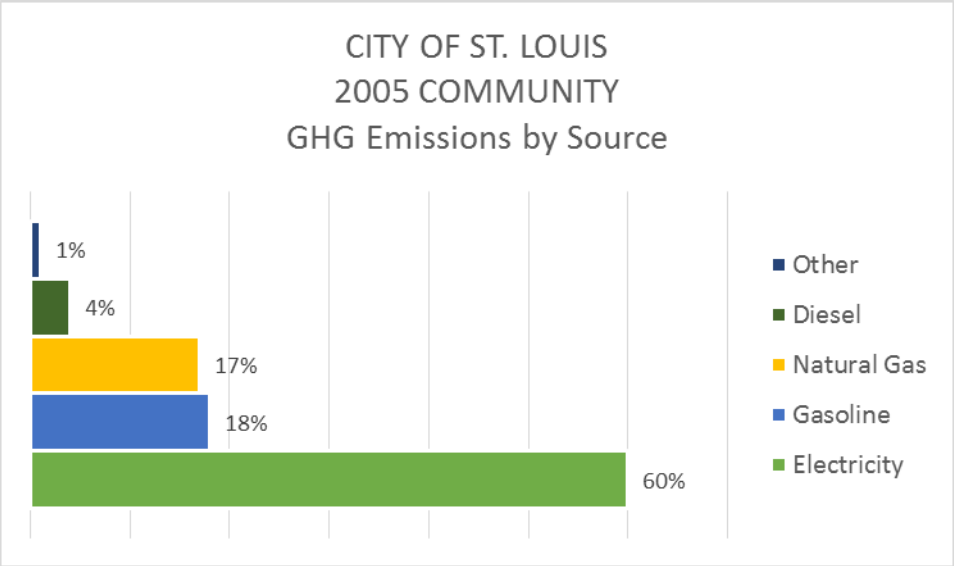


**Percentages may not total to 100% due to rounding*

Summary of Community Emissions by Source

In 2005, electricity accounted for almost 60% of GHG emissions in the City of St. Louis community, more than all other fuel sources combined. Gasoline accounted for 18%, and natural gas 17%. Combined, they accounted for 95% of all emissions.

Figure 2: Revised Community Emissions by Source (2005)



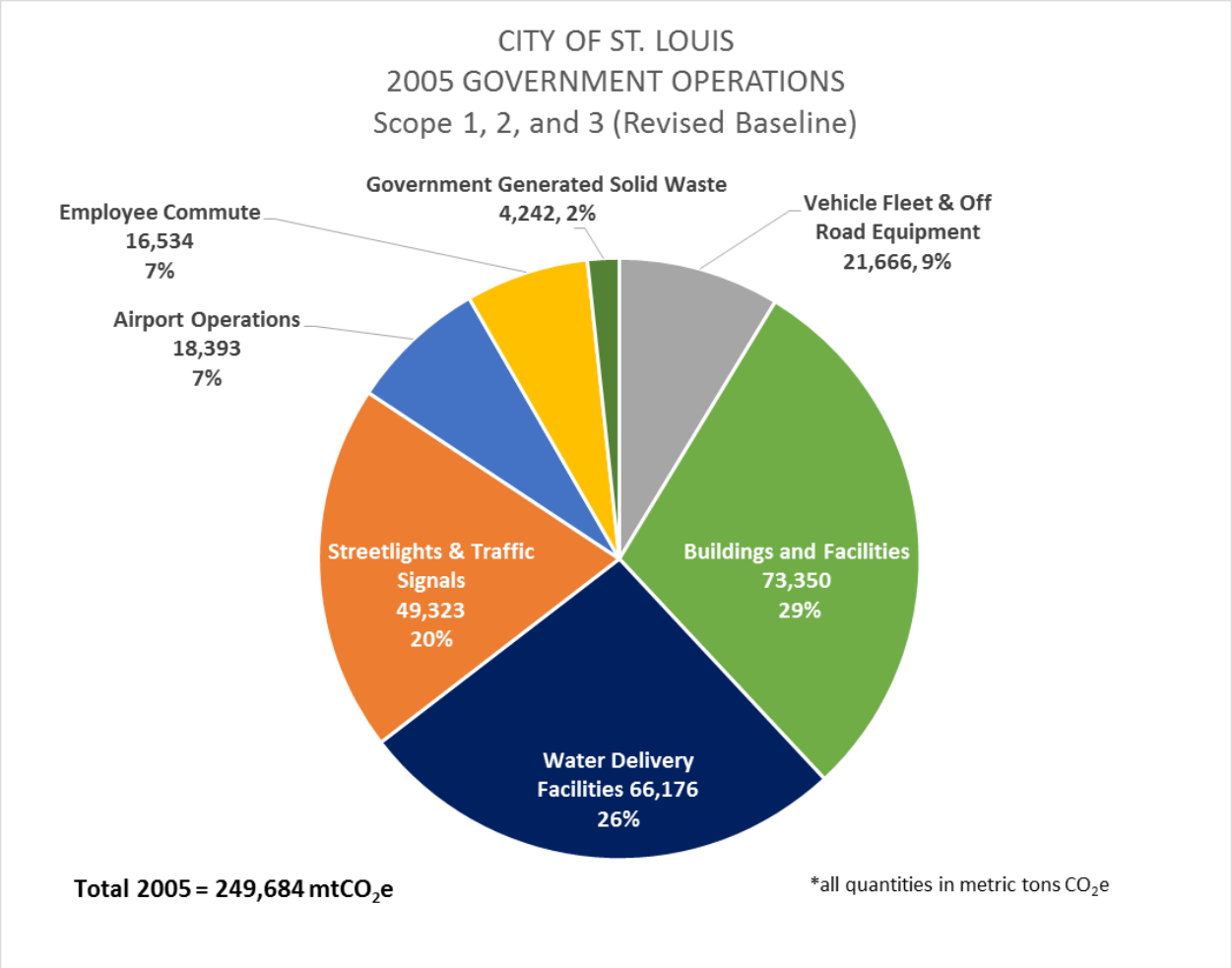
GOVERNMENT OPERATIONS EMISSIONS INVENTORY – CY 2005 BASELINE REVISION

In 2005, the GHG emissions originally calculated and reported for City Government Operations totaled 316,240 $mtCO_2e$. All A emissions were originally reported as belonging to "government operations", however, due to several leasing agreements with vendors, such as airlines and restaurants, only a portion of those emissions are now attributed to "government operations". The redistribution of the Airport emissions has resulted in a reduction in the emissions reported for City Government Operations. The revised baseline for 2005 has now been updated to 249,684 $mtCO_2e$.

Summary of Government Operations Emissions by Sector

City buildings, facilities and the City Water Division accounted for 56% of the GHG emissions, followed closely by public street lighting (traffic signals, street lights, and other types of lighting).

