City of Binghamton

Greenhouse Gas Inventory Report

For Baseline Year
- 2006 -

City of Binghamton
Restoring The Pride

ICLEI
Local Governments for Sustainability

Mayor Matthew T. Ryan

MISSION STATEMENT

To excel at progressive governance based on participatory democracy, transparency, sustainable development, and innovative management. Our ideas and our actions will embody and affirm justice, equity, diversity, inclusion and fairness.

VISION STATEMENT

The City of Binghamton under the Ryan administration will be a vibrant community of healthy neighborhoods that honor tradition, welcome diversity and provide a sense of security for citizens of all ages and walks of life. There will be opportunities for work that is valued and fairly compensated. The city will maintain and upgrade infrastructure that supports sustainable, integrated development. The government will be responsive to an informed citizenry actively engaged in deliberating ideas and establishing priorities.

"The City of Binghamton's maxim should be this: moving toward sustainability is an opportunity for growth and prosperity."

~The City of Binghamton's Commission on Sustainable Development and Smart Growth, 2009

Inventory for Baseline Year 2006

Completed 2010

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With Support From: ICLEI– Local Governments for Sustainability

Cover picture: Downtown at Night (From Observation Lounge of State Office Building) . Photo taken by Laura Roth of Washington, DC. Picture available online at: http://en.wikipedia.org/wiki/File:Downtown_Binghamton_at_Night.jpg

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I. Introduction

Try as we might to see humans as separate from our environment, history has clearly demonstrated that humans are not only subject to the laws of nature but that the health and prosperity of our species is undeniably linked to the state of our environment. When we release pollutants into the environment, we contaminate our food and water and, in the end, our own bodies. When we remove trees from our hillsides or fill in wetlands, we experience floods that damage our homes and businesses. When humans disturb the balance of nature, we are not immune to the quakes that follow.

Climate change is a prime example of how human activities that disrupt the environment can result in negative consequences for our species. While global warming might cause the current mix of species on the planet to change, deserts to grow, and coastlines to shrink, the planet will ultimately survive and reach a new equilibrium. However, climate change will likely result in immeasurable economic costs as well as significant impacts on the quality of life for humans across the world. The issue of global warming, therefore, should be of concern to anyone who wishes to provide a safe, secure, and prosperous future for the generations that will come after us.

A. Global Warming 101[1]

The Greenhouse Effect

The climate we enjoy on Earth is made possible due to a delicate balance of naturally occurring gases that trap some of the Sun's heat near the Earth's surface. This naturally-caused greenhouse effect is what keeps the Earth's temperature stable at an average of approximately 60°F—warm enough to support life as we know it. Without this natural greenhouse effect, our planet's average temperature would not be warm enough to sustain life.

Global Warming: The Enhanced Greenhouse Effect

The problem we now face is that human actions have disturbed this natural balance by producing additional large amounts of some of these greenhouse gases (GHGs), and these gases are warming the climate. The two greenhouse gases of most concern to local governments are carbon dioxide, or CO_2, and methane.

[1] This section is excerpted from ICLEI-Local Governments for Sustainability's *Cities for Climate Protection Milestone Guide,* which is available to members only on http://www.icleiusa.org.

I. Introduction

Emissions of CO_2 are produced whenever fossil fuels—such as oil, natural gas, gasoline, diesel fuel, and coal—are burned to produce electricity, heat buildings or power vehicles. Through our daily energy-using activities, we are increasing the amount of CO_2 in the atmosphere and magnifying the natural greenhouse effect. The net effect of this increased atmospheric concentration of CO_2 and other GHGs is to trap more of the Sun's heat, causing the Earth's average temperature to rise—the phenomenon known as global warming.

Methane is the second most important greenhouse gas resulting from human activities. Methane, or CH_4, is a byproduct of organic waste and sewage decomposition. In urban areas, methane gas is produced as organic waste (i.e. paper, yard trimmings, wood, and food waste decompose) in landfills. Sewage treatment plants are also a significant urban source of methane. In terms of its greenhouse effect, methane is 21 times more powerful per unit of carbon than CO_2.

There is scientific consensus that global warming is occurring and that humans are the primary cause. Pre-industrial levels of carbon dioxide (CO_2) were 270 to 280 parts per million (ppm) in the atmosphere. Today, the level of CO_2 in the atmosphere is about 368 ppm—about 30% higher.[2] Scientists participating in the British Antarctic Survey have succeeded in charting the atmospheric concentration of carbon dioxide over the last 800,000 years. Their research has shown that temperature unfailingly rises and falls in response to carbon dioxide levels.

CO_2 levels are higher now than they have been in the past 650,000 years. According to NASA scientists, the 1990s were the warmest decade of the century, and the first decade of the 21st century is well on track to be another record-breaker. The years 2002, 2003, 2004, 2005, and 2006, along with 1998, were the warmest six years since the 1890s, with 2006 being

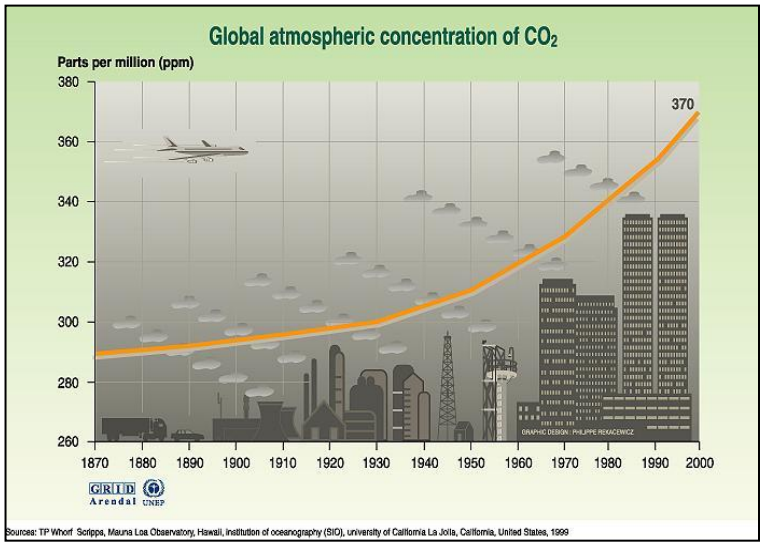


Figure 1. Global Atmospheric Concentration of CO_2 Over Time.
Source: United Nations Environmental Program (UNEP), available at: http://www.grida.no/publications/vg/climate/page/3062.aspx

[2] Intergovernmental Panel on Climate Change (IPCC) (2001). *Climate Change 2001: Synthesis Report, Summary for Policymakers*. Available at: http://www.ipcc.ch/pdf/climate-changes-2001/synthesis-spm/synthesis-spm-en.pdf

the warmest year in over a century. Over the last 100 years, temperatures at the Earth's surface increased by an estimated 1.4 degrees F.[3,4] This present concentration of CO_2 will double in 45 years if current patterns of fossil-fuel use continue, with drastic temperature increases predicted to occur as well. Even the slightest increase in average global temperature can cause major changes in climate patterns, resulting in more frequent and extreme weather events. Globally, while some regions may experience warming, other regions may become colder. Precipitation may increase in some regions, causing floods and mudslides, while decreasing in other regions, causing droughts and water shortages.

Here in the U.S., we are already feeling climatic effects of more frequent and extreme weather events, mirroring the models developed by scientists. Over the last several years, the Midwest has endured one of the worst droughts on record. Higher temperatures are melting the snow-pack that provides much of the water supply for people in the western United States. Experts predict the region could lose nearly half its water supply by 2100.

B. Local Effects and Impacts of Climate Change

It is clear that almost every place on the planet will be affected by climate change to some degree. Some regions will experience more severe impacts than others, and some regions may experience seemingly favorable changes (i.e. milder winters). However, the overall harms due to climate change are much more substantial than the perceived gains. The following is a summary on what our area can expect as a result of climate change under a high emissions scenario.[5]

With rising temperatures come negative health impacts. More frequent and severe summer heat waves and worsening air quality will put many species, including humans, at risk. As the number of hot days amplify so does the risk of heat stress and even death (the elderly, young children, and the poor being the most vulnerable). The risk of respiratory and cardiovascular ailments would certainly increase. The drought-like summers combined with heavy rainstorms lead to more frequent outbreaks of viruses, such as the West Nile, carried by mosquitoes. The IPCC projects that the threat of Lyme disease carrying ticks could push northward. The IPCC also notes that lung-damaging air pollution, as a result of ground level

[3] National Aeronautics and Space Administration (NASA) (January 2006). *2005 Warmest Year in Over a Century*. Available at: http://www.nasa.gov/vision/earth/environment/2005_warmest.html

[4] National Oceanic and Atmospheric Administration (NOAA) (January 2007). *NOAA Reports 2006 Warmest Year on Record for U.S.* Available at: http://www.noaanews.noaa.gov/stories2007/s2772.htm

[5] The Nature Conservancy (September 2006). *Climate Change Impacts in New York*. Available at: http://www.nature.org/initiatives/climatechange/files/new_york_factsheet_5.pdf.

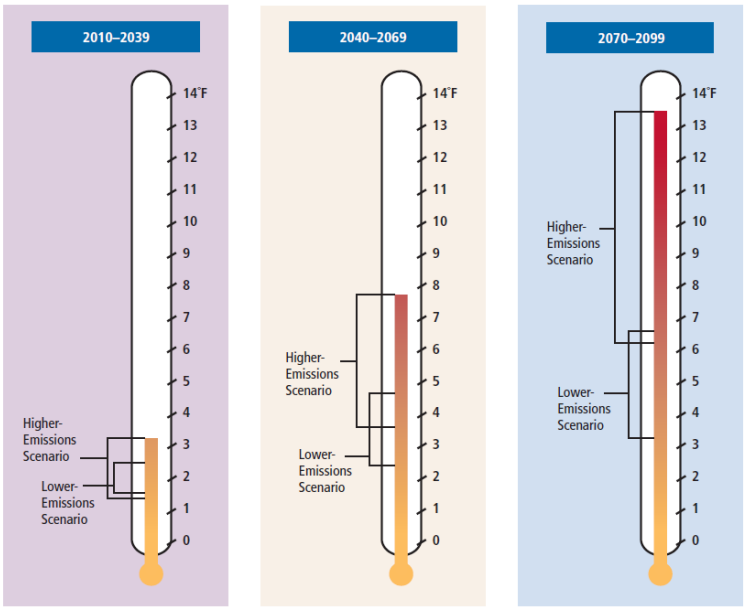
ozone, could be brought on by a warming climate.[6] This holds true for levels of airborne pollen as well. With accelerating pollen production, the allergy season would be lengthened, increasing allergy symptoms and asthma risks.[7] New York's clean drinking water supply will be at risk due to excess run off from heavy rainstorms. Searching for alternative water supplies would inflict an economic burden.[8]

The most obvious effect we can expect from rising temperatures would be warmer summers. In the summer we can expect heavier, more damaging rain to fall. The frequency of these heavy rainfall storms would increase, leading to more widespread flooding. The increase in precipitation can also affect water quality, increase the incidence of waterborne diseases, worsen soil erosion, and diminish the replenishment of groundwater supplies. Short term droughts are to be expected with rising summer temperatures. The earlier melting of snow increases runoff and soil moisture. The late winter/early spring runoff is a precursor for reductions in soil moisture during the late summer/early fall due to the warmer temperatures driving evaporation rates upward. Natural and managed eco-systems would be stressed across the state.[9]

Figure 2. Changes in Regional Average Summer Temperature.

Source: Northeast Climate Impacts Assessment (2007). See footnote #6.

The Northeast is already experiencing rising temperatures, with potentially dramatic warming expected later this century, especially if emissions of heat-trapping gases continue along the path of the higher-emissions scenario. These "thermometers" show projected increases in regional average summer temperatures for three time periods: early-, mid-, and late-century.



[6] Northeast Climate Impacts Assessment (2007). *Confronting Climate Change in U.S. Northeast*. Available at: http://www.climatechoices.org/assets/documents/climatechoices/confronting-climate-change-in-the-u-s-northeast.pdf.
[7] *Ibid.*
[8] The Nature Conservancy (September 2006).
[9] Northeast Climate Impacts Assessment (2007).

I. Introduction

Here in the Northeast we would have warmer winters. Precipitation is expected to increase by 20-30% with more rain and less snow. Snow will become more slushy and wet, decreasing the number of snow-covered days.[10] Maple syrup production is highly sensitive to climate. When producing sap, sugar maple trees require above freezing temperatures during the day and below freezing by night. With warmer winters in sight, the maple industry faces a lot of uncertainty. There is even the threat of non-native tree species and insect pests migrating northward, which could push out sugar maples and other species or even eventually wipe them out of the state completely.[11]

Forests are critical ecosystems that provide many recreational, economic, and environmental benefits. The number of Hemlock trees is projected to shrink by about 50% toward the end of the century. With the warmer winters, comes the expanding northward migration of the hemlock woolly adelgid. This invasive insect has already destroyed hemlock tree stands in states along the eastern coast, from Georgia to Connecticut. They are now established in the southern section of New York.[12] In addition, the risk of northeast forest fires is projected to see an increase of 10-20%, and lake levels are expected to decrease due to increased evaporation and smaller recharge rates.

