Introduction

Columbia City Council reaffirmed Columbia's commitment to take action to reduce climate pollution (Resolution 83-17A) on June 19, 2017. The first step in establishing reduction targets is to complete a greenhouse gas emissions inventory with a breakdown of emissions for buildings and transport sectors. This data is made available to the public in order to assist informed decision-making to determine immediate and future actions to be taken by the community. These emissions-reducing actions will be included in Columbia's first Climate Action and Adaptation Plan.

Gases that trap heat in the atmosphere are called greenhouse gases (GHG). In the United States, GHG emissions caused by human activities increased by 7 percent from 1990 to 2014. Carbon dioxide accounts for most of the nation's emissions and most of the increase since 1990. Electricity generation is the largest source of GHG emissions in the United States, followed by transportation. In Columbia, emissions per person have decreased slightly in the last few years as population has increased.

The increase in GHGs in the atmosphere can lead to an increase in the number and the intensity of extreme weather events and the degradation of our air quality. Extreme weather events, like torrential rains, contribute to flooding and can destroy homes and infrastructure. Studies estimating economic damage from climate change in the United States show combined values of market and nonmarket damage across sectors – agriculture, crime, energy, human mortality, and labor – to increase as global mean temperature increases. Communities across America are learning that smart investments provide a healthier environment, attract new business, create jobs, and build stronger communities. Columbia is taking action to both understand and reduce its contribution to increasing GHG emissions into the air.

Methods

The methodology used for the 2015 greenhouse gas inventory was the U.S. Community Protocol for Accounting and Reporting Greenhouse Gas Emissions. It is widely used by municipalities in over seventy countries. ICLEI ClearPath is the software used for the emissions inventory calculations.

Greenhouse gas emissions are grouped by five sectors: residential, commercial and industrial energy use, transport, and waste emissions. The report calculates carbon dioxide equivalent (CO2e) emissions from electricity production and natural gas consumption, transportation, and the Columbia Sanitary Landfill and wastewater treatment plant.

For this report, GHG emissions generated in the community were totaled by calculating emissions of carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O) from data on energy use and waste generation. CH4 and N2O were converted to CO2 equivalent (CO2e) global warming potential (GWP) units developed by the Intergovernmental Panel on Climate Change (IPCC). The total units of CO2e then

represent the sum total of all greenhouse gases multiplied by their corresponding global warming potential factor. The protocol does not calculate the hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF6), or other GHGs in the community analysis. All gases are reported in the standard GHG units of metric tons (tonnes) CO2e. One metric tonne is equal to 2,205 U.S. pounds.

This inventory is for Scope 1 and Scope 2 emissions associated with Columbia. Scope 1 refers to emissions produced within the city limits and released into the community atmosphere. This includes combustion of all fossil fuels such as gasoline, diesel, natural gas, coal, propane and any other fuel producing greenhouse gases within the city limits. Methane produced from landfill waste and wastewater treatment is also included in Scope 1. Scope 2 emissions include greenhouse gas emissions that occur as a consequence of using grid-supplied electricity, which occur due to usage within the city, but the emissions occur outside the city limits. This report does not address Scope 3 emissions, which refers to all other greenhouse gas emissions that occur outside of the city as a result of activities that take place within city limits. An example of Scope 3 emissions would be production of goods used or consumed within the city. These scope distinctions help to avoid double counting between communities and to clarify where emissions are generated.

2015 Community GHG Emissions results

*Activities by residents, visitors, and workers in Columbia resulted in the emission of **2,421,399 metric tons of CO2e in 2015**.*