Figure 3: Revised Government Operations by Sector (2005)

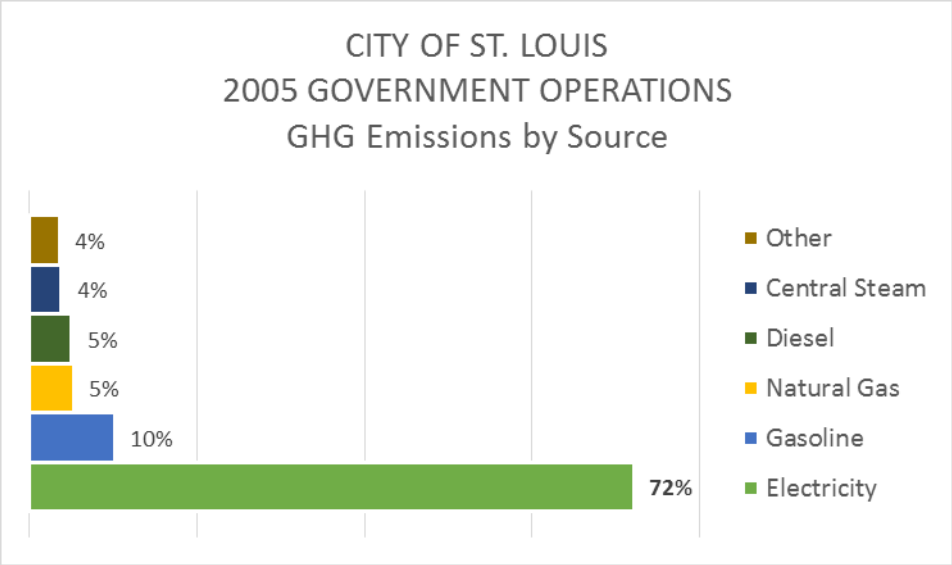


**Percentages may not total to 100% due to rounding*

Summary of Government Operations Emissions by Source

Figure 3 provides a summary of City government emissions by source. Electricity use dominates the City's emissions, accounting for about 72% of GHGs. Vehicle fuels (gasoline and diesel) together accounted for the second most emissions. Natural gas and diesel follow in third place.

Figure 4: Revised Government Operations Emissions by Source (2005)



PART II: GREENHOUSE GAS EMISSION INVENTORY REPORT – CY 2015

This section of the report describes an update to the City of St. Louis Greenhouse Gas Inventory for calendar year 2015.

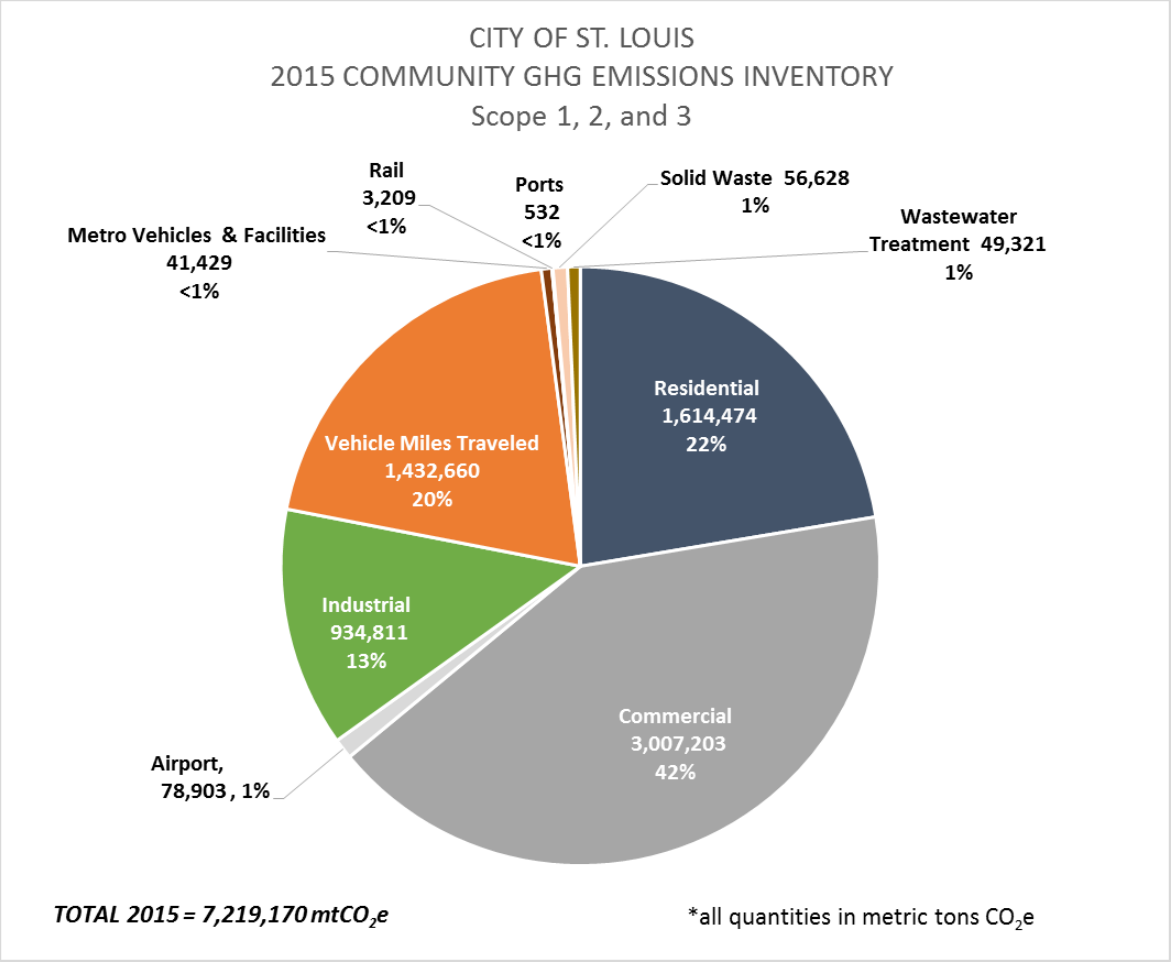
COMMUNITY EMISSIONS INVENTORY – CY 2015

In 2015, community GHG emissions for the City of St. Louis totaled 7,219,170 $mtCO_2e$, or 22.9 $mtCO_2e$ per person based on a population of 315,685 (United States Census Bureau, 2016). Scope 1 and 2 activities emitted 7,113,221 $mtCO_2e$ of GHGs; the remaining emissions from waste generation and wastewater treatment, or Scope 3 activities, generated an additional 105,949 $mtCO_2e$.

Summary of Community Emissions by Sector

Commercial buildings accounted for the largest percentage of emissions. All sectors related to buildings and facilities, i.e. Commercial, Residential and Industrial, combined account for 84% of emissions.

Figure 3: Community Emissions by Sector (2015)

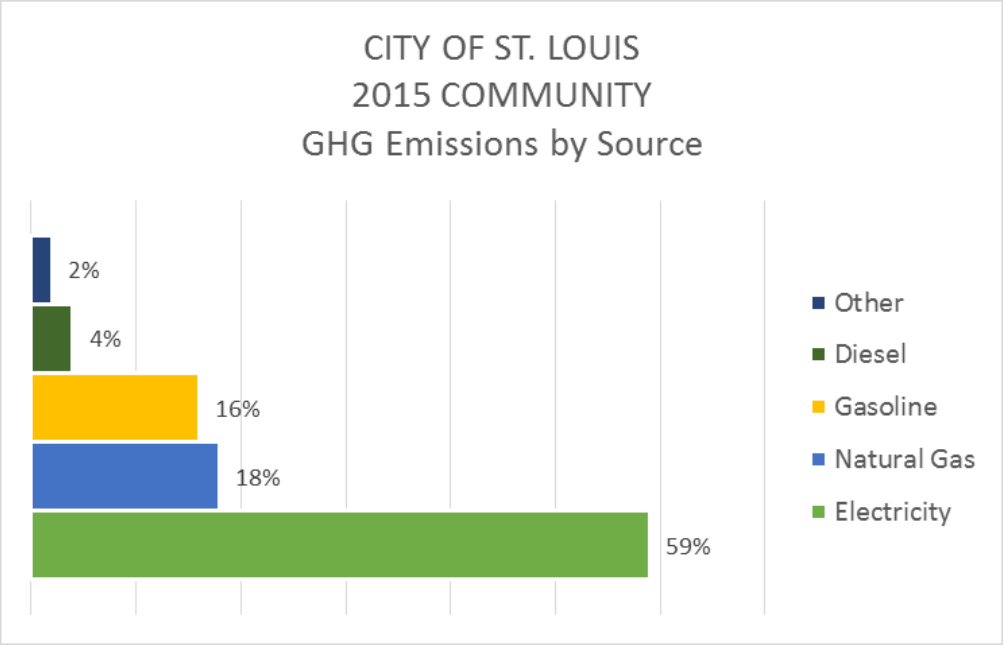


**Percentages may not total to 100% due to rounding*

Summary of Community Emissions by Source

Electricity accounted for 59% of GHG emissions in the City of St. Louis community, more than all other fuel sources combined. Next came natural gas, with 18%, which is about the same percentage as in 2005; and gasoline and diesel combined with 20%. Similar to 2005, all combined, they accounted for nearly all of the emissions.