The agricultural industry is extremely important to the economy in New York, with the dairy products being the State's leading agricultural product. The livestock industry will suffer from an increase in heat stress inflicted upon the animals. The intensity and frequency of heat in the summer would depress milk production and birthing rates in cows for weeks or even months. Milk production could be reduced by up to 15% in the summer months. A decrease in production could amount to substantial losses for farmers with an already small marginal profit.[13] With the higher temperatures, more air conditioning will be needed to maintain the current levels of production. Greater air conditioner use will result in higher electricity costs (produced by fossil-fuels) which only add to climate change. Agricultural pests and weeds would be driven northward with rising winter temperatures. The northward invasion of these pests and weeds would increase the pressure for farmers to have to use more herbicides and pesticides on their crops, which would increase production costs and have health related implications. For other crops, such as apples and corn, yields would be expected to decrease.

[10] Union of Concerned Scientists (2007). *New York: Confronting Climate Change in the U.S. Northeast*. Available at: http://www.climatechoices.org/assets/documents/climatechoices/new-york_necia.pdf
[11] Northeast Climate Impacts Assessment (2007).
[12] Union of Concerned Scientists (2007).
[13] Northeast Climate Impacts Assessment (2007).

The consequences of climate change for our region will be extremely significant and will far outweigh the perceived gains of changes, such as milder winters. The costs of delay are high. Taking action to reduce climate change now will prove to be less expensive than the economic and environmental damage from the cost of doing nothing.

C. Local Actions Being Taken on Climate Change

Despite the efforts of some, federal leadership has not been strong enough to enact the measures needed to combat the trends of climate change. However, bold reforms and innovative actions have emerged over the decade at both the state and local levels. More than 1,017 mayors from the 50 states, the District of Columbia and Puerto Rico, representing a total population of over 86,652,633 citizens, have signed the Mayor's Climate Protection Agreement. More than 1,000 cities worldwide, including 600 in the US, have joined ICLEI (see next page). Twenty-eight states have completed Climate Action Plans (CAP), and three are currently in the process of developing CAPs, including New York State which intends to complete its plan by April 2011. Most Mayors and Governors, who deal daily with economic, environmental and social challenges introduced by climate change, are stepping up to the challenge of combating climate change. Rather than waiting for direction from Washington, our state and local leaders have instead taken bold action to deal responsibly with climate change. To these officials, it has become clear that investing in GHG mitigation strategies is a path toward a more vital, prosperous and secure future.

Sharing this same vision, Mayor Matthew T. Ryan has taken strong steps to bring Binghamton into this network of proactive communities. Though Binghamton contains only a small portion of a large global population, it is important for our community to do its part. Mayor Ryan signed the U.S. Conference of Mayors Climate Protection Agreement on April 19, 2007 and began undertaking a number of initiatives to reduce the City's impact on global warming and to promote sustainable development. For example, with City Council's support, the administration created a Tree Fund and reinstated a Shade Tree Commission in order to meet the Mayor's promise of boosting tree plantings by 10% annually. In addition, the administration has pledged to add green vehicles to the City's fleet when possible, which it did in 2009 with the addition of three hybrid police vehicles. The City has also taken a number of steps to reduce energy consumption in its facilities. [14]

[14] For a detailed list of the City's sustainability initiatives, see Appendix A: Existing Government Measures.

I. Introduction

To further the City's commitment to sustainable development and engage public participation, the Mayor and City Council convened the Commission on Sustainable Development and Smart Growth on April 3, 2008 to research best practices in sustainable development and develop recommendations to the City on this topic. One year later, the Commission released a 73-page report, entitled *Moving toward Sustainability: an Opportunity for Growth and Prosperity,* which covered a broad range of subjects, including climate change, storm water management, land use, historic preservation, green building, and economic development.[15] The first recommendation presented in the report was that the City should join ICLEI – Local Governments for Sustainability's Cities for Climate Protection (CCP) campaign and undertake the five milestones of the CCP to reduce greenhouse gas emissions. Software and technical assistance supplied by ICLEI provides communities with a simple, standardized means of calculating greenhouse gas emissions of establishing targets to lower emissions, of reducing greenhouse gas emissions, and of monitoring, measuring and reporting performance.

In April of 2009, the City formally joined ICLEI's CCP campaign, and the release of this report marks the City's completion of Milestone One of the CCP, conducting a baseline emissions inventory and forecast. The next steps for Binghamton will be to set an emission reduction target and complete a Climate Action Plan, followed by implementing the CAP and measuring the results of its activities (see next section for details on the ICLEI Cities for Climate Protection Milestone process). The City plans to develop a Climate Action Plan and set an emission reduction target by the end of 2010.

D. ICLEI and the Cities for Climate Protection Program[16]

ICLEI-Local Governments for Sustainability[17] (ICLEI) is a membership association of local governments committed to advancing climate protection and sustainable development. Since its inception in 1990, ICLEI has grown to include over 1,000 cities in the world, more than 600 of which are in the United States. Through their climate mitigation work, ICLEI seeks to achieve significant reductions in greenhouse gas emissions by assisting local governments in taking action to reduce emissions, quantify their progress, and realize multiple benefits for their communities. Over 600 local governments from

[15] The Commission on Sustainable Development and Smart Growth report may be accessed online at: http://www.cityofbinghamton.com/department.asp?zone=dept-city-council&pid=5&pm=page.

[16] Excerpts of this section were taken from ICLEI USA's website (www.icleiusa.org).

[17] ICLEI – Local Governments for Sustainability was formerly known as the International Council for Local Environmental Initiatives

around the world, including over 230 in the United States that represent over 20% of the US population, have joined ICLEI's Cities for Climate Protection (CCP) campaign. As a CCP participant, local governments pledge to reduce global warming pollution by completing five Milestones:

Milestone One: Conduct a baseline emissions inventory and forecast.

Milestone Two: Set an emissions reduction target.

Milestone Three: Develop a Local Action Plan for reducing emissions.

Milestone Four: Implement policies and measures.

Milestone Five: Monitor emissions reductions and verify results.

ICLEI provides software tools, technical assistance, and other resources to CCP participants to help officials, staff, and their community partners pursue effective actions to reduce greenhouse gas emissions while creating various associated benefits for their communities. Additionally, ICLEI offers specialized tools and expertise in priority areas for local governments such as developing municipal green fleets, mitigating the urban heat island effect, implementing solid waste management programs, and developing state and local policy initiatives. Through the CCP campaign, local governments of all geographic locations, political affiliations, and populations join to share learning and increase collaboration—New York City meets Montgomery County, MD; Atlanta connects with Seattle; and San Antonio, Texas joins San Francisco—and as interest in the campaign increases, robust regional networks and nodes of activity are established.

As stated previously in this introduction, the City of Binghamton joined ICLEI USA and the Cities for Climate Protection Campaign in April of this year upon recommendation from the Commission on Sustainable Development and Smart Growth. Having completed Milestone One, conducting the baseline greenhouse gas emission inventory for 2006 and an emissions forecast, the City will be moving forward with developing a Climate Action Plan and adopting an emission reduction target this fall and anticipates that it will be completed by the end of 2010.

A. Methodology

In order to have an understanding of the amount of greenhouse gases emitted by the City of Binghamton, an inventory was conducted for the baseline year of 2006. This year was found to be the earliest year for which sufficient data was available to complete an inventory. Comprehensive data was collected regarding total energy consumption, fuel usage, and waste disposal in Binghamton. From this information, emission quantities were categorized and totaled with the assistance of the ICLEI's Clean Air and Climate Protection (CACP) software. The numbers obtained from this inventory will be extremely helpful in the next step of developing a Local Climate Action Plan, which will outline a strategy for how the City will achieve its target for reducing greenhouse gas emissions.

1. CACP Software

In 2001, ICLEI joined forces with the National Association of Clean Air Agencies (NACAA) and the U.S. Environmental Protection Agency (EPA) to build a software product that helps local governments create greenhouse gas inventories, quantify the benefits of reduction measures, and formulate local climate action plans. The resulting product was the Clean Air and Climate Protection (CACP) software, which was released in 2003 and updated in 2009. CACP is a one-stop emissions management tool that calculates and tracks emissions and reductions of greenhouse gases (e.g. carbon dioxide, methane, nitrous oxide) and criteria air pollutants (NOx, SOx, carbon monoxide, volatile organic compounds, PM10, PM 2.5) associated with electricity, fuel use, and waste disposal.[18]

Data for the inventory was collected by reaching out to many sources within the Binghamton City Government and the private sector. This data was then organized for entry into the software's two main inventory sections: *Government* and *Community*. The program further breaks down the local Government and Community sections to provide a more detailed picture of emission sources. For example, the Community analysis provides a summary of residential, commercial, industrial, transportation and waste emissions, and the Government analysis shows emissions by department and other categories.

As one reads through this report, it is important to note that CACP reports emissions in tons of carbon dioxide equivalents (CO_2e) as opposed to tons of each type of gas. Being that different greenhouse gases have different global warming potentials (GWP), scientists developed CO_2e as a universal standard

[18] Excerpted from ICLEI's website (http://www.icleiusa.org/action-center/tools/cacp-software).

of measurement against which the impacts of releasing different greenhouse gases can be evaluated.[19] The ability of a gas to trap heat compared to carbon dioxide is considered its GWP. For example, methane, which is the second most common GHG, has a GWP of 21 times that of carbon dioxide. Therefore, one ton of methane gas in the atmosphere is the equivalent of 21 tons of carbon dioxide, or simply 21 CO_2e. By converting all greenhouse gas emissions to CO_2e, it is possible to summarize the GHG emissions of a community with a single number, allowing us to compare total emissions from one activity to another and from one community to another.

In addition to calculating the equivalent CO_2 emissions from energy consumption, the software also determines the amount of criteria air pollutants that are caused by fuel combustion. Under the authority of the Clean Air Act, the EPA regulates six substances called criteria air pollutants: carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter (PM), and sulfur dioxide. These substances are the most common air pollutants found in the United States and cause particularly detrimental impacts on health and the environment because of their abundance. As a result, Congress has set standards for permissible concentrations of these pollutants. CACP software automatically calculates the amount of pollutants being released due to activities in the community, and this report provides that data in addition to GHG emissions.

2. Protocol

For its inventory, the City of Binghamton followed the methodology laid out in the *Local Government Operations Protocol for the Quantification and Reporting of Greenhouse Gas Emissions Inventories* (LGOP) version 1.0, which was developed by the California Air Resources Board, California Climate Action Registry, ICLEI, and The Climate Registry.[20] The LGOP was used specifically as the guide for compiling the Government profile, not the Community profile. An emissions source (i.e. a building, group of vehicles, etc) was considered governmental if it was deemed as within the City of Binghamton's *financial* or *operational* control.

In addition to using the LGOP, the City followed ICLEI's standards for selecting emission potentials and other coefficients, which were established by the Environmental Protection Agency and other reputable organizations. These coefficient sets were selected for use in the Clean Air and Climate Protection

[19] This method of comparing global warming potentials was created by the IPCC (Intergovernmental Panel on Climate Change) and is updated as new information on the lifetime and harmfulness of each gas is gathered (see section D in Appendices for complete listing of GWPs).

[20] The LGOP is available at: http://www.icleiusa.org/programs/climate/ghg-protocol

software and pertained to all aspects of the inventory. The City also utilized ICLEI guidelines for a variety of other aspects of the inventory. For example, to categorize emissions according to whether they were directly or indirectly released as a consequence of local actions, ICLEI's 'scopes' concept was employed for the government profile (see Appendix B: Local Government Operations Standard Inventory Report). There were 3 types of Scopes for emissions:

> **Scope 1** – Direct emissions from sources within the local government's organizational boundary. For example, the combustion of gasoline within a car's engine as it was driving within the City of Binghamton.
>
> **Scope 2** – Indirect emissions from the consumption of purchased energy in City buildings. They were a consequence of activities that took place within Binghamton, but whose emissions actually occurred in another area. For example, electricity used in the City Hall caused the emission of GHG at electricity generation facilities outside Binghamton.
>
> **Scope 3** – Simply emissions that could not be classified as either Scope 1 or 2. For example, if the government contracted construction work to be performed, emissions would have occurred from privately owned equipment, but they would be used as a result of a government decision.