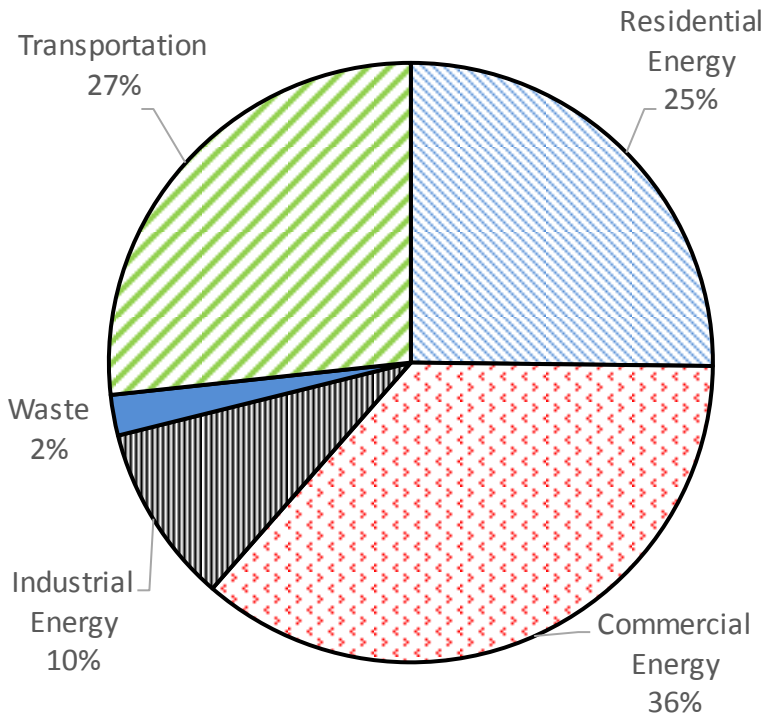

Figure 1: Emissions by Sector

Overview of emission sources

In 2015, seventy-one percent of our community emissions are a result of energy used to cool, heat, light and power our homes, offices, and industrial facilities. Emissions from transportation account for 27%. Emissions associated with solid waste and wastewater makes up the remaining 2%. Community emissions increased 2.6% from 2010. There was a decrease in the emissions associated with energy from 2010 (14K mtCO2e decrease). Waste and transportation emissions increased (77K mtCO2e, combined).

Energy

Energy emissions are the emissions created by the production of electricity and the consumption of natural gas. To calculate CO2e emissions from electricity the energy production, energy usage by sector, and power purchase information were collected from the three utilities that provide electric power to the City: Columbia Water and Light, University of Missouri Columbia (UMC) Power Plant, and Boone County Electric Cooperative.

Each of the three utilities purchases power from multiple sources, including various power production facilities or power control areas (PCA). Precise emission coefficients for each power production facility and PCA were obtained from the Environmental Protection Agency's Emissions & Generation Resource Integrated Database (eGRID). The eGRID provided emission coefficients in "tons of carbon dioxide equivalent per megawatt hour," or CO2e/mWh, from each plant.

Sector	Emissions (mtCO2e)
Energy Sector	**1,721,277**
Subtotal Natural gas	192,435
Subtotal Electricity	1,528,222
Residential Energy	**609,733**
*Natural Gas	97,595
Electricity	512,138
Commercial Energy	**877,303**
*Natural Gas	72,569
Electricity	804,794
Industrial Energy	**234,241**
*Natural Gas	22,271
Electricity	211,290
Waste	**53,071**
Wastewater	**5,850**
Solid Waste	**47,222**
Transportation	**647,051**
Aggregate Emissions	**2,421,399**

Table 1: 2015 mtCO2e by Sector

The energy Columbia consumed (in mWh) from each power provider and power supplier was multiplied by the specific emissions coefficient to calculate annual emissions in metric tons. The three utility totals were divided into residential, commercial, and industrial sectors using the usage percentages provided by each utility. The usages for each emissions sector were also summed. It should be noted that ICLEI considers universities to be commercial, hence emissions from the UMC Power Plant are attributed entirely to the commercial sector. Government emissions are also considered commercial. Electricity production emissions were calculated in the same way in 2000, 2005, and 2010 inventories.

Data for natural gas sales (in therms) to residential, commercial, and industrial sectors in Columbia were collected from Ameren UE, the city's sole provider. Aggregate emissions

by sector were calculated by summing electricity production emissions and natural gas consumption emissions for each sector. For results, see Table 1.

Solid Waste

The 2015 solid waste emissions were reported in MTCO2e using data for the Columbia Sanitary Landfill contained in the EPA Large Facility Greenhouse Gas Database. Biogenic CO2 was excluded at the recommendation of ICLEI.

Wastewater

This inventory calculates emissions from each stage of treatment: primary treatment, anaerobic digestion, and treatment pond/effluent release.

Transportation

Transportation emissions are defined as emissions from combustion of fossil fuels, biodiesel, and ethanol by internal combustion engines within the City of Columbia. As with previous inventories, the 2015 inventory represents only automobile traffic because it represents the primary mode of travel within the City, because vehicle miles traveled (VMT) is the only available reliable information.

The U.S. Department of Transportation Office of Highway Policy Information publishes an annual statistics series that contains daily VMT traveled in many urbanized areas of the U.S. Table HM-71 from Highway Statistics 2015 was obtained directly from the Department of Transportation, which also provided data for previous Columbia's greenhouse gas inventories. Daily VMT was multiplied by 365 to calculate yearly VMT. Yearly VMT was input to ClearPath, which gave emissions in MTCO2e.