Figure 4: Community Emissions by Source (2015)



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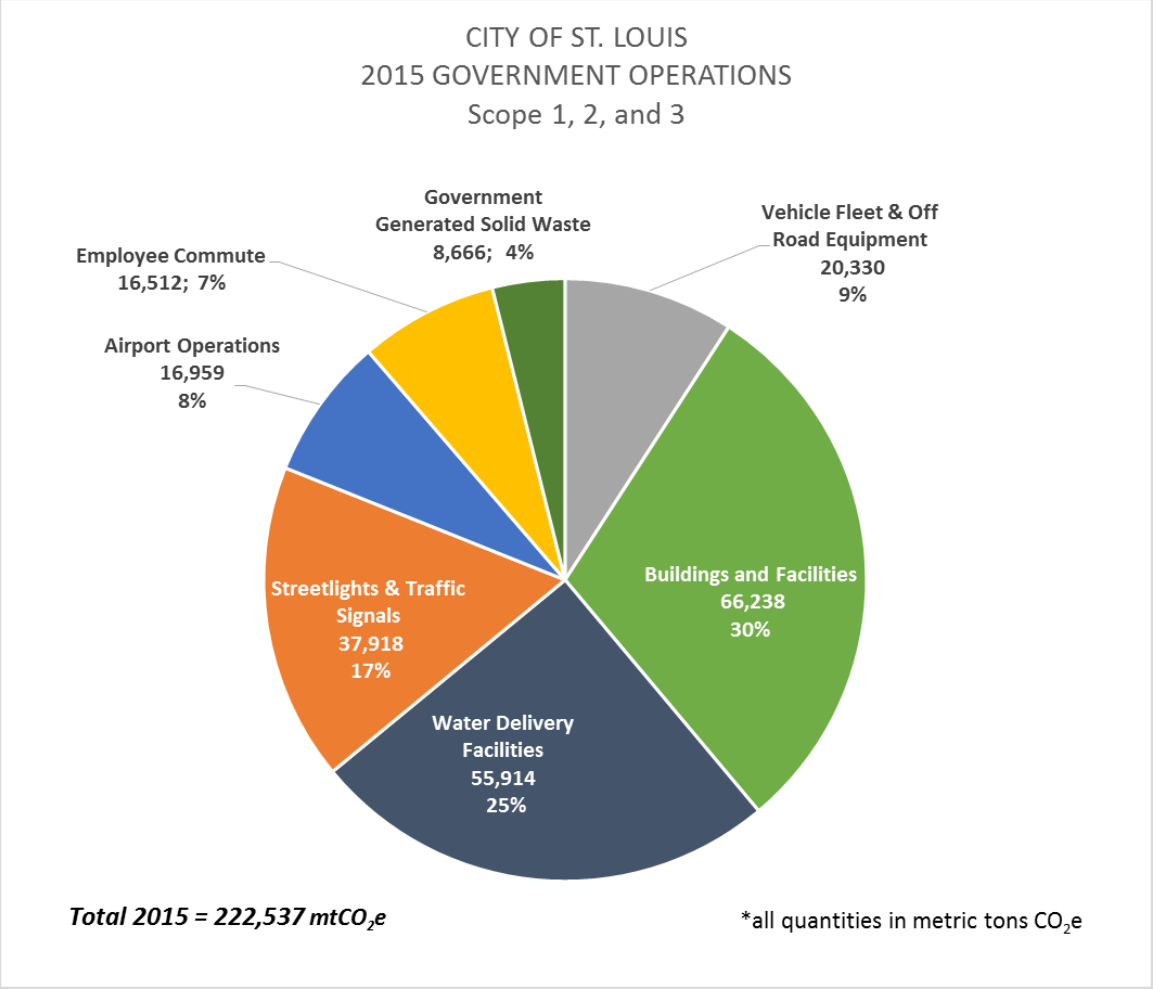
GOVERNMENT OPERATIONS EMISSIONS INVENTORY – CY 2015

During 2015, greenhouse gas emissions from government operations totaled 222,537 $mtCO_2e$. Scope 1 and 2 activities emitted 197,359 $mtCO_2e$ of GHG emissions. The remaining emissions, or Scope 3 activities consisting of employee commute and waste generation, created an additional 25,178 $mtCO_2e$. Overall emissions generated by government operations only account for 3% of the City's total Community emissions.

Summary of Government Operations Emissions by Sector

As in 2005, City buildings, facilities and the City Water Division accounted for the largest portion of GHG emissions at 55%, combined. Public street lighting (traffic signals, street lights, and other types of lighting) were responsible for 17% of government emissions.

Figure 5: Government Operations by Sector (2015)

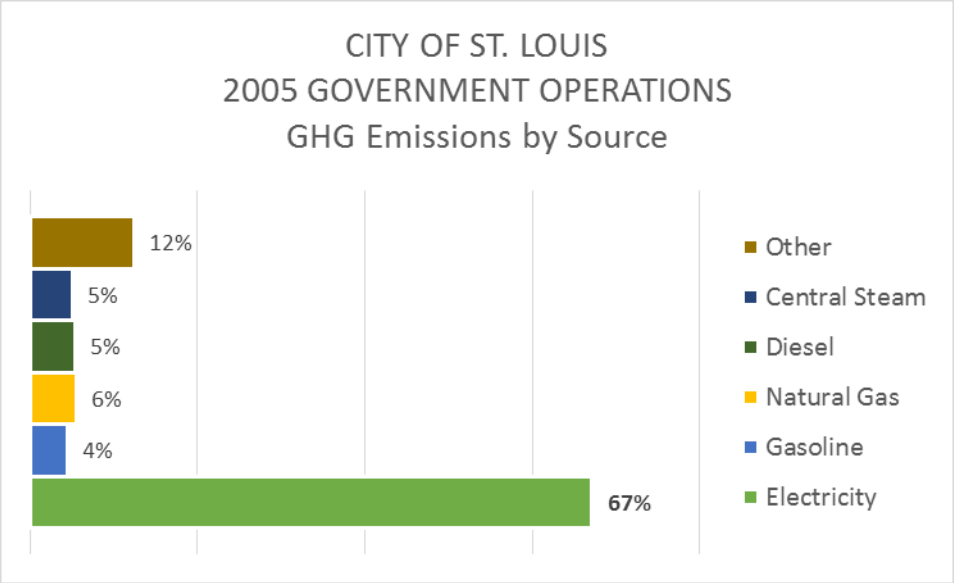


**Percentages may not total to 100% due to rounding*

Summary of Government Operations Emissions by Source

Electricity use dominated the City government's emissions in 2015, accounting for 68% of emissions, almost three times as much GHG emissions as all other sources combined, but less than the 72% accounted for in 2005. Natural gas was third, accounting for 7%, slightly higher than the 5% reported in 2005.