As a closing note, it is important to recognize that the emission numbers put forth in this report should be considered estimates since the calculations were performed with standardized coefficients and could not account for all factors. In addition, an absolutely complete inventory would be extremely complex and expensive to conduct. Certain data (i.e. the amount of fuel used for home barbeques) was simply beyond the level of detail practical for this project. Though it is not possible to determine the exact amount of greenhouse gas emissions, we can account for the most prevalent sources of emissions. As such, the Clean Air and Climate Protection software provides us with the best estimate for the emission levels of Binghamton in 2006, which is an important first step in the process of developing a strategic plan for reducing greenhouse gas emissions and doing our part to reduce the impacts of global warming.

B. Emissions Inventory Results

1. Overall Profile

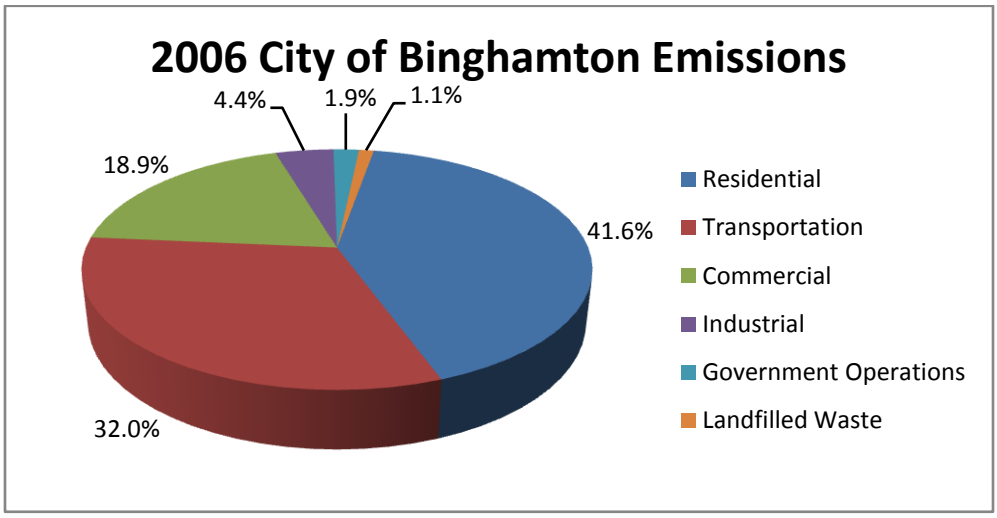


Figure 3. The Complete Emissions Profile for the City of Binghamton.

Sector	CO_2e (tons)
Residential	269,986
Transportation	207,628
Commercial	122,724
Industrial	28,466
Government Operations	12,470
Landfilled Waste	7,270
Total	**648,544**

Table 1. Emissions Quantities Relating to Figure 2.

Greenhouse gas emissions were inventoried for the baseline year of 2006 (January to December). The overall profile of Binghamton's GHG emissions looks similar to that of other communities in the United States.[21] Residential and commercial buildings account for the vast majority of energy consumption and thus the majority of emissions. In the case of Binghamton, these sectors account for 60.5% of overall emissions. Transportation is the next largest emission source and contributes to nearly a third of Binghamton's emissions, which is also typical in the US. The remaining sectors (industrial, governmental, and landfilled waste) account for a relatively small portion of Binghamton's overall emissions, but are significant sources nevertheless. Also like other communities, the majority of

[21] The overall profile of GHG emissions is a combination of the Community and Government profiles. Information about the sources of data and other details are available in the following sections that are devoted specifically to those two profiles.

emissions in Binghamton come from the private sector, or the 'Community' as categorized by the CACP software. Only 1.9% of the emissions in Binghamton come from activities that are within the City government's *financial* or *operational* control (see Figure 4: Emissions by Public and Private Sectors). The community and government emission profiles will be discussed in further depth in the following sections of this report.

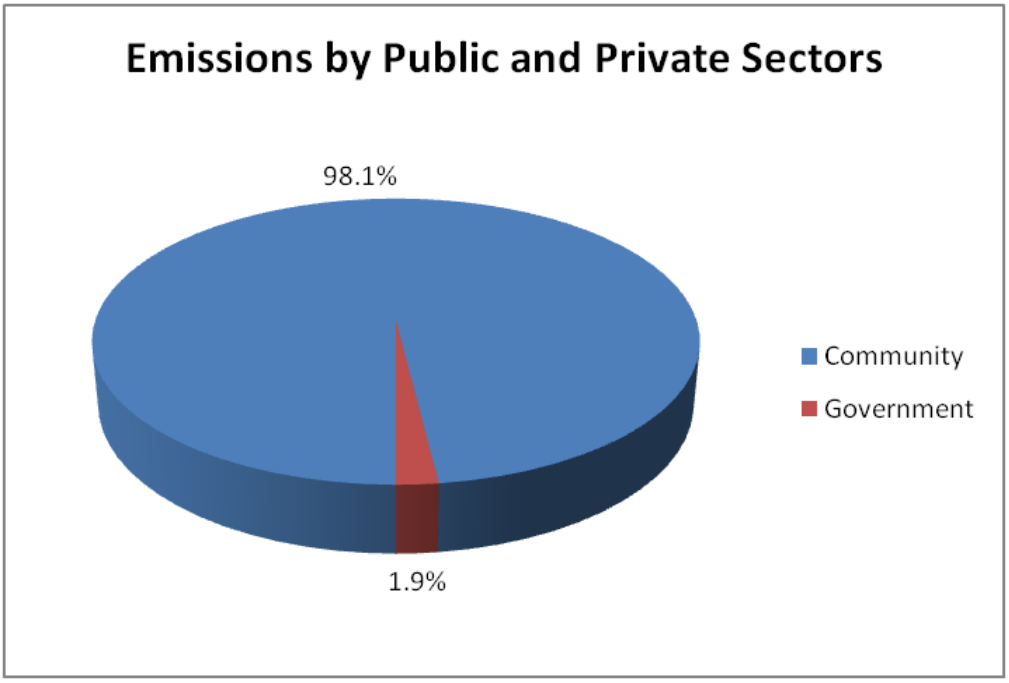


Figure 4, Comparison of Private vs. Public Sector Emissions. In 2006, the government emitted an estimated 12,470 tons of carbon dioxide equivalent gases, while the community emitted 636,074 tons.

The inventory reported that the Binghamton's total GHG emissions in 2006 were 648,544 tons of carbon dioxide equivalents. Based on population data from the 2000 Census, Binghamton's 2006 emissions per capita were 14.3 tons of CO_2e. This number is significantly lower than the United States per capita emissions, yet it is higher than the per capita emissions for larger North American cities (see next page Figure 5, Per Capita Emissions).

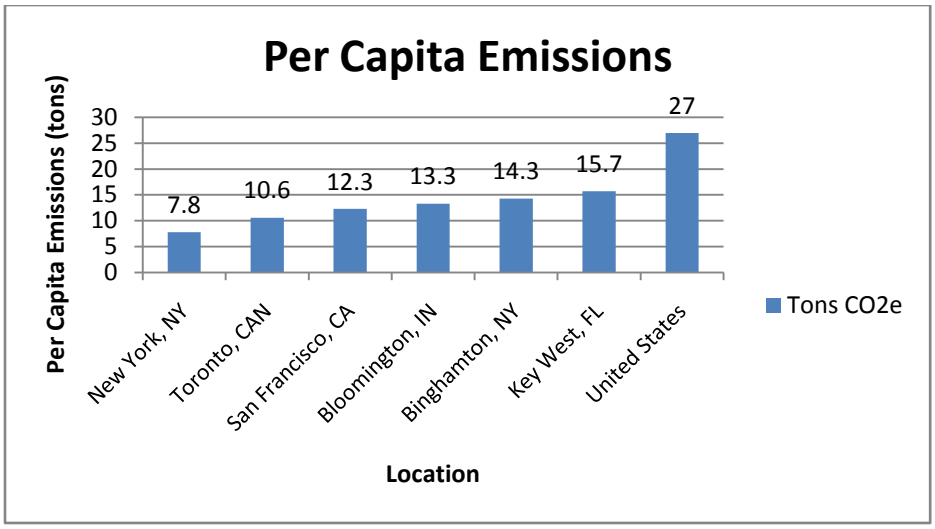


Figure 5. Per Capita Emissions of Select Cities and the United States. *Calculations are based on reported greenhouse gas inventories with the understanding that differing methodologies and emissions sources exist.*

Sources: 1) Inventory of New York City Greenhouse Gas Emissions (2007) (available at: http://www.nyc.gov/html/om/pdf/ccp_report041007.pdf); 2) City of Key West Greenhouse Gas Emissions Inventory Report (available at: http://www.keywestcity.com/egov/docs/1215117643_946716.pdf)

In addition to reporting the tons of CO_2e emitted, the CACP software also generated reports that listed the main greenhouse gases and criteria air pollutants emitted from each source (see Table 2, Quantities of all emissions inventoried among both Community and Government for Binghamton). As explained in the introduction to this report, the criteria air pollutants are the substances that are regulated by the EPA under the Clean Air Act because of their particularly detrimental impacts on health and the environment. For the most part, the emissions of greenhouse gases and criteria air pollutants correlate with the amount of energy consumed, depending on the type of fuel. For example, residential and commercial buildings consume the vast majority of electricity (see Figure 6), which is produced largely by coal in this region, and thus account for the majority of CO_2, SO_x, CO, and PM10 emissions. In contrast, the burning of gasoline from vehicle use produces more N_20, NO_x, CO, and VOC emissions than electricity production, which is why transportation and government operations account for higher emissions of these substances.

Methane (CH_4) production, however, does not directly correlate with energy consumption as it is not a direct product of the burning of fossil fuels. The largest source of methane caused by human activities in the U.S. is landfills, accounting for 34 percent of all methane emissions. Methane is generated in landfills and open dumps as waste decomposes under anaerobic (without oxygen) conditions. Similarly, human sewage and livestock manure management results in anaerobic decomposition of organic matter

and results in the production of methane. In addition, methane escapes into the atmosphere during the production, processing, storage, transmission, and distribution of natural gas and coal.[22]

Table 2, Quantities of All Emissions Inventoried Among Both Community and Government for Binghamton. *Note that carbon dioxide (CO_2) is listed in tons while the rest are listed in pounds.*

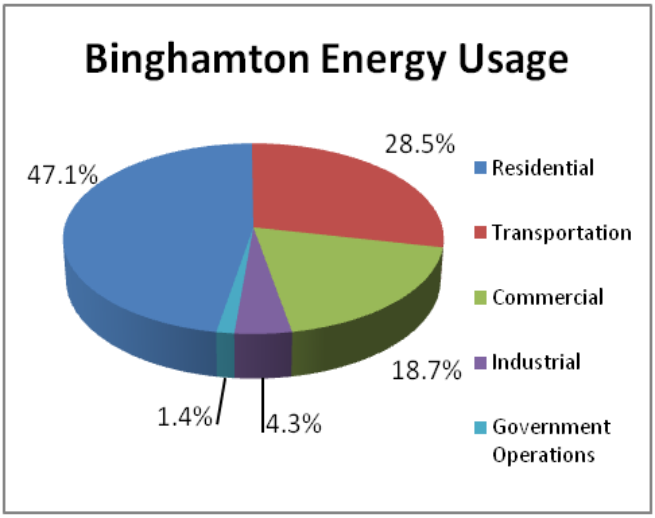
Key: Carbon Dioxide (CO_2); Nitrogen Dioxide (N_20); Methane (CH_4); Nitrogen Oxides (NO_x); Sulfur Oxides (SO_x); Carbon Monoxide (CO); Volatile Organic Compounds (VOC); Particulate Matter with diameters of 10 micrometers or less (PM10)

Sector	CO_2 (tons)	N_20 (lbs)	CH_4 (lbs)	NO_x (lbs)	SO_x (lbs)	CO (lbs)	VOC (lbs)	PM10 (lbs)
Residential	269,178	2,105	45,875	805,213	403,775	286,838	49,371	122,107
Transportation	203,957	22,393	19,063	1,371,776	75,677	10,915,771	1,126,236	38,802
Commercial	122,265	1,801	17,076	354,226	472,266	197,815	27,681	131,723
Industrial	28,384	431	1,453	117,339	151,301	58,067	8,034	33,190
Government Operations	10,893	2,684	106,785	52,571	61,515	149,634	16,413	17,531
Landfilled Waste	0	0	101,910	0	0	0	0	0
Total	**634,677**	**29,414**	**292,162**	**2,701,125**	**1,164,534**	**11,608,125**	**1,227,735**	**343,353**

Finally, the CACP software allows us to compare energy usage across sectors in a standardized format. By converting different measures of energy (kilowatts, therms, etc) into million British thermal units (MMBtu), one has a standardized measure with which to compare total energy consumption across different fuel types. The resulting pie chart (see Figure 6 and Table 3, The Binghamton Energy Usage: standardized energy usage during 2006 among all sectors) looks very similar to the breakdown of GHG emissions by sector.