2000-2015 Community GHG Emissions Comparisons

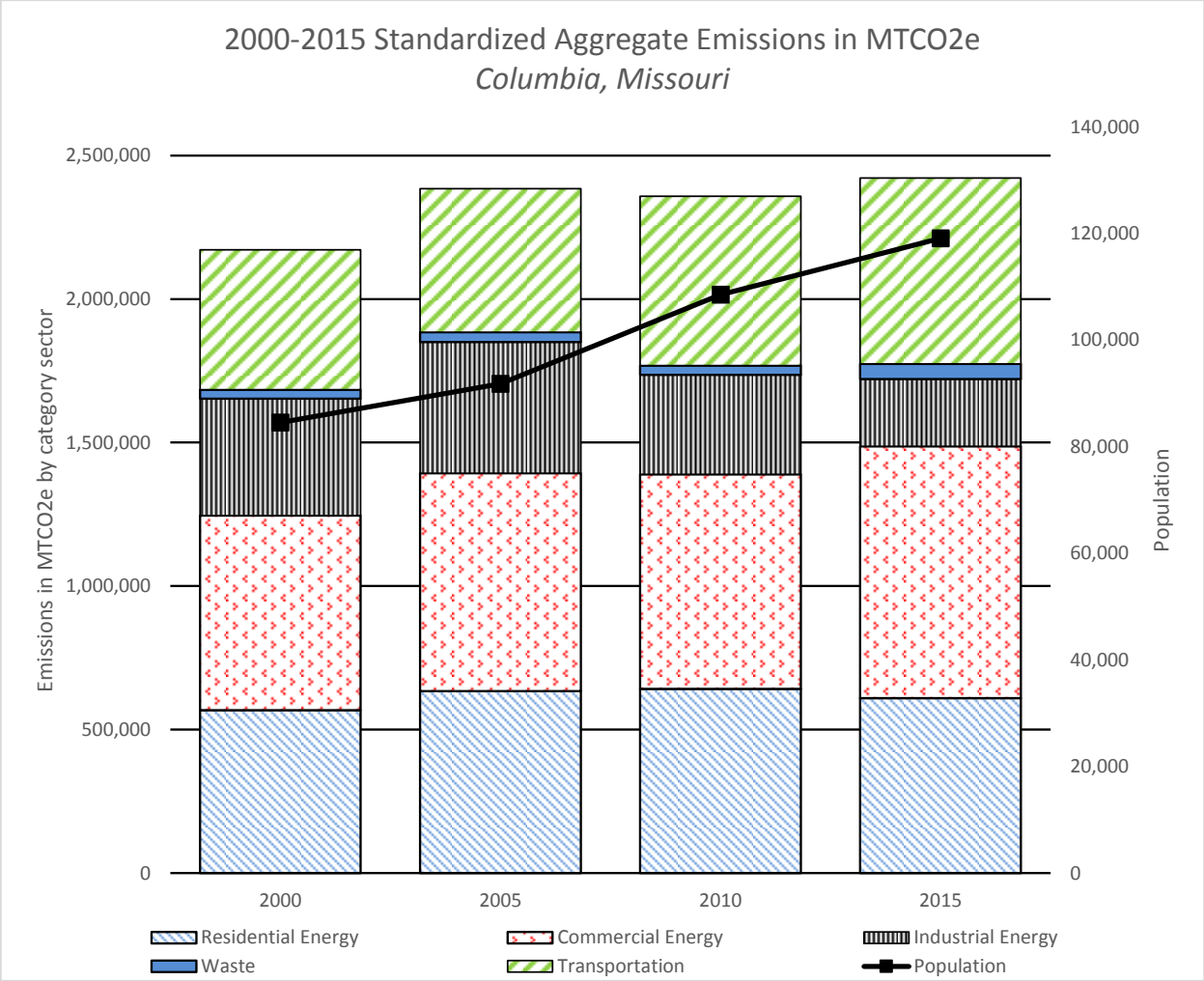

Figure 2: 2000-2015 Standardized Aggregate Emissions in mtCO2e

From 2000 - 2015, community emissions have increased 12%. There was a decrease in the emissions associated with energy from 2010 (14K mtCO2e decrease), as a result of cleaner energy in the portfolio.

Conclusion

The first step in establishing reduction targets is to complete a greenhouse gas emissions inventory with a breakdown of emissions for buildings and transport sectors. The data included in this report will assist informed decision-making to determine immediate and future actions to be taken by the community. These emissions-reducing actions will be included in Columbia's first Climate Action and Adaptation Plan. In order to meet carbon reduction goals, Columbia will need to make smart investments in clean energy.