Figure 6: Government Operations Emissions by Source (2015)



**Percentages may not total to 100% due to rounding*

Part III: Comparison of Baseline Year 2005 to 2015 GHG Emissions

Between 2005 and 2015, total community GHG emissions decreased by 862,248 mtCO2e, or 11%, against an overall decrease in population of nearly 2.8%. The per capita emissions decreased from an average of 24.9 mtCO2e per capita to 22.9 mtCO2e per capita. Per capita emissions are an often used metric used for comparison, however, emissions are not solely the product of the residents of the City of St. Louis, but also the individuals working in the City's commercial and industrial businesses, and the resulting vehicle emissions from traveling throughout the City.

Table 2: Per Capita Emissions 2005 - 2015

Year	2005	2010	2013	2015
Population	324,945	319,294	318,496	315,685
per capita emissions Scope 1,2,3	**24.9**	**23.9**	**21.7**	**22.9**

The decreases in overall community emissions appear to have resulted largely from reductions in emissions from Vehicle Miles Traveled, responsible for 38% of the overall reductions in emissions, followed by commercial emissions (25%), residential emissions (33%) and industrial emissions (8%). There were also reductions in emissions from Metro, and the Airport, however these sectors represent a small portion of overall emissions. Increases in emissions resulting from ports, waste and wastewater were largely due to more accurate reporting process or updates in the guidance for completing inventories, but only represent a small portion of total emissions.

Despite the net decreases in emissions for the period between 2005 and 2015, GHG emissions increased 3% (301,244 mtCO2e) between 2013 and 2015. The sectors with the greatest increase in GHG emissions between these two years were vehicle miles traveled, commercial buildings, and industrial facilities; combined these sectors increased 280,306 mtCO2e. The reason for this increase is currently unclear, but is likely correlated to an uptick in commercial activity in the City.

Figure 7: Comparison of Community Sector Emissions from 2005 to 2015

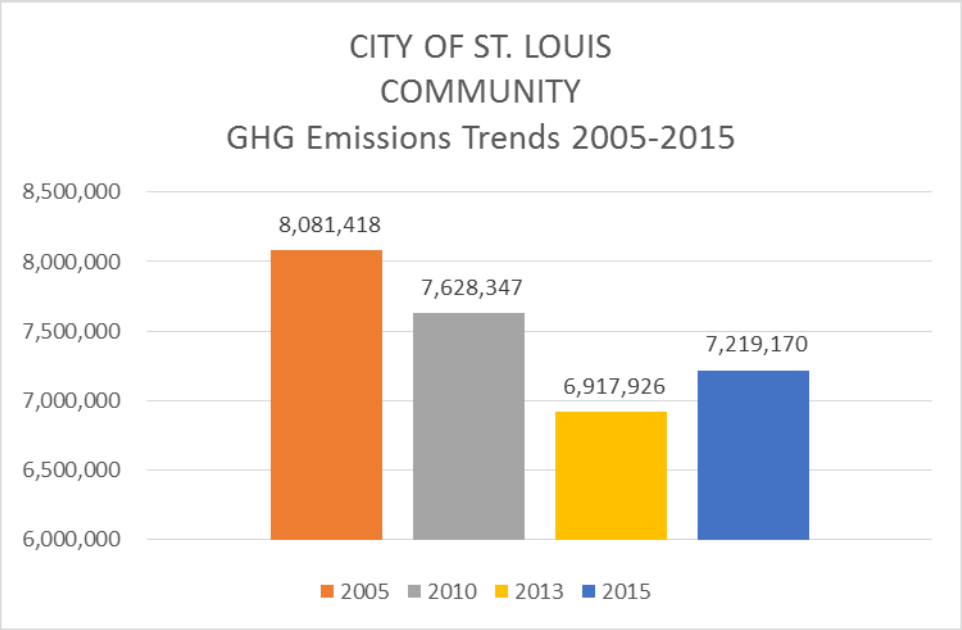
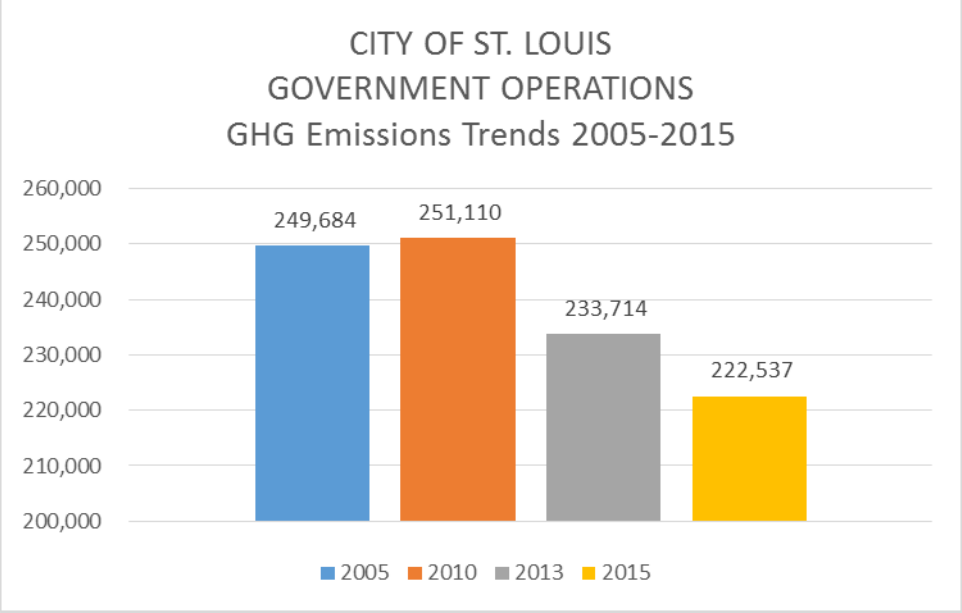


Figure 10: Comparison of Government Sector Emissions from 2005 to 2015



Part IV: Detailed 2015 Community Sector Analyses

Commercial Buildings and Facilities

In 2015, commercial building emissions were 3,007,203 $mtCO_2e$ or 42% of all GHGs emitted by the St. Louis community. A significant portion, approximately 34%, of all GHG emissions in the City of St. Louis came from electricity consumption in the commercial sector.

Commercial buildings and facilities use energy when operating systems, such as lighting and HVAC. In addition, activities occurring in commercial buildings often involve equipment that consumes energy, such as appliances, retail displays, and refrigeration equipment. Sometimes this equipment consumes as much or more energy than the basic building systems. Consequently, it is not unusual for commercial buildings to account for a significant portion of total GHG emissions. Eighty-two percent of commercial emissions (2,459,127 $mtCO_2e$) came from the consumption of electricity, while 15% (461,031 $mtCO_2e$) came from the consumption of natural gas. Less than 3% came from the consumption of distillate fuel oils, steam, kerosene and propane.

Airport

The Airport leases space to vendors and serves a community greater than the City of St. Louis, therefore its emissions are not completely under operational control of the City or Airport Authority. Total emissions generated from the Airport facility, vehicle fleet, and waste generation, however, do occur in the community and are accounted for in the community inventory. This is in accordance with the most current Local Government Operations Protocol and U.S. Community Protocol.