Figure 6 and Table 3. Binghamton Energy Usage: *Standardized Energy Usage During 2006 for All Sectors.*

Sector	Energy Usage (MMBtu)
Residential	4,291,229
Transportation	2,597,425
Commercial	1,708,289
Industrial	392,985
Government	124,124
Total	**9,114,052**



[22] United States Environmental Protection Agency (2009). *Methane: Sources and Emissions*. Available at: http://www.epa.gov/methane/sources.html.

2. Community Profile

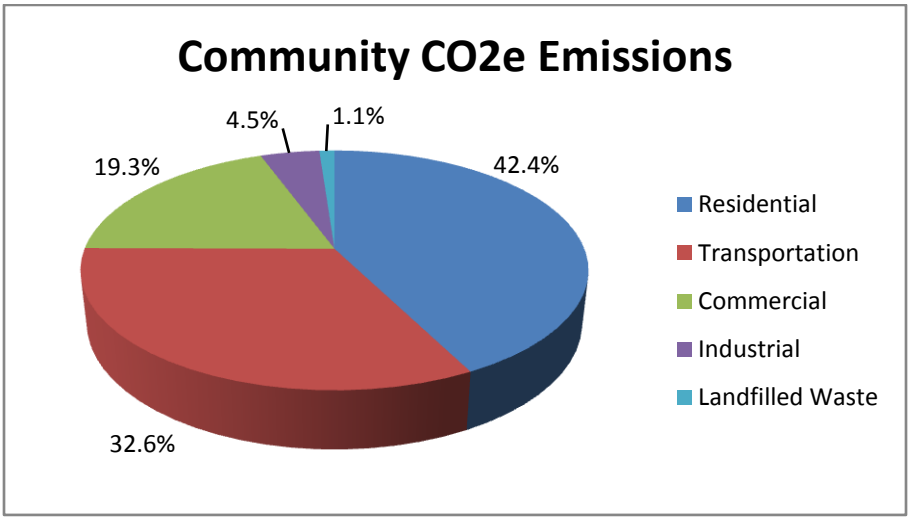


Figure 7. GHG Emissions from Binghamton's Community Sector.

Sector	CO_2e (tons)
Residential	269,986
Transportation	207,628
Commercial	122,724
Industrial	28,466
Landfilled Waste	7,270
Total	**638,950**

Table 4. Community Emission Quantities Relating to Figure 7. The data is the same as Table 1, with the omission of Government Operations emissions.

The Community section in the CACP software was separated into the following sub-sections:

- Residential
- Commercial
- Industrial
- Transportation
- Waste

Residential

Buildings designated as "Residential" by the electric utility provider New York State Electric and Gas (NYSEG) accounted for the greatest emissions of greenhouse gases in the City of Binghamton. According to the 2000 census, there were 23,971 housing units within the City.[23] The electricity and natural gas segment of the Community emissions fall under of Scope 2 (see Methodology) energy consumption for 2006. Records were produced from NYSEG. There are other sources of residential emissions that were

[23] U.S. Census Bureau. *2000 Census State and County Quickfacts*. Available at: http://quickfacts.census.gov/qfd/states/36/3606607.html

not included in the inventory (i.e. non-grid fuel use) due to the difficulty in collecting such data. However, electricity and gas are strongly believed to be responsible for the great majority of residential emissions.

Commercial and Industrial

These two segments account for commercial and industrial businesses in Binghamton. Emissions were calculated from the amount of kWh of electricity and therms of natural gas used by NYSEG accounts categorized as "Commercial" and "Industrial."

Transportation

The main piece of information used by the inventorying software for this category was the number of *vehicle miles traveled* (VMT) by vehicles on roads within the City of Binghamton's boundaries. The Binghamton Metropolitan Transportation Study (BMTS), a Broome County department, maintained a suitable model to isolate traffic within City limits. The model estimated an average daily VMT for 2006 of 885,499 miles. According to John Sterbentz, BMTS Transportation Analyst:

> *VMT figures were estimated using the BMTS Binghamton Urban Area travel model. The VMT figure was estimated for all roads within the City of Binghamton municipal boundaries only, with a functional classification of Collector and above. All VMT numbers generated by the model were initially PM peak hour VMT. These PM peak hour VMT figures were then converted to average daily VMT by dividing by a factor of .09, as recommended in NCHRP Report 365, Travel Estimation Techniques for Urban Planning (page 89, Table 45; "Conversion factors for critical periods of internal auto travel, Urban Area Population 200,000 to 499,000").*
>
> *This figure was then divided by a figure of .86 to account for travel on roads with a functional classification of Local. According to the 2007 Highway Performance System Summary Tables, nationally, approximately 14% of VMT in urban areas occurs on roads functionally classified as "Local".*

The daily VMT produced by the model was multiplied by 365 to arrive at 323,207,135 annual miles for 2006. Then, this figure was broken down according to CACP's default vehicle types, which was deemed as sufficient by BMTS:

- Heavy duty (diesel): 5.4%
- Light trucks (diesel): 1.3%
- Passenger cars (diesel): 0.3%
- Light trucks (gasoline): 32.4%
- Passenger cars (gasoline): 60.6%

From this information, default coefficients were used by the software regarding vehicle fuel efficiency to compute emissions.

When combining the Community and Government components to make the overall emissions profile, care had to be taken to avoid double-counting energy consuming entities. For example, the vehicle miles traveled provided by the BMTS model included all travel by all vehicle types within the City of Binghamton. Therefore, government vehicles, public transportation, and others are accounted for by the BMTS model. In order to ensure that Binghamton's municipal motor vehicle use was not included twice, these emissions were subtracted from the emissions calculated from the model's estimates in order to have an accurate total for the Community Transportation segment.

Landfilled Waste

Although the decomposition of organic waste caused only a small portion of the Community's total CO_2e, it was by far the greatest emitter of methane for this sector. While some of the methane produced was captured to be either flamed off or sold to a private company, the remaining 101,910 lbs of methane were released into the atmosphere. For calendar year 2006, 14,956 tons of garbage collected by the City was landfilled. The EPA 2006 national breakdown of waste types (see Table 5) was used for the calculation of emissions instead of the Broome County Landfill's waste analysis information because the categories of waste composition from the County did not match with the categories required by the CACP software.

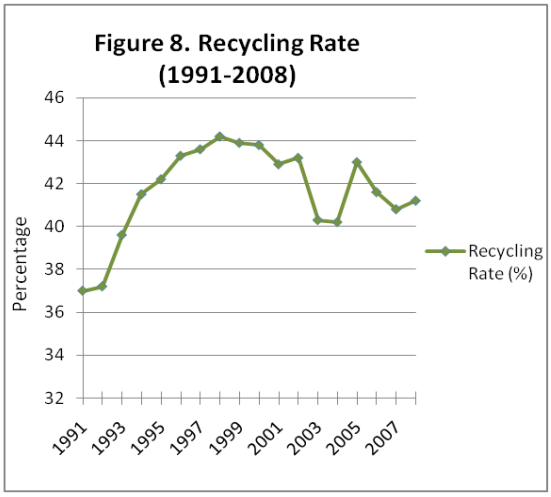
Indirectly, solid waste collection within the City has contributed to additional harmful emissions. A large portion of the Government's Department of Public Works fleet was devoted to the transportation of waste. Although the criteria air pollutants NO_x and carbon monoxide were not treated by CACP 2009 as gases that contribute to carbon dioxide equivalents, the combustion of motor vehicle fuels emitted significant amounts of these pollutants.

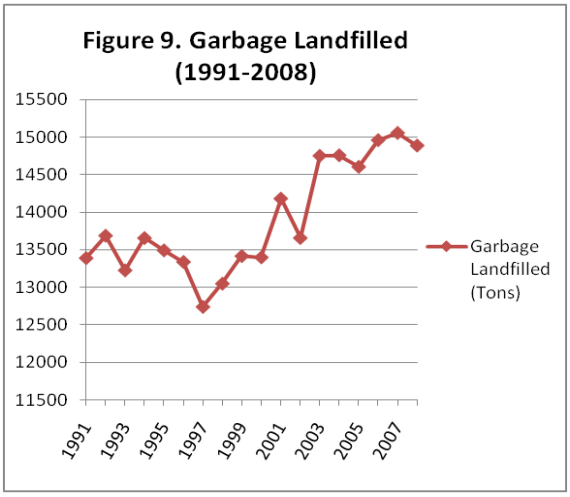
Waste Type	Percent of Total
Paper Products	24.3%
Food Waste	18.0%
Plant Debris	7.3%
Wood or Textiles	13.3%
All Other Waste	37.1%
Total	**100%**

Table 5. EPA Waste Analysis: Materials Discarded in the Municipal Waste Stream in 2006.

Source: Environmental Protection Agency. Table 3: "Materials Discarded in the Municipal Waste Stream, 1960-2006." Available at: http://www.epa.gov/epawaste/nonhaz/municipal/pubs/06data.pdf

It is important to note the trend in Binghamton's waste production and recycling, as contained in the City of Binghamton 2009 Solid Waste Management report.[24] As can be seen in Figures 8 and 9, the tonnage of waste landfilled has been increasing overall while the percentage of incoming waste that is recycled has been declining (the City of Binghamton began a recycling program in 1991). Recycling not only reduces local emissions of methane, but it reduces emissions as a cause of resource extraction and manufacturing. Thus, it is important to improve recycling in order to reduce GHG emissions.





3. Municipal Emissions Profile

While the local government's role in leading the fight against climate change is an extremely important one, the municipality's contribution to the City of Binghamton as a whole is a very small percentage of total energy consumption and emissions. The government sector in Binghamton accounts for only 1.9% of the total CO_2e (12,470 tons) for all of Binghamton. The residential, commercial, industrial and waste emissions make up the remaining 98.1%. The fraction of the City government's contribution to total City emissions is typical, for most municipalities have found they fall between 2-5% of total emissions.

While the Government Sector emissions may seem like a miniscule amount compared to the Community emissions, it is still important to make government operations more energy efficient to not only reduce emissions but to also reduce the City budget, and thus taxes. Furthermore, City government should lead by example and promote energy conscientious within the community.

[24] City Of Binghamton Department of Public Works (2009). *Solid Waste Management*. Available at: http://cityofbinghamton.com/%5Clibrary%5Cpages%5Cdept-public-works%5C2008%20SOLID%20WASTE%20REPORT.pdf.

II. Greenhouse Gas Inventory

The local government analysis contains many different sections which use a variety of energy sources, including electricity gasoline, diesel, and natural gas. The overall breakdown of the emissions (in tons CO_2e) from these energy sources for the government is shown in Figure 10: CO_2e Emitted by Fuel Type. The natural gas and electricity are used for heat and power in City facilities. Gasoline and diesel account for fuel consumption by the vehicle fleet and the commute for employees of the City of Binghamton.

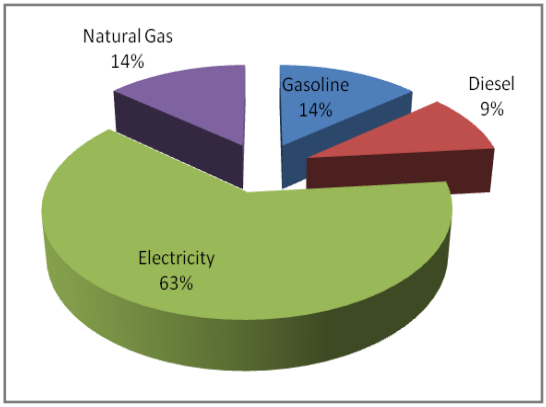


Figure 10. CO_2e Emitted by Fuel Type used in Government Operations

In the CACP software, the government analysis was further broken down into many different sub-sectors over which the municipality has financial and/or operational control. When the City begins working on completing the second ICLEI Climate Action Milestone, it will be very helpful to know how many tons of CO_2e, nitrous oxide, methane, and criteria air pollutants each sector is releasing into the atmosphere. The inventory for the City of Binghamton used calendar year 2006, with the exception of a few numbers explained further in the individual sectors for which there was no accurate data from 2006. CACP broke down the government controlled operations into 8 sub-sectors:

- Buildings and Facilities
- Streetlights and Traffic Signals
- Water Delivery Facilities
- Wastewater Facilities
- Vehicle Fleet
- Employee Commute
- Other Process Fugitive
- Refrigerants for all Sectors

A few sectors outlined in the software were not included in this inventory (including Airports, Ports, Transit Fleet and Electric Power) because they were either not located within the City limits or not controlled by the municipality. The software also included solid waste generated by City operations; however neither the City of Binghamton nor the Broome County Landfill tracked the amount of waste coming solely from the local government. Instead, the waste was included in the total amount coming from Binghamton, which is described further in the Community emissions profile.

The following figure shows the breakdown of the percentages of emissions coming from the different government controlled sub-sectors. Table 6 details a further breakdown of energy consumption and emissions for the local government.

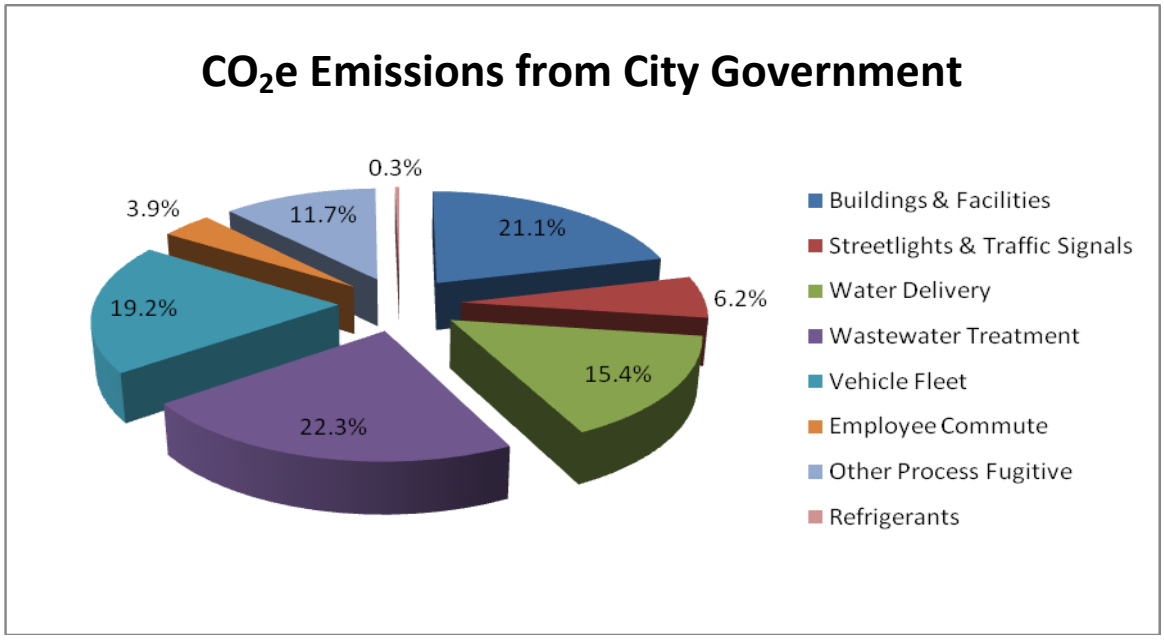


Figure 11. CO_2e Emissions from Government.

NOTE: 'Other Process Fugitive' consisted of the methane and nitrous oxide that was released as a result of operations at the Sewage Treatment Plant

Government Sector	Energy (MMBtu)	Cost	CO_2e (tons)
Buildings & Facilities	31,851	$425,366	2,626
Streetights & Traffic Signals	7,262	$330,564	772
Water Delivery	19,713	$238,163	1,920
Wastewater Treatment	29,445	$790,351	2,783
Vehicle Fleet	29,795	$422,186	2,393
Total	**118,086**	**$2,206,629**	**10,493**

Table 6. Emissions and Energy Quantities Related to Figure 11.
Values reflect energy usage and associated costs to the City of Binghamton.

The five sectors outlined in Table 6 were the highest contributing sources of energy use and tons of CO_2e for the City government. City employee commute was not included in this table because it was considered Scope 3 (see Methodology), and therefore was not directly related to the government's operations. The two other sectors that were not included in the table, Other Process Fugitive and

Refrigerants, did not have energy consumption or cost associated with their uses and will be addressed further in their individual sections. The energy in MMBtu shown in Table 6 is the compilation and conversion of the different types of fuel used to power these sectors into a common unit.

Buildings and Facilities

The Buildings and Facilities sector of the local government consisted of the places over which the City had operational and/or financial control. The facilities included in this sector ranged from fire stations to City Hall to the central garage for City vehicles. The types of energy used, amounts consumed, and electric and gas costs were available in the City's utility bills. By going through the individual bills for each month in 2006, it was possible to add up the total energy consumption for the year. The analysis found that the Buildings and Facilities sector was responsible for 21.1% of the CO_2e emissions from the government's analysis: the highest sector for energy consumption and greenhouse gas emissions. The water treatment facility is not accounted for in the Buildings and Facilities segment of the inventory as it is categorized as a part of the water delivery sector. Similarly, the sewage treatment plant utility usage is included in the wastewater sector. Figure 12 and Table 7 illustrate the breakdown of each department's building energy use.

It is important to note that the City Hall building houses the central police station, one of the fire stations, as well as offices for the following departments:

- Assessment
- Building & Construction
- City Clerk
- City Court
- Code Enforcement
- Corporation Counsel
- Data Processing
- Dog Control
- Economic Development
- Engineering
- Finance
- Fire Bureau
- Parks & Recreation
- Personnel / Civil Service
- Planning Housing & Community Development
- Public Works
- Vital Statistics
- Youth Bureau
- Mayor's Office

Therefore the energy use for those departments is included in that of the City Hall building and is not broken down by department. The energy use in parks covers pavilion lights, bathroom facilities, vending machines and some outdoor lighting. The ramp section is the energy required for the lighting in City owned or operated parking ramps. The tons of CO_2e emitted and the electric & gas costs for each department's facilities are shown in Table 7.

The majority of electricity consumption came from the City Hall, accounting for 46% of the total emissions in the Buildings category. The Police Department's Lee Barta Substation (now a community center) contributed the smallest amount of electric emissions with only 1%, but it is important to keep in mind that some of the emissions and electricity use from City Hall included the Police Department offices and central station. Because of the way the electricity meters are set up for the City Hall building, it is impossible to separate out how much each floor or department within the building consumes. The electric and natural gas for government operations was supplied by New York State Electric and Gas (NYSEG).

Building	Energy MMBtu	Tons CO_2e	% CO_2e	Cost
City Hall	14,328	1,218	46%	$150,463
Fire Department	4,968	321	12%	$63,166
Police Department	268	26	1%	$2,807
Public Works	4,377	334	13%	$93,494
Parks	5,159	437	17%	$88,208
Ramps	2,752	290	11%	$27,228
Total	**31,852**	**2,626**	**100.00%**	**$425,366**

Table 7. Energy Consumption and CO_2e Emissions for Municipal Buildings by Department.

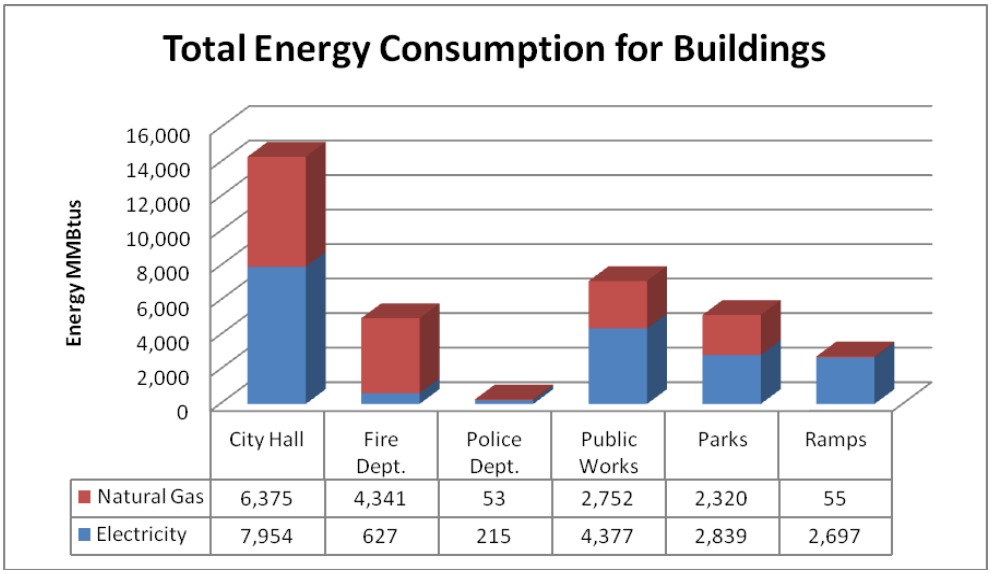


Figure 12. Energy Consumption for Municipal Buildings by Department.

Streetlights & Traffic Signals

The three sub-sections considered under the Streetlights sector are streetlights, traffic lights, and underpass lights. In total, this sector is accountable for 6.7% of the total CO_2e tons for the local government. The electricity bills for the municipality include the streetlights as one total number and give the location and energy consumed by each individual traffic light in Binghamton. All of the lights in the City of Binghamton use electricity for power. Figure 13 and Table 8 break each sub-sector down into more detail.

Figure 13. City Streetlight and Traffic Signal Energy Consumption

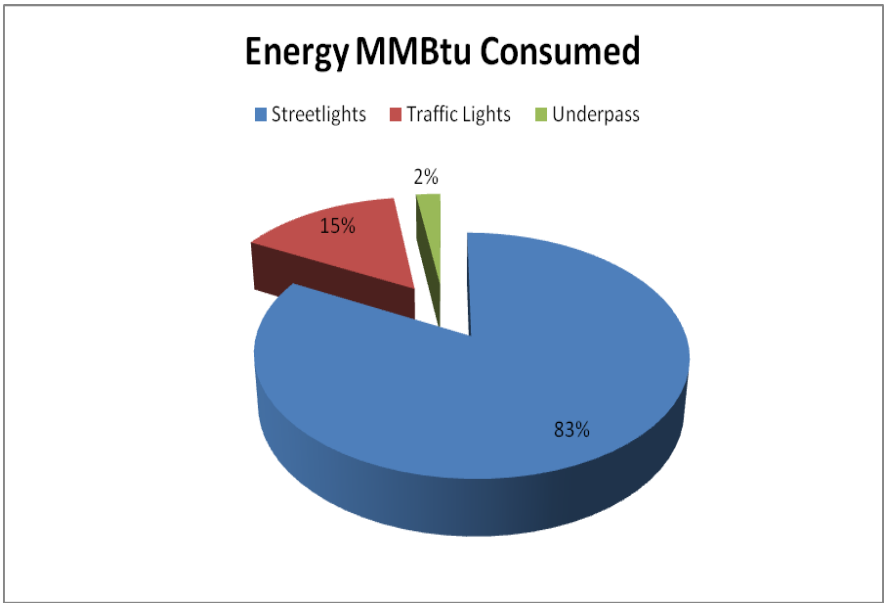


Table 8. City Streetlight and Traffic Signal Energy Consumption and CO_2e Emissions

Sub-Sector	CO_2e Tons	Cost
Streetlights	692	$296,940
Traffic Lights	125	$63,419
Underpass	19	$2,588
Total	**836**	**$362,947.00**

Water Delivery Facilities

The water delivery section of the government analysis includes the water treatment facility and the pumps around the City that supply water for community use. The majority of the energy consumed in this area comes from the treatment of the water from the Susquehanna River. Once the water has been treated, it is pumped up to water tanks on the surrounding hills. When needed, the water flows down into Binghamton mainly due to the force of gravity, requiring very little electrical power. Binghamton's water treatment facility accounts for a large portion of the government's emissions: 15.4% or 1,920 tons CO_2e. On average, the facility treats about 7 million gallons per day and 2.55 billion gallons annually. The processes used are essential, yet extremely energy consuming and expensive.

Water Delivery Facility	CO_2e tons	Energy (MMBtu)	Cost
Electricity	1,708	16,082	$173,994
Natural Gas	213	3,631	$64,169
Total	**1,920**	**19,713**	**$238,163**

Table 9. Water Delivery Facility Energy Consumption and CO_2e Emissions

Wastewater Facility

The sewage treatment plant is jointly owned between the City of Binghamton and Johnson City. Binghamton has more financial control over the site, contributes the majority of the waste (estimated to be about 57% on a normal day and 75% on wet days), and owns 54.8% of the facility.[25] It is difficult to determine what the exact portion of sewage coming into the plant from Binghamton is. The sewer systems and pipes are set up such that all the influent is combined en route to the plant, so there is no way to determine exactly for how much Binghamton alone is responsible. Within Binghamton alone there are 13,975 sewer connections, and 27,117 sewer connections in the entire area that the plant services. The maximum amount the joint sewage plant can accommodate daily is 60 million gallons. On average, about 20 million gallons come into the facility daily, which is around 7.3 trillion gallons per year. The sewage treatment process and buildings accounted for 18.2% of the government's emissions in CO_2e. Sewage treatment plants are necessary and vital elements of urban communities, and their processes are extremely energy-intensive. Electricity and natural gas are the main sources of power, with a negligible amount of propane used, as can be seen in Table 10.