In 2015, total Airport emissions equaled 78,903 $mtCO_2e$. For reporting purposes, all Airport emissions were summed together. These emissions consisted of buildings and facilities (74,933 $mtCO_2e$), Airport fleet vehicles and transit vehicles (2,985 $mtCO_2e$), and waste generation (985 $mtCO_2e$). Emissions related to flights are not included in these totals.

Residential

Residential buildings cause GHG emissions primarily by consuming fossil fuel for HVAC and to operate household appliances and equipment. They account for a significant percentage of total community emissions, because households are so numerous.

In St. Louis in 2015, residential buildings emitted 1,614,474 $mtCO_2e$, or 22% of total community emissions. Seventy-one percent (1,138,910 $mtCO_2e$) of residential emissions derived from electrical consumption, and 29% (468,656 $mtCO_2e$) derived from consumption of natural gas. Small amounts of kerosene, propane, and fuel oil continue to be used for residential heating, but together they accounted for less than 1% of residential emissions.

Industrial

Industry was the fourth largest emitting sector with 934,811 $mtCO_2e$, or 13% of the community total. Sixty-two percent of industrial emissions (576,147 $mtCO_2e$) came from the consumption of electricity, while 36% (336,269 $mtCO_2e$) came from the consumption of natural gas, and less than 2% came from the consumption of distillate fuel oils, steam, kerosene and residual fuel oil.

Vehicle Miles Traveled

Vehicle Miles Traveled (VMT) primarily accounts for emissions from automobiles and trucks. Trips that originate or terminate in the City of St. Louis are included, however, not those that transit through the

City without stopping, primarily on the highways. Emissions generated by the Metro Transit system are accounted for separately, as are heavy rail traffic and operations at river ports.

According to East-West Gateway (EWG), the metropolitan planning agency for the greater St. Louis area, VMT accounted for 1,432,660 $mtCO_2e$ of GHG emissions in 2015, or 20% of total community emissions. EWG utilizes an online emissions modeling system provided by the Environmental Protection Agency, called Motor Vehicle Emission Simulator (MOVES). MOVES uses science-based algorithms that estimate emissions for mobile sources at the national, county, and project level for criteria air pollutants, greenhouse gases, and air toxics. MOVES provides a more accurate estimate than what would be possible from the ClearPath tool.

Metro Transit

Metro Transit (Bi-State Development Agency) operates the public bus, light rail, and "Call-A-Ride" systems in the St. Louis Metropolitan Area. Only facilities and operations in the City of St. Louis are considered in this inventory.

The Metro Transit system operations generated 41,429 $mtCO_2e$ in 2015, less than 1% of total community emissions. Fifty-seven percent of Metro's emissions were from the consumption of electricity. Forty percent were from the consumption of diesel fuel and less than one percent came from the consumption of gas.

Rail and Ports

The City of St. Louis is one of the nation's largest rail hubs, served by six Class 1 railroads and several local ones. Rail operations generate GHG emissions, primarily via the consumption of diesel fuel to operate locomotives. Emissions come from operations that originate or terminate in the City of St. Louis, as well as operations that transit through the City. Detailed emissions generating activity data is not readily available and was estimated using average ton-miles per gallon and data regarding tons of rail freight from the most recent St. Louis Freight Study (AECOM Technical Services, et al., 2013).

The Metropolitan Port of St. Louis is the third largest inland river port in the country, moving about 32 million tons of product annually by barge and tug. The regional port extends 70 miles along the Illinois and Missouri sides of the Mississippi River, and is operated by several different port authorities (stlcommercemagazine, 2011). The St. Louis Port Authority is one of them, running 19 miles along the Missouri side of the river along the boundary of the City of St. Louis. Although the City has a Port Authority, all ports are leased by the City, therefore the City does not hold operational control. Detailed emissions generating activity data is not readily available and was estimated using average ton-miles per gallon (Association of American Railroads, 2015) and data from the most recent St. Louis Freight Study regarding waterborne freight (AECOM Technical Services, et al., 2013).

Rail transportation generated 3,209 $mtCO_2e$ in 2015, and the port generated 532 $mtCO_2e$ within the City of St. Louis. Combined they represented less than 1% of total community emissions. Emissions from the Metro Transit light rail system are included in the Metro Transit section and not included in the rail section.

Solid Waste

Solid waste causes GHG emissions in several ways. Some GHG is emitted by trucks burning fossil fuel as they collect and transport waste to a landfill outside of the City limits. The City of St. Louis does not own

or operate a landfill. As organic compounds in the waste decay, methane is released, a powerful greenhouse gas. Local governments have some control and influence over the size and composition of the community waste stream, via reuse, recycling, and recovery policies. Emissions from solid waste are categorized as Scope 3 and have been estimated using standardized methodologies for mixed solid waste.

In 2015, the transport and decay of solid waste generated 56,628 $mtCO_2e$ of GHG emissions, less than one percent of total community emissions.

Wastewater Treatment

In the City of St. Louis, wastewater is collected and treated by the Metropolitan St. Louis Sewer District (MSD), a public agency not under the control of the City. MSD's collection area covers 525 square miles, encompassing all of the City of St. Louis and about 80% of St. Louis County. It serves a population of about 1.3 million people, a minority of which live in the City of St. Louis (Metropolitan St. Louis Sewer District, 2016). There are two primary treatment facilities that serve the City of St. Louis, one within the city limits and one located in south St. Louis County. MSD estimated the amount of waste processed for residents and businesses of the City of St. Louis at each facility. Only emissions specific to the City of St. Louis were considered in this inventory.

As wastewater is treated, it can release several GHGs. At MSD, the emissions are limited to small amounts of nitrous oxide, natural gas consumed in the treatment process, and the incineration of sludge. In 2015, wastewater treatment emissions attributable to the City of St. Louis totaled 49,321 $mtCO_2e$, less than 1% of total community GHG emissions.

Part V: Detailed 2015 Government Sector Analyses

By better understanding the relative scale of emissions from each sector of its operations, the City can more effectively focus emissions reductions strategies to achieve the greatest reductions.

Buildings and Other Facilities

The City operates over 180 buildings and facilities serving a variety of purposes. Through their use of energy for heating, cooling, lighting, and other equipment, they account for a significant portion of greenhouse gas emissions at 66,223 $mtCO_2e$ plus Airport facilities at 13,209 $mtCO_2e$. Seventy-three percent were from electrical consumption (57886 $mtCO_2e$), 10% came from the consumption of natural gas, and 10% came from the consumption of central steam heat. In addition, the chemicals used in fire suppression, air conditioning, and refrigeration equipment are very harmful GHGs. If the equipment leaks, the amount leaked can be small, but have significant effects. These are difficult to track with accuracy and only 162 $mtCO_2e$ was reported. It is recommended that additional information be made available for collection for facilities and for the fire department.

Airport Facilities and Operations

The Airport leases space to vendors and serves a community greater than the City of St. Louis, therefore its emissions are not completely under operational control of the city or Airport Authority. Airport emissions for 2015 have been distributed between those the Airport Authority has operational control over and those which they do not. For 2015, it was determined that 80% of the Airport office building energy usage is attributed to Airport vendors, 84% of the Airport terminal energy usage is attributed to vendors and public use, and 46% of the waste generation is attributed to the general public and vendors, not under the direct operational control of the Airport Authority. Only the emissions related to operations of the Airport, and under the control of the Airport Authority were accounted for within the government operations inventory.

Airport emissions associated with operations totaled 16,959 $mtCO_2e$ in 2015. For reporting purposes, all Airport emissions were summed together. These emissions consisted of electricity and natural gas use by buildings and facilities (13,209 $mtCO_2e$); fuel usage by airport fleet vehicles (1,472 $mtCO_2e$) and transit vehicles (1,528 $mtCO_2e$); fugitive emissions related to refrigerants (162 $mtCO_2e$); and waste generation (589 $mtCO_2e$).

Water Delivery Facilities

The City of St. Louis operates water delivery facilities that purify, distribute, and transport water used for potable water, sprinkler systems, and irrigation. As water delivery facilities are particularly large users of energy, and thus, large emitters of greenhouse gas, they are separated from other buildings and facilities for more specific examination.

The City of St. Louis Water Division maintains two water treatment plants that draw water from the area's two main rivers. The Chain of Rocks Plant is located on the Mississippi River about eleven miles north of the center of the City. The Howard Bend Treatment Facility is located in St. Louis County on the Missouri River, 37 miles above the confluence of the Missouri and Mississippi Rivers. Combined, these two plants have the capacity to treat and distribute 380 million gallons of water per day.

Water Delivery Facilities emissions of 55,914 $mtCO_2e$ in 2015, or 25% of total government emissions are attributed to electricity and natural gas use. Approximately 96% of emissions came from the consumption of electricity.

Street Lights, Traffic Signals, and Other Public Lighting

The City of St. Louis operates a range of public lighting, including traffic signals and streetlights. In 2015, GHG emissions from public lighting in the City were 37,918 $mtCO_2e$, about 17% of City government emissions. Emissions from this sector derive entirely from the consumption of electricity. The City recently replaced many lights with LEDs resulting in significant reductions since 2005.

Vehicle Fleet and Mobile Equipment

The City of St. Louis operates a fleet of on-road and off-road vehicles and equipment. In addition, the Metropolitan St. Louis Police also operate a fleet. This section does not include emissions attributable to the fleet operated by the Airport, or those attributable to public transportation. These are discussed in the Airport sections, and in the Community section for Metro Transit, respectively.

The City fleet emitted 20,330 $mtCO_2e$ or 9% of the City's emissions. Of this, 55% came from the consumption of diesel, 45% came from the combustion of gasoline, and less than 1% came from CNG.

Employee Commute

Many City employees use vehicles to commute to and from work. When vehicles burn fuel, greenhouse gases are released into the atmosphere. Although the individual employees maintain control over their personal commuting decisions, the City can opt to influence actions via incentives, commuting programs, and other policies. For this reason, emissions from this sector have been estimated in this inventory as Scope 3, but have been considered separately from the Scope 1 and 2 emissions.

No employee commute survey was performed for 2015. The employee survey data from 2011 was utilized for this report. A comprehensive employee commute survey is recommended for the next GHG emissions inventory update. Details regarding the prior survey can be found in the previous Greenhouse Gas Inventory Report on the City's website. Survey results from 2011 showed employees commuting to work were estimated to have emitted 16,512 $mtCO_2e$, or 7% of total government emissions. The methods by which this estimate could be constructed allowed for only a rough estimate of straight-line distances between origin and destination using zip codes, not actual road distance traveled. Data collected included information about personal vehicle year, make and model providing a means to develop fuel efficiency factors, and number of days per week traveling to work by personal vehicle, public transportation, biking or walking.

Government Generated Solid Waste

Local government operations produce solid waste, which cause GHG emissions in several ways. Some GHG emissions are emitted by the trucks that burn fossil fuel as they collect the waste. Some solid waste may be incinerated, releasing GHG. Most solid waste is landfilled. There, organic compounds in the waste decay, releasing methane, a powerful greenhouse gas. Local governments have some control over the size and composition of their waste stream, via reuse, recycling, and recovery policies. However, there are no operational landfills in the City and the landfills used by the City are not under the control of the City. For these reasons, emissions from solid waste have been estimated in this inventory based on the annual tons of waste generated.

Waste generated by the Airport is discussed in the Airport section of this report. All other City operations generated an estimated 8,666 $mtCO_2e$ of GHG emissions, about 4% of total emissions.

City of St Louis Greenhouse Gas Inventory – General Methodology

The City of St. Louis greenhouse gas emissions inventory was completed for both, the baseline year 2005 and 2015 emissions update, using local data sources whenever available for energy use, fuel consumption and waste generation. The government operations portion of the greenhouse gas emissions inventories follows the recommended or alternate methods outlined in the *Local Governments Operations Protocol* (LGOP) (ICLEI-Local Governments for Sustainability, 2010), which serves as a national standard for quantifying and reporting greenhouse emissions from local government operations. Operational control was utilized to define the government's organizational boundary, as opposed to financial control. This included autonomous departments with government-appointed board members. No similar standard to the LGOP was available for the community side of this inventory at the time the work was conducted for the 2005 inventory. Since that time, ICLEI has developed the *U.S. Community Protocol for Accounting and Reporting of GHG Emissions* (ICLEI-Local Governments for Sustainability USA, 2013) and collaborated with C-40 and the World Resources Institute to develop the *Global Protocol for Community-Scale Greenhouse Gas Inventories* (World Resources Institute; C40 Cities Climate Leadership Group; ICLEI-Local Governments for Sustainability;, 2014). For the purposes of this inventory, the Global Protocol was used as the primary guidance and the U.S. Community Protocol served as a supporting document by providing methodology for calculations.

For 2005, data was entered into ICLEI's emissions-calculating software, Clean Air-Climate Protection (2009) version 3.0 (CACP). CACP was the primary tool used by local governments in the United States to conduct greenhouse gas emissions inventories. ICLEI has since developed an online emissions management software suite called ClearPath. Data for 2015 was entered and calculated using ClearPath.

The Emissions and Generation Resource Integrated Database (eGRID), published by the U.S. Environmental Protection Agency is a globally recognized source of emissions data for the electric power generated in the United States. eGRID uniquely links air emissions with electricity generation (Environmental Protection Agency, 2016). 2012 eGRID data was used for the 2015 inventory as it was the most up-to-date available at the time of this inventory's completion. The 2005 inventory used 2005 data.

The Intergovernmental Panel on Climate Change (IPCC) is the international body for assessing the science related to climate change. The IPCC was set up in 1988 by the World Meteorological Organization (WMO) and United Nations Environment Programme (UNEP) to provide policymakers with regular assessments of the scientific basis of climate change, its impacts and future risks, and options for adaptation and mitigation. The IPCC periodically publishes Assessment Reports. These are published materials composed of the full scientific and technical assessment of climate change. Included in these reports are GWP for six primary greenhouse gases. The GWP provides a simple measure of the radiative effects of emissions of various greenhouse gases, integrated over a 100 year time horizon, relative to an equal mass of CO_2 emissions ($mtCO_2e$). The 2015 inventory used the GWP from the IPCC 4th Assessment Report (Solomon, et al., 2007). The 2005 inventory used slightly different factors based on the IPCC 2nd Assessment Report (Houghton, et al., 1995). Scientific estimates for GWP will continue to be evolve as more scientific research of the energy absorption rates and changing atmospheric conditions progress.

APPENDIX

2015 Community Emissions Inventory – Detailed Methodology

Residential, Commercial, and Industrial Sector Facilities

Energy consumption information for residential, commercial and industrial sectors within the City of St. Louis for 2015 was obtained primarily from the three major energy suppliers in the St. Louis area: Ameren Corporation, Laclede Gas Company, and Trigen-St. Louis Energy Corporation of Veolia North America.