Sewage Treatment Plant	Energy MMBtu	CO_2e (tons)	CH_4 (lbs)	Cost
Electricity	17,335	1,841	127	$544,137
Natural Gas	7,225	424	80	$85,436
Propane	1	0	0	$24
Total	**24,561**	**2,265**	**207**	**$629,597.00**

Table 10. Sewage Treatment Plant Energy Consumption and CO_2e Emissions

[25] Johnson City owns 45.2% of the facility.

Vehicle Fleet

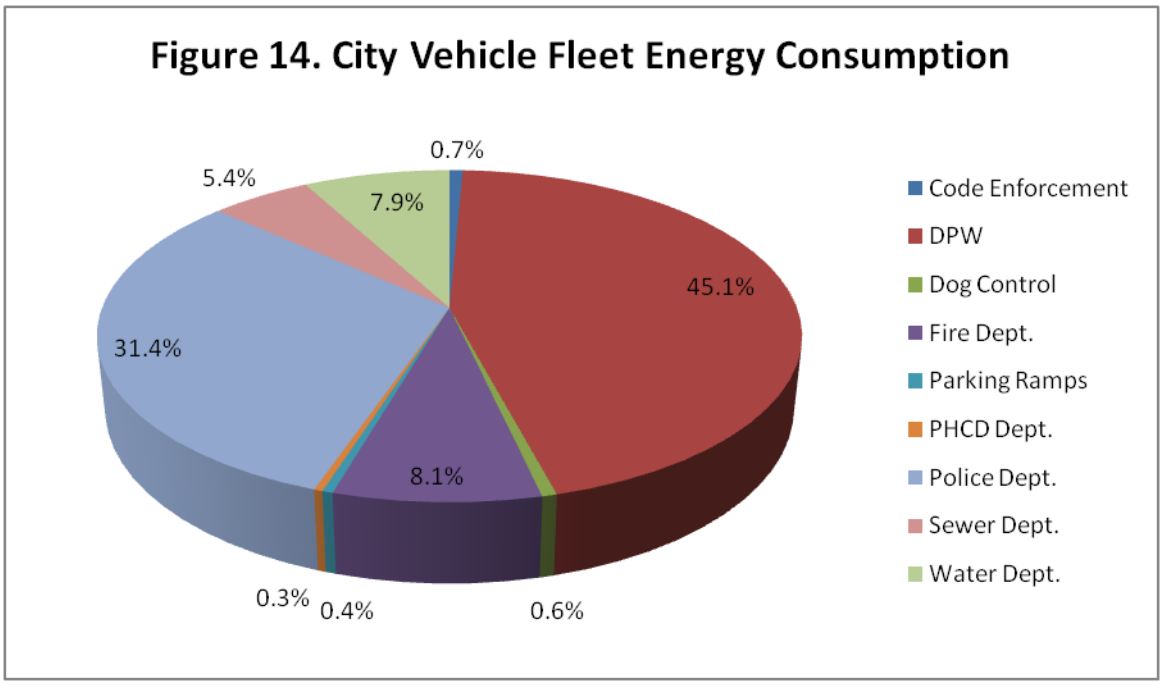
This sub-section consists of all the vehicles owned and operated by the City that were in use in 2005.[26] The numbers used in this section are from what data was available at the time of this inventory. Before 2009, the only records the City kept in regards to their vehicle fleet was the amount of money spent on gas as a lump sum for the entire year and an estimate of how much fuel was purchased each year. There was no information on how much each department spent on fuel, exactly how much was consumed, or the miles-per-gallon for each car or truck. Also, there are no records kept now or in the past regarding how much fuel is consumed by all other City owned machines, e.g. lawnmowers, weed cutters, and street cleaners. The Purchasing Department and Department of Public Works were able to provide how much was spent on fuel in 2005, an estimate of the amount of fuel purchased, and a list of all City-owned vehicles. However, in order to get a general idea of how much fuel each department consumes, the following breakdown of gas and diesel was taken from the new system enacted in 2009. For the sake of the inventory, it was assumed that each department used about the same amount from year to year and that there is basically the same amount of vehicles in service as well. Because the system that is now in use did not keep track of how much gas *each* car in a department consumed in 2009, it was assumed that the gas consumption for each department was split up evenly among the cars and/or trucks. The tracking system has now been updated to record information by car, and this improvement will help the City to have more accurate data for future inventories.

Figure 14 illustrates the breakdown of energy usage for each department for their portion of the City fleet, and Table 11 outlines the gallons of gasoline and diesel consumed by departments along with the corresponding CO_2e emissions and costs.

Table 11. Vehicle Fleet Fuel Consumption and CO_2e Emissions

Department	Gasoline Use (gal)	Diesel Use (gal)	Tons CO_2e	Cost
Code Enforcement	1,722	0	17	$2,967
DPW	32,465	67,880	1086	$194,600
Dog Control	1,390	0	14	$2,443
Fire Dept.	4,995	13,875	194	$35,517
Parking Ramps	1,009	0	10	$1,745
PHCD Dept.	805	0	8	$1,309
Police Dept.	75,308	0	747	$129,588
Sewer Dept.	7,410	4,940	128	$21,729
Water Dept.	8,976	8,976	189	$32,288
Total	**134,080**	**95,671**	**2393**	**$422,186.00**

[26] Initially, the baseline year for this inventory was 2005. A tremendous amount of data on City operations for this year was gathered before it was discovered that NYSEG could not supply community utility data prior to 2006. As a result, the baseline year was changed to 2006. Due to the fact that such City government operations do not vary significantly from year to year and it takes a lot of time to gather this data, some of the inventory data for City operations comes from 2005.



It is clear that the Department of Public Works consumed the majority of the gasoline and diesel and used 45% of the total energy consumed by the government fleet. Since the fuel used by the DPW included all of the machines operated by the City, it makes sense that the gas and diesel consumption would be the highest for this Department. The Police Department comes in a close second with 31% of the energy used by the City's vehicle feet. Once again, this number was high because of the duties of the Police Department, with many cars driving around the City daily.

Employee Commute

The employee commute was considered to fall under Scope 3 emissions because it was not something that the local government had direct control over. Please note that the numbers and information in this sector come from the original baseline year of 2005, however the baseline year data was considered representative of 2006 as well and therefore remained unchanged (see footnote #25). For 2005, there were an estimated 600 employees who traveled to work. A web survey was sent to employees via email, and 56 individuals responded to the survey. The survey showed that 75% of employees drove alone to work and that the average, one-way distance to City Hall (via roads) for employees was 4.32 miles (see Table 12 for further details). The average fuel economy of employee motor vehicles was 21.7 mpg. In extending the survey's sample to 600 employees, the ratios were kept the same. This resulted in 450 who drove alone each workday, 54 used a combination of modes, 32 walked each workday, 32

carpooled, 21 took public transportation, and 11 biked. By adjusting the collected data to include only those polluting on their commute to work, the final number of employees whose commutes resulted in the emission of greenhouse gases was 521.

Table 12. Employee Commute Transportation Modes

Mode of Transportation	Percentage
Drove alone	75%
Walked	5.36%
Carpooled	5.36%
Public Transportation	3.57%
Biked	1.79%
Used a combination of above modes	8.93%
Total	**100.0%**

Other Process Fugitive

This section of the local government analysis accounts for certain processes that produce a large amount of GHG emissions other than CO_2. The only process fugitive emissions that are significant for the City of Binghamton come from the sewage treatment plant. Since the plant uses anaerobic digestion in the treatment process, biogas (the by-product of anaerobic decomposition of organic material by bacteria) is produced as a result, which on average contains about 65-75% methane. The methane can then be captured and used to power another part of the system. In 2006, the Joint Sewage Treatment Plant started to capture this methane. However, there was a leak in the system, so the recorded numbers were not accurate and the data collection stopped. Then, in July 2009 they started keeping track of the methane produced again and began using it to produce heat needed to keep the sludge at a required temperature. The amount of digester gas produced per day was taken from 2009 data because it was the most accurate number available. By using the calculation in the Local Government Operations Protocol, it was possible to determine the estimated annual methane emissions for the plant, which was determined to be 48.12 metric tons. The amount of emissions of nitrous oxide, another fugitive emission, was calculated for the sewage treatment plant. In 2006, the plant did not utilize the practices of nitrification or denitrification. Both practices are now used, with nitrification starting in April 2008 and denitrification in June 2009. According to calculations, the amount of nitrous oxide that was emitted before nitrification and denitrification were in place was 1.46 metric tons released annually. It is important to account for nitrous oxide because it has a global warming potential of 310 and is significantly more harmful than carbon dioxide and even methane.

Refrigerants

While the amount of refrigerants used by government operations was determined by a best estimate, a very small amount of refrigerant can have a very large global warming potential. This data was obtained by traveling to the different City buildings and recording the types and amount of refrigerant used in air conditioners and vending machines. Though it is a refrigerant that was used in many of the air conditioners inventoried, R-22, otherwise known as Freon, was not accounted for by CACP because it has been phased out and is no longer used due to its harmful ozone depletion potential. The replacement refrigerant for Freon is R-134a. However, even this HFC (hydrofluorocarbon) is extremely harmful to the environment with a global warming potential of 1,300. Though each air conditioner only uses a few ounces of this HFC, this section is still included in the inventory because refrigerants are extremely harmful to the atmosphere. For the vehicle fleet air conditioners the purchasing department had an estimate of filling their refrigerant tank twice during the year, which amounts to 60 lbs of R-134a and 39 tons CO_2e. The estimated CO_2e resulting from government air totaled 1 ton of CO_2e.

C. Forecast and Target

In order to develop strategies and implement actions that will decrease energy consumption, it is important to have a projection of emission trends we continue under a "business as usual" scenario. The United States Federal Energy Information Administration conducts yearly studies that, given current energy usages, project future demand for many different kinds of energy and areas of the country. For electricity demand in commercial, residential, and industrial sectors, *Table 77: Electric Power Projections for New York* was used from the supplementary tables to the Annual Energy Outlook 2009 (http://eia.doe.gov/oiaf/aeo/supplement/supref.html). The numbers for natural gas demand was taken from *Table 117: Natural Gas Consumption by End Use Sector*, and the gasoline and diesel came from *Table 45: Transportation Sector Energy Use*. From this information, it was possible to calculate the annual percentage changes among the 14 years from 2006 to 2020 and the overall changes projected for each sector. Table 13, Projected Changes in Fuel Consumption in 2020 from 2009 Levels, shows the breakdown of different sectors and the values used to calculate the forecasted amount of emissions. From these estimated changes, the projected emissions in 2020 were calculated and are shown in the Figure 15.

Sector	Annual Change	Overall Change
Residential		
Electricity	0.214%	3.08%
Natural Gas	0.594%	8.68%
Commercial		
Electricity	1.13%	17.1%
Natural Gas	1.72%	26.8%
Industrial		
Electricity	-0.142%	0.98%
Natural Gas	4.48%	6.46%
Transportation		
Diesel	0.863%	12.8%
Gasoline	-0.671%	-9.88%