Ameren Missouri is part of St. Louis-based Ameren Corporation, serving 64 counties across central and eastern Missouri. Ameren electricity is generated primarily through coal-fired power plants located outside of the city limits. Ameren provided annual electricity consumption data in kWh for residential, commercial and industrial sectors within the City limits of St. Louis. Electricity consumption proves to be a major greenhouse gas contributor for the City. Ameren's 2014 Integrated Resource Plan is a 20 year plan that supports cleaner energy which includes the expansion of renewable generation, retiring about one-third of the coal-fired generation, and converting two units to natural gas in 2016 (Ameren, 2014).

Laclede Gas Company is primarily a regulated natural gas distribution utility serving the St. Louis, MO area and several southeastern Missouri counties. Laclede provided natural gas consumption data in amount of therms for the residential, commercial and industrial consumers within the City limits, allowing for direct entry into ClearPath.

Trigen-St. Louis Energy Corporation district energy network produces and distributes steam to nearly 70 customers in downtown St. Louis, including some city government buildings, through 17 miles of steam pipes. The central plant also produces and sells up to 15 megawatts of cogenerated electricity on the Midwest Independent System Operator (MISO) market (Veolia North America, 2015). Trigen provided data for natural gas consumed while producing steam and some electricity through a combination of gas turbines and heat recovery boilers. Trigen meets the EPA's Mandatory Reporting Rule (MRR) requiring facilities producing in excess of 25,000 $mtCO_2e$ per year to disclose and report emissions data (Environmental Protection Agency, 2013). The emissions data reported to the EPA for 2015 was entered directly into ClearPath.

Energy consumption data for liquefied petroleum gas (LPG or propane), kerosene and fuel oils were not available to be collected directly and thus were estimated using ICLEI's recommended practices. Adjusted sales of LPG, kerosene, distillate fuel, and residual fuel by sector for the State of Missouri are reported by the U.S. Energy Information Administration (U.S. Energy Information Administration, 2015). The number of Missouri and City of St. Louis households using these fuels to is reported in the American Community Survey (United States Census Bureau, 2016).

To estimate the total amount of kerosene, distillate and residual fuel used by the residential sectors, total Missouri consumption was divided by the number of Missouri households using the fuel, to yield the average Missouri household consumption. The household average was then multiplied by the number of households in City of St. Louis using the fuel to yield the community total. The calculated total amount of each fuel consumed was entered into the ClearPath to calculate the associated GHG emissions.

To estimate the total amount of LPG, kerosene, distillate fuel, and residual fuel used by the industrial sector, the number of people employed in industrial occupations (within the City) were multiplied by the average rate of fuel consumption for industrial occupations for the state of Missouri. The same calculation was used to estimate the total amount of kerosene, distillate fuel, and residual fuel used by the commercial sector (within the City), only using commercial sector-related occupations and average fuel consumption rates.

Airport Facilities

First, an analysis of building, facilities, waste generation, and vehicle groups was completed by St. Louis Lambert International Airport. Given the Airport is serving the community, all emissions are reported under the community inventory. The 2005 inventory excluded Airport emissions from the community inventory and only reported them under the government operations inventory. For comparison purposes to future inventories, the 2005 baseline community GHG inventory was adjusted to include the Airport emissions. However, emissions from flights are not included in this inventory. Emissions data for flights would be more appropriate for a St. Louis "regional" GHG emissions inventory than a City inventory. The travel demands for flights provided by vendors of the Airport are driven by a widespread community, including several counties in Missouri and Illinois, not solely the City.

Emissions from theAirport facilities were determined based on electric (kWh) and natural gas (therms) consumption per meter or building, which were entered directly into ClearPath. Other emissions estimated by the addition of refrigerants, using the "simplified mass balance" alternate method as described in the LGOP by equation 6.6.2.1, was used for calculating refrigerant fugitive emissions and entered into ClearPath. Tons of solid waste generated by Airport operations were entered directly into ClearPath, using the current national average factor for100% mixed solid waste.

Vehicle Miles Traveled (VMT)

Emissions associated with vehicles on roadways within the City of St. Louis in 2015 were estimated by East-West Gateway Council of Governments, the metropolitan planning organization for the greater St. Louis area. The Environmental Protection Agency (EPA) tool, Motor Vehicle Emission Simulator (MOVES) (Environmental Protection Agency, 2015), was utilized by East-West Gateway, per the recommendation by the ICLEI Community protocol. The 2005 inventory used an estimated figure of vehicle miles traveled (VMT) provided by provided by the Missouri Department of Transportation's Planning division's 2005 report, "Daily VMT by County by Functional Class". VMT was entered directly into CACP, applying a vehicle mix based on national averages built into the CACP software.

Public transit provider, Bi-State Development Agency dba Metro Transit (Metrolink, Metrobus, and Call-A-Ride), provided total gasoline and diesel use for 2015 for all vans and buses, and electric for rail and other facilities. Metro estimated 65% of their total gasoline consumption occurred in the City, as well as 50% of diesel fuel for transit buses and 26% of diesel fuel for transit vans occurred in the City. Fuel amounts were entered directly into ClearPath to calculate emissions.

Solid Waste

Emissions from waste are an estimate of methane generation that will result from the anaerobic decomposition of all organic waste sent to landfill in the year 2015. It is important to note that emissions are generated over long periods of time from the activity that caused them. Attributing all future emissions to the year in which the waste was generated incorporates all emissions from actions taken during the inventory year into that year's greenhouse gas release. This facilitates comparisons of

the impacts of actions taken between inventory years and simplifies the analysis of the impact of actions taken to reduce waste generation or divert it from landfills.

The characterization of the waste stream for 2015 was based on a national average of 100% mixed solid waste, which was provided as an option in ClearPath. The Streets Department Deputy Refuse Commissioner provided the tons of waste sent to landfills and the amount recycled for the City in 2015. The ClearPath calculator computed downstream landfill emissions from 100% mixed solid waste generated by the community. The calculations proceed according to Equation SW.4.1 of the Community Protocol.

The City of St. Louis does not maintain an active landfill, otherwise landfill emissions that occur within the City limits during the inventory year would also be reported. All solid waste is transported from a transfer station in the City to a landfill 50 miles away in Marissa, IL. Prior inventories did not include emissions generated by transportation of the waste from the City, however, this has been included in the 2015 inventory. Transportation of waste during the year resulted in an additional 1,208 $mtCO_2e$ emissions.

Wastewater

Metropolitan St. Louis Sewer District (MSD) has two primary wastewater treatment facilities, Bissell and Lemay. Bissell is located within the City limits, so regardless of the origination, all wastewater and resulting GHG emissions generated at Bissell are accounted for in the inventory. Additionally, a portion of wastewater generated within the city is treated at the Lemay plant in St. Louis County. MSD estimated the proportion of City wastewater processed by the Lemay plant and it has been included in this inventory. Prior inventories only included emissions for the proportion of wastewater generated within the City and treated at either plant.

For the 2015 inventory, MSD provided the average daily amount of nitrogen in treated effluent discharged from the Bissell wastewater treatment plant (the nitrogen load), and for the proportion of nitrogen in treated effluent for the Lemay plant. The ClearPath calculator calculated N_2O emissions from effluent discharged to rivers and estuaries according to Method WW.12 of the Community Protocol.

The Community Protocol recommends the reporting of other emissions generating data that applies to the wastewater treatment process. Due to no formal protocol for the community inventory in the past, prior inventories only reported N_2O emissions. For the 2015 inventory, metric tons of sludge for incineration, as well as energy consumption, were provided as emissions generating activities.

The amount of sludge incinerated within the City at the Bissell plant, as well as the estimated amount of sludge generated by the City but incinerated at the Lemay plant was provided by MSD. The ClearPath calculator computed stationary N_2O emissions from the combustion of sludges produced by treatment plant processes according to Equations WW.4 and WW.5 of the Community Protocol for CH4 and N_2O, respectively.