Table 13. Projected Changes in Fuel Consumption in 2020 from 2009 Levels

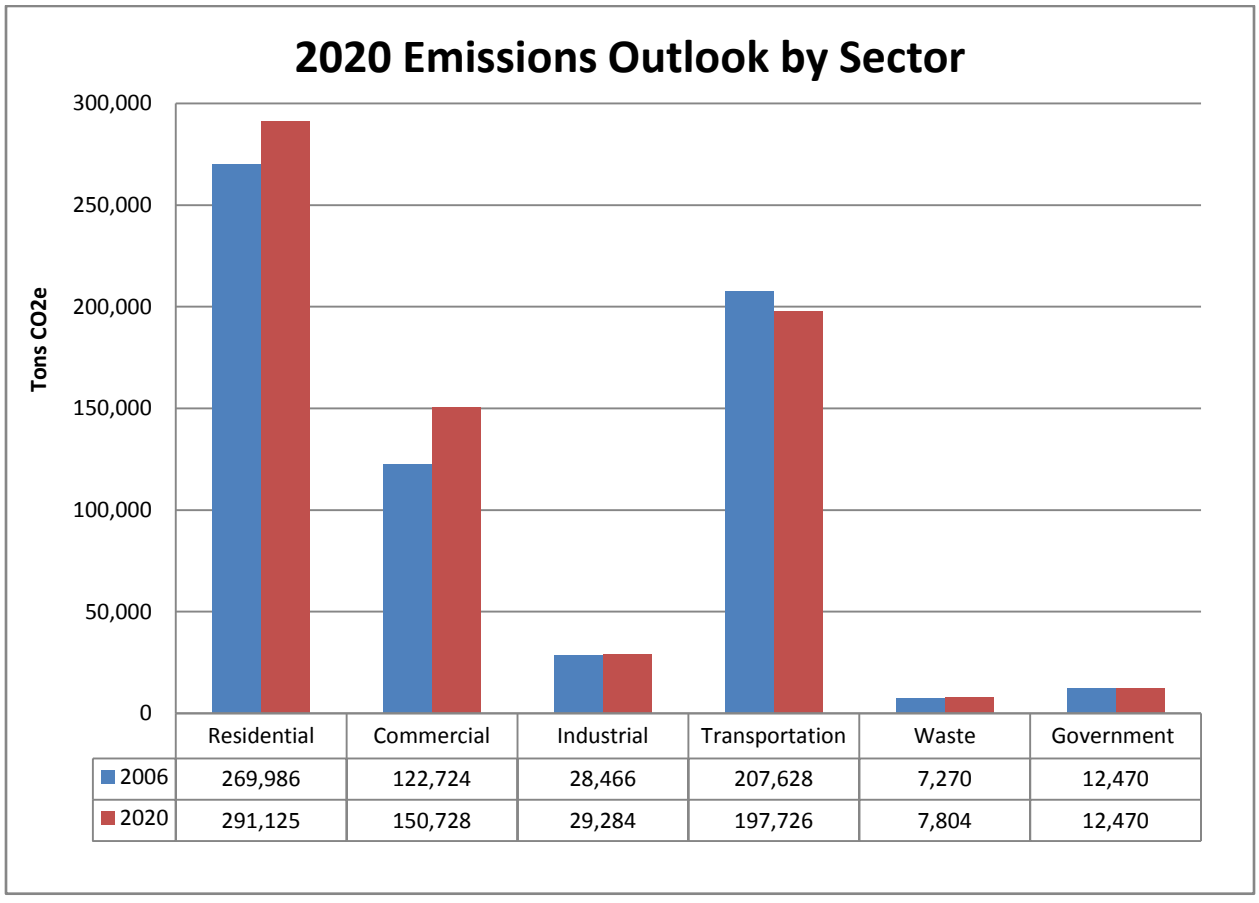


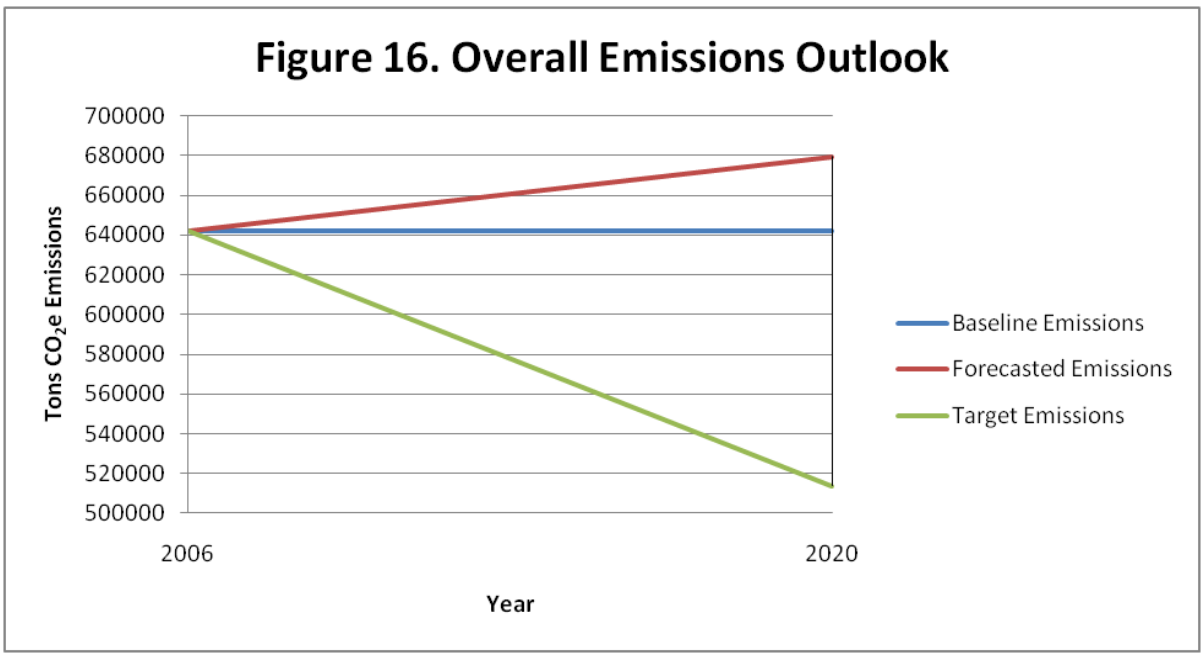
Figure 15. Emissions outlook by sector from 2006 to 2020.

As the Figure 15 illustrates, Residential and Commercial emissions are both projected to be significantly higher. However, Industrial emissions from electricity are expected to decrease while emissions from natural gas are expected to increase, resulting in only about a thousand tons CO_2e more than 2006 emissions. The Transportation emissions projection shown for 2020 is lower, which is a reasonable assumption due to higher fuel efficiencies for all vehicles within the coming years. Emissions from government operations were reasoned to remain constant, based on the lack of new facility construction and expansion plans. The City also has several energy saving measures planned or recently enacted.

From Binghamton's Solid Waste Management Report of 2008, the City's landfilled tonnage was projected to increase as well. As of 2006, the City of Binghamton was responsible for land-filling 14,956 tons of garbage. The amount thrown away in 2020 is expected to be around 16,055 tons. While there are no direct CO_2 emissions from garbage in landfills, the pollutant of concern is methane, which has a global warming potential of 21. In 2006, an estimated 101,910 lbs of methane was released from garbage in the landfill. That number is expected increase to about 109,399 lbs in 2020. The projected increase in waste was calculated by using the graph for tons of waste landfilled from 1991 to 2007. By extending the trend line out to 2020, it was possible to estimate the future amount of waste produced by Binghamton.

The total tons CO_2e for 2006 was calculated at **648,544** and are estimated to be **689,137** for 2020, an increase of about **40,593** tons.

Figure 16. Overall Emissions Outlook



By 2020, if nothing is done to curb emissions, the City of Binghamton will be releasing 5.8% more CO_2e gases into the atmosphere than in 2006.[27] Most members of ICLEI's Cities for Climate Protection Campaign aim for a target of a 15-20% reduction in emissions by 15 years after the baseline inventory year. To accomplish a 20% reduction by 2020, Binghamton overall would need to decrease total emissions of carbon dioxide equivalents to 518,835 tons, about 129,708 tons lower than 2006. It is important to note that the numbers estimated in this forecast are not exact, but they give a best estimate of where Binghamton currently stands and gives us a foundation to develop a strategic plan for emission reductions. It is important for Binghamton to take action now since the longer the community waits, the greater the problem will be and the harder correcting it will be.

D. Information Gathering Process

Overall, it took two and a half months to conduct the emissions inventory and complete this report. The work was performed by two Binghamton Planning Department interns, Laura Willemsen and Jonathon Ryan, along with the advisement of Amelia LoDolce, the Sustainable Development Planner.

A large portion of the energy usage data came from the main local energy provider, NYSEG. All of the electricity and natural gas usage for the Community analysis was provided by NYSEG's Regional Manager of Community Outreach & Development, Bob Pass, in the form of a spreadsheet which contained monthly aggregate kWh and therm use broken down into the main sectors of Residential, Commercial, and Industrial. For the electricity and natural gas consumed by the Government sector, the information was pulled from utility bills for 2006 located in the Finance Department of City Hall. The quantities of power usage were not totaled for each department at the end of each month, so it was necessary to look at each metered address and categorize them into respective departments for entry into the Clean Air and Climate Protection software. The Binghamton-Johnson City Joint Sewage Treatment Plant bills were not kept in City Hall, and the information for that facility was obtained by going to the plant and looking through their bills.

In many instances, data was very hard to find or wasn't satisfactorily detailed for reporting purposes, especially in records from our baseline year of 2006. In the future, it would be very helpful to keep better track of certain government activities so that when additional inventories are undertaken, the

[27] Population change was not taken into account in this forecast as updated population trend data will not be available until after the completion of the 2010 Census. Regardless, for the purposes of this inventory, it is safe to assume that energy per capita will increase above 2006 levels.

information gathered is more specific and easier to find. One area which would be extremely helpful to have better records on is the annual fuel consumption and use by department of the City's vehicle fleet. Since motor vehicle fuel combustion was a large contributor to greenhouse gas emissions, it would be very useful for future inventories (or just for the City's knowledge) to have exact numbers on how much fuel is used each time a vehicle fills up, what their fuel efficiency is, how many gallons of gasoline and diesel off road machines utilize, etc. The system that was put in place in late 2008 is already much better than what was in place before, but these are some improvements that could even be made to the current method.

Emissions Sources Not Included

There was a handful of greenhouse gas emitting sources that were not inventoried because there was too much uncertainty associated with them. However, any items that were impossible to include were minor in comparison to the known data of electricity, natural gas, and vehicle usage.

Propane – Propane use in homes was less prevalent in the City of Binghamton than in the more rural areas of Broome County. Sales records that were acquired for the City by two main distributors were deemed too error-prone based on the way they were organized (by zip code, which did not match well enough with Binghamton's geographical boundaries).

Air Travel – A portion of the emissions from planes traveling to and from the Greater Binghamton Airport are a consequence of resident travel and commercial activity within the City. However, it was unlikely that realistic flight and passenger numbers could have been established.

Train Freight – Some goods are shipped via railway in the City. The emissions from trains were not included, as a series of information requests about track distances and number of shipments in 2006 was unsuccessful.

Resident Activities – This was a broad category of emissions that would have been very difficult to quantify. For example, some residents in the City heat their homes by burning wood or wood pellets. There are also fossil fuels combusted by gas grills and recreational vehicles, but it would be very time consuming and costly to account for emissions from these sources.

III. Conclusion & Next Steps

The science is clear: climate change is real and will have significant social, environmental and economic costs across the globe. The time to act is now. With or without national leadership on this issue, local governments must step up to the plate to address climate change mitigation and adaption. The completion of the City of Binghamton's greenhouse gas emission inventory marks an important milestone in the City's route to meeting its commitment to substantially reducing GHG emissions. Having a baseline measurement of emissions will allow the City to develop a realistic and measured strategy for meeting a specific reduction target. The City will lay out this strategy in a Climate Action Plan, which should be completed by the end of 2010, and proceed with implementing policies and practices that will allow Binghamton to reduce its impact on global and local environments while simultaneously stimulating economic development, safeguarding public health, creating the development of green collar jobs, reducing taxes, and revitalizing Binghamton. Further, reducing GHG emissions and fossil fuel energy consumption in Binghamton can help to build a more resilient community that is less vulnerable to the fluctuations in the prices of fossil fuels.

Even though less than 2% of Binghamton's GHG emissions came from government activities in 2006, City government has an important role to play reducing emissions from both the public and private sectors. Through policy decisions about land use and development, energy-efficient building practices, waste reduction and recycling programs, the City can directly and indirectly stimulate more changes in behavior outside of City government that will reduce emissions. The City can further help residents and businesses to reduce emissions and save money by providing educational opportunities and financial resources that enable them to take action themselves. Choosing to invest combating climate change is a decision to invest in a sustainable, prosperous future for Binghamton.

City of Binghamton Green Initiatives

Tree City USA

For four years running and ten total years, the City of Binghamton has received the title of "Tree City USA" which the Arbor Day Foundation awards to municipalities committed to community forestry. The criteria to receive this title include having a Tree Board or Department, a tree care ordinance, a comprehensive community forestry program, and an Arbor Day observance and proclamation. The City's tree related efforts include the following:

Shade Tree Commission
The Shade Tree Commission is an advisory board for the City of Binghamton made up of seven members, who are charged with studying the problems and determining the needs of the City of Binghamton in connection with its tree planting programs. The Commission is also responsible for helping the Parks and Recreation Department decide what type of trees will be planted in the City, and for assisting with the dissemination of news and information regarding selection, planting, and maintenance of trees within the City limits. In addition, the Shade Tree Commission provides advice to the Planning Commission in the review of site plans in regards to trees and landscaping. **Contact the Commission at:** 772-7001 or shadetree@cityofbinghamton.com.

Street Tree Planting Program
The City of Binghamton Parks Department offers a free tree planting service. Residents interested in having a tree planted in the utility strip in front of their property should complete the Tree Request Form and return it to the Park's Department. For more information or a Tree Request Form, call the Parks Department at 772-7017 or visit their website: http://www.cityofbinghamton.com/dept-parks-recreation.asp.