Natural gas and electricity consumption were also provided by MSD for the Bissell plant, but these amounts are treated “as information only” to avoid double-counting of emissions within the City of St. Louis. Emissions from natural gas and electricity consumption have already been accounted for under the industrial sector. However, for the Lemay plant located in St. Louis County, emissions

generated by natural gas consumption (for purposes of incinerating sludge generated by the City only) have been accounted for. The ClearPath calculator computes emissions from natural gas consumption according to Community Protocol Method WW.15 for energy used in the wastewater treatment process.

Ports

Although St. Louis has a Port Authority, all ports are leased out. The city does not hold day-to-day operational control of the ports. Freight and fuel use is not readily available from the Port Authority or other sources. Due to the lack of available data, emissions had to be estimated. The tons of waterborne freight reported for 2010, as taken from the most recent St. Louis Regional Freight Study (AECOM Technical Services, Inc, et al., 2013), was used to help estimate emissions. The tons of freight were divided by the average ton-miles per gallon of fuel (Center for Ports and Waterways Texas Transportation Institute, 2012) for a barge to estimate the gallons of diesel fuel. The gallons of fuel were entered directly into ClearPath. The Community Protocol preferred method involves colleting detailed information about the shipping vessels, maximum power rating, hours of operations and tons of freight. The U.S Army Corp of Engineers collects some of this data, but it was not readily available at the time of this report. Following protocol TR.7.A is recommended for future inventories.

Rail

Data from the St. Louis Regional Freight Study was the most recently available citing tons of rail freight associated with the City of St. Louis in 2010 (AECOM Technical Services, Inc, et al., 2013). The tons of freight were divided by the average ton-miles per gallon of fuel to determine the estimated gallons of distillate fuel oil consumption by heavy rail within the City. The gallons of fuel were entered directly into ClearPath. This is a more accurate method of determining emissions than was used in prior inventories and has resulted in higher emissions than previously reported.

Tons of rail freight were not available for the 2005 inventory. Prior inventories estimated the total amount of fuel used within the City by dividing the total fuel consumption by miles of rail for the state of Missouri, then multiplying average fuel use per mile by the number of rail miles (70.79 miles) within the City of
St. Louis. The amount of fuel was then entered into CACP.

Airport Facilities and Operations

First, an analysis of building and facilities, waste generation and vehicle fleets was completed by St. Louis Lambert International Airport to determine what percentage would be considered to be under direct operational control of the Airport. A consultant was hired by the Airport to assist with this process and with assembling data appropriate for the GHG emissions inventory.

Prior inventories included all Airport emissions under government operations. For comparison purposes, the 2005 baseline GHG inventory has been adjusted by applying the appropriate percentages of facilities, etc. under government operational control vs. what is not under direct control of the Airport.

Table 3. Airport Operational Control

2015 AIRPORT OPERATIONAL CONTROL

AIRPORT TERMINAL		
	Government Operations	16%
AIRPORT OFFICE BUILDINGS & FACILITIES		
	Government Operations	20%
WASTE GENERATION		
	Government Operations	54%
VEHICLE FLEET		
	Government Operations	100%
TRANSIT FLEET		
	Government Operations	100%
PROCESS AND FUGITIVE RELEASES		
	Government Operations	100%

The facilities and waste generation not under the Airport's operational control, in most cases being under the control of vendors of the Airport, were not included in the inventory for government operations, but were included in the community inventory. Emissions from the Airport facilities were determined based on electric (kWh) and natural gas (therms) consumption per meter or building, which were entered directly into ClearPath. Other emissions estimated by the addition of refrigerants, using the "simplified mass balance" alternate method as described in the LGOP by equation 6.6.2.1, was used for calculating refrigerant fugitive emissions and entered into ClearPath. Tons of solid waste generated by Airport operations was entered directly into ClearPath, using a national average factor for 100% mixed solid waste available in ClearPath .

Emissions from Airport vehicles and off-road equipment were determined based on direct measurement of fuel use primarily from fuel card purchases of gasoline, B-20 bio-diesel and compressed natural gas (CNG). The gallons of fuel were associated with vehicle types when entered into ClearPath to better determine emissions based not only on the fuel, but the efficiency of the vehicle type.

Buildings and Facilities

Emissions from City government buildings and facilities were determined based on monthly billing records for each meter or building. Units provided for electricity (kWh) and natural gas (therms) allowed for direct entry into ClearPath.

Trigen invoices for steam heat provided thousand pounds condensate (mlbs) and had to be converted to MBtus to allow for emissions calculations. The total amount of mlbs condensate for district steam send-out for the community were divided by the equivalent amount of MBtus to determine a factor. This factor was then multiplied by the mlbs condensate reported on monthly invoices to determine the MBtus for each government building using steam heat. Next, emissions data reported by Trigen for community-wide steam generation under the MRR within the EPA FLIGHT Tool (Environmental Protection Agency, 2013) was used to derive emissions factors for CO_2, CH4, and N_2O emissions. These factors were then multiplied by the MBtus for each building to derive the emissions.

No refrigerants were reported or estimated for government buildings. Minimal data for previous inventories was accounted for and included with the emissions associated with the building energy consumption. Although emissions generated by refrigerants are minimal, it is recommended this be collected and reported in future inventories.

Water Delivery Facilities

Emissions from water delivery facilities were determined based on electric (kWh) and natural gas (therms) consumption per facility which were entered directly into ClearPath. No refrigerants were reported or estimated.

Streetlights

Emissions from City public lighting, including traffic signals and street lights, were determined based on a summary report by month in kWh from the electric utility, Ameren, for public lighting. The total kWh were entered into ClearPath as no divisions were made between lighting types.

Vehicle Fleet and Mobile Equipment

Emissions from City vehicles and off-road equipment were determined based on direct measurement of fuel use primarily from fuel card purchases of gasoline, diesel and compressed natural gas (CNG). The gallons of fuel were associated with vehicle types when entered into ClearPath to better determine emissions based not only on the fuel, but the efficiency of the vehicle type. Airport vehicles were included in the section for Airport facilities and operations.

Government Generated Solid Waste

The Streets Department Deputy Refuse Commissioner provided the tons of waste sent to landfills and the amount recycled for the City government for the fiscal year of 2015. The characterization of the waste stream sent to landfill was based on based on a national average of 100% mixed solid waste provided as an option in the ClearPath calculator.

Recycling programs are reflected in the emissions calculations as reduced total tonnage of waste going to landfills. The model, however, does not capture the upstream emissions from production-related energy use associated with the transformation of recycled materials as part of the inventory.

Employee Commute

The methodology for estimating the employee commute emissions portion of the inventory is based solely on estimated vehicles miles traveled based on estimated miles between employees' work and home zip codes. This information was developed primarily through an online City Employee Commute Survey developed specifically for the purposes of this inventory and conducted in April and May of 2011, and no new survey was completed for the 2015 inventory. Details regarding the survey can be found in the previous Greenhouse Gas Inventory Report on the City's website[3]. Survey results from 2011 showed employees commuting to work were estimated to have emitted 16,512 $mtCO_2e$, or 7% of total government emissions. The methods by which this estimate could be constructed allowed for only a rough estimate of straight-line distances between origin and destination using zip codes, not actual road distance traveled. Data collected included information about personal vehicle year, make and model providing a means to develop fuel efficiency factors, and number of days per week traveling to work by personal vehicle, public transportation, biking or walking.

[3] https://www.stlouis-mo.gov/government/departments/mayor/initiatives/sustainability/documents/index.cfm

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