Yard Tree Coupon Program
The City of Binghamton is sponsoring the Yard Tree Coupon Program in an effort to encourage property owners to plant trees. Developed by the City of Binghamton Shade Tree Commission in 2008, the Yard Tree Coupon Program provides a $35 coupon to eligible property owners for the purchase of a tree that will be planted on their land. Interested residents or property owners should complete the Yard Tree Coupon Application and return it to the Department of Planning, Housing, and Community Development. The form is available online at http://www.cityofbinghamton.com/dept-planning.asp. For more information, please contact Sustainable Development Planner Amelia LoDolce at 772-7028 or anlodolce@cityofbinghamton.com.

Tree Planting Donation Fund
A City fund set up in 2007 which will allow the Parks and Recreation Department to accept private donations to reach Mayor Ryan's goal of boosting tree plantings by 10% annually over the next five years. To donate, call 607-772-7017.

Greening City Facilities

In all actions the City is committed to identifying and pursuing opportunities to adopt green practices for its facilities, such as: energy efficiency and conservation in City operations, green cleaning products, energy star office appliances, post consumer recycled paper, and energy conservation awareness raising. Additional information on green initiatives within City facilities:

Energy Efficiency

In 2004, the City began a 15 year contract with Siemens Building Technologies to implement energy savings measures for City operations. Siemens has upgraded City facility and traffic lights, facility heating, ventilating, and air conditioning systems, and facility control systems. As of April 30, 2009, this contract has allowed the City to save a total of $765,962 and reduce its annual energy consumption by approximately 2 million kilowatt hours, or the equivalent total energy use for 12 homes28.

Conservation Policy

On May 23, 2008, Mayor Matt Ryan introduced a Resource Conservation Policy to help the City of Binghamton reduce carbon emissions, minimize resource consumption, and cut costs. The conservation policy includes new guidelines for City employees to reduce the energy used by electronics, to recycle common office supplies, to properly dispose of batteries and other potentially toxic materials, and to minimize fossil fuel consumption by reducing City vehicle idling. The policy provides supplementary information explaining the positive impact of such practices.

In addition, City Hall changes its hours of operation to 8am-4pm during the summer season in order to save costs on security and utilities. The building begins the summer schedule on Tuesday, May 27th and will resume normal business on Tuesday, September 2nd. The City accrues approximately $4,000 in savings on security alone.

Purchase of Hybrids

In April 2009, the Binghamton Police Department added to their fleet three 2008 Nissan Altima hybrids, a more fuel efficient alternative to the long-used Ford Crown Victoria. While the Crown Victoria's fuel efficiency ranges from 8-12 miles per gallon of gasoline, the new hybrids will drive at 35 miles per gallon, as they run in part on gas and part on an electric motor. Using the hybrids, the Department anticipates saving two-thirds the cost of gas. Last year the Department spent roughly $280,000 on gasoline, meaning that a large-scale transition to hybrids would amount to substantial savings. It is also expected that the Altimas will have much lower maintenance expenses, given their dependability, and the frequent breakdowns of the Crown Victorias. The Nissan Altima hybrids cost $21,500, slightly more than the Ford Crown Victorias price of $20,000. It is anticipated that the hybrids' fuel-efficiency and reliability will make up the difference in a short amount of time. The City is looking to add additional hybrids to the fleet in the near future.

Ely Park Electric Vehicles

In 2009, the City also replaced Ely Park Golf Course's gas-powered carts with an electric alternative. The new carts are charged in Ely Park's storage garage overnight, when electricity rates are at their lowest. In light of studies of other courses, the City anticipates the change will produce significant cost-savings. The electric carts will continue to be in use while operations of the golf course are under management of Ely Park LLC.

[28] The average household consumption of energy, as measured by the US Department of Energy, was 10,656 kWh in 2001 (http://www.eia.doe.gov/emeu/recs/recs2001/enduse2001/enduse2001.html).

Recycling

The City has accomplished a successful solid waste program through an aggressive recycling program, and a bag "user fee" program. In 1991, the City adopted a Pay-As-You-Throw garbage collection system. Residents pay for City "green bags," which funds the costs of garbage disposal, allowing residents to only pay for the garbage that they produce. This program not only spreads the cost more equitably, it also provides an incentive for recycling. The combination of the bag and recycling programs has produced a dramatic decrease in the waste stream. The average overall yearly tonnage has decreased by nearly 48%, and the City recycling rate in 2008 was 41.2%, above the national average of 32.5%. This has led to a savings of around $300,000 per year in landfill tipping fee costs.

Additional Recycling Efforts:

Recycling Enhancement Program

In November of 2008, the City of Binghamton rolled out its new Recycling Enhancement Program. The purpose of the Recycling Enhancement Program is to increase the City's rate of recycling, reduce garbage disposal costs for low-moderate income residents, and provide youth employment opportunities. The program will continue into the fall of 2009. The Program funds 1) television public service announcements that promote recycling, 2) youth recycling educators who provide education on recycling and waste reduction to residents and deliver recycling bins to households without bins, 3) the placement of new outdoor recycling receptacles along Main and Court Streets.

Construction and Demolition Material Reuse and Recycling

In keeping with Mayor Ryan's commitment to sustainable development, the City is promoting deconstruction, preservation, salvaging, and other green building practices through a range of efforts. Reusing and recycling building materials provides numerous environmental and economic benefits including: diverting materials from landfills, increasing the useful life of landfill space, conserving natural resources, decreasing greenhouse gas emissions, and stimulating economic development through the creation of recycling businesses and jobs. In addition, functional or aesthetic features that are not found in new products can be offered by salvaged materials. City efforts to promote the recycling and reuse of construction and demolition materials include:

- On February 24, 2009, the City sponsored a workshop on deconstruction, which was attended by over 40 contractors, homeowners, community groups, architects, historic preservation advocates, environmental consultants, and public officials, including representatives from the City and County. Deconstruction is the process of systematically dismantling a building to remove materials for reuse and recycling.
- In the Fall of 2009, the City had three residential buildings taken down through the process of deconstruction through its Restore NY grant.
- The City allows members of the Preservation Association of the Southern Tier (PAST) to salvage materials from buildings slated to be demolished with City funds. The PAST Showroom, at 21 North Depot Street, offers a wide variety of items salvaged from deconstruction sites, including slate roofing, stairway railings, light fixtures, sinks, claw foot bathtubs, windows, doors, fireplace mantels, moldings and much more. For more information or to schedule an appointment, please call the Showroom's manager, Karen Anderson, at (607) 648-3835, or visit the organization's website at www.pastny.org.

Green Home Construction

Straw Bale

The City is turning a former eyesore into New York State's first straw bale affordable home. The new home at 47 Mary Street, to be built in 2010, will feature at least three energy efficiency design elements, including straw bale construction, tankless water heating and underfloor space heating. Straw bale construction provides three times the insulation value of conventional design, producing significant energy savings for property owners. Tankless water heating is 34% more energy efficient than conventional storage tank water heating. Underfloor space heating has been shown to achieve 40% in fuel savings when compared to forced air systems. The City will sell the completed home to an owner occupant who qualifies under guidelines established by the U.S. Department of Housing and Urban Development (HUD), which administers the HOME program.

Energy Star Universal Design Construction

1 Tremont: NSP funds have allowed the City to demolish this fire damaged building and then construct a new, Energy Star rated home (construction will occur in 2010). The home will have universal design elements, making it handicap accessible. The City plans to sell the redeveloped property to an owner occupant.

Neighborhood Stabilization Program under the Housing and Economic Recovery Act (HERA) late last year, and the City began assembling its grant proposal shortly thereafter. The Program then received additional funding through the American Re-Investment and Recovery Act (ARRA), which was passed in February. The City's grant comes from HERA, and it may apply for additional NSP funding from ARRA.

River Trail Development

The Binghamton River Trails Commission is an umbrella organization committed to systematic coordination of resources, development and use of the City's waterways within the framework of the Local Waterfront Revitalization Plan (LWRP) and the downtown revival. Based at City Hall, the BRTC partnership includes stakeholders who represent commercial, cultural, recreation, and environmental interests in the future of our waterways and our community. To get involved or for more information, call the Department of Economic Development at 607-772-7161 or visit http://www.cityofbinghamton.com/dept-economic-development.asp.

Community Garden Development

The City has provided support for resident initiated and maintained community garden development in all interested sides of the City by providing grant funding and land for these initiatives. Supporting the growth of local food production is an important part of rebuilding locally based, resilient economies and reducing greenhouse gas emissions from food transport. There are currently five community gardens in the City of Binghamton managed by Volunteers Improving Neighborhood Environments (VINES) (http://www.vinescommunitygardens.org).

Climate Change

Mayor Matt Ryan officially signed the Mayor's Climate Protection Agreement on April 19, 2007, adding Binghamton to the list of more than 1,017 municipalities that have pledged to take proactive measures in dealing with climate change in the absence of strong federal leadership.

In April 2009, the City became a member of ICLEI- Local Governments for Sustainability (ICLEI) and committed to participating in ICLEI's Cities for Climate Protection campaign, which involves undertaking the 5 Milestone process for reducing greenhouse gas emissions. The City joined ICLEI upon recommendation from the Commission on Sustainable Development and Smart Growth. A greenhouse gas inventory (Milestone 1) was completed with the assistance of two Binghamton University interns in 2009. By Fall 2010, the City intends to have adopted a reduction target (Milestone 2) and to have developed its Climate Action Plan (Milestone 3) for achieving the reduction target. Funds from the Energy Efficiency and Conservation Block Grant will be used toward personnel costs for developing the Climate Action Plan. The Climate Action Plan will be written by the City's Sustainable Development Planner with assistance from Binghamton University interns and in conjunction with guidance from an advisory committee made up of representatives from the City Hall (Mayor's Office, all Departments, City Council), the community (residents, business, educational institutions), and environmental advocacy organizations. The final steps of the CCP will be to implement the action plan (Milestone 4) and monitor and evaluate the impacts of the action plan (Milestone 5).

Binghamton Energy Efficiency Pilot Program

Starting in mid-2009, the Sustainable Development Planner has been working to create a revolving fund for residential energy efficiency retrofits. Having researched model programs in other communities, the City now has a blueprint for the Binghamton Energy Efficiency (Be2) program. The goal of the Be2 Pilot Program is to create a financial incentive for homeowners to weatherize their homes, thereby reducing energy costs for consumers, stimulating the development of green collar jobs, and reducing greenhouse gas emissions. Through the Be2 program, home owners will have access to the upfront capital needed to fund energy efficiency improvements to their homes. Program participants will then have a benefit assessment placed on their property, which will be paid off over a set period of time. The benefit assessment payments will be re-circulated through the program, creating a revolving fund that will maximize the use of program dollars. The Be2 program will be launched in 2010.

Local Government Operations Standard Inventory Report

1. Local Government Profile

Jurisdiction Name: City of Binghamton, NY
Street Address: 38 Hawley St, City Hall 4th Floor
City, State Zip Country: Binghamton, NY 13901 USA
Website: www.cityofbinghamton.com

Size (sq. miles): 10
Population: 45,217
Annual Budget: $78,857,896
Employees (Full Time Equivalent): 550
Climate Zone: 5
Annual Heating Degree Days: 7273
Annual Cooling Degree Days: 337

Contact Person: Sustainable Development Planner
Name: Amelia LoDolce
Email: anlodolce@cityofbinghamton.com
Phone Number: (607) 772-7028

Services Provided:

☒ Water treatment	☐ Mass transit (buses)	☐ Airport
☒ Water distribution	☐ Mass transit (light rail)	☐ Seaport/shipping terminal
☒ Wastewater treatment	☐ Mass transit (ferries)	☐ Marina
☒ Wastewater collection	☐ Schools (primary/secondary)	☐ Stadiums/sports venues
☐ Electric utility	☐ Schools (colleges and universities)	☐ Convention center
☒ Fire Protection	☒ Solid waste collection	☒ Street lighting and traffic signals
☒ Police	☐ Solid waste disposal	☐ Natural gas utility
	☐ Hospitals	☒ Other Senior Recreation Centers

Local Government Description:

The City of Binghamton is the local unit of government responsible for implementing City programs and policies to enhance the quality of life for residents and visitors to the City of Binghamton.

2. GHG Inventory Details:

Reporting Year: 2006
Protocol Used: Local Government Operations Protocol
Control Approach:

GHG Emissions Summary (All Units in Metric Tons Unless Stated Otherwise)*

Buildings and Other Facilities								
SCOPE 1		CO_2e	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6
	Fugitive Emissions	0.907	0.907	0	0	0.000919	0	0
	Total Direct Emissions	0.907	0.907	0	0	0.000919	0	0
SCOPE 2		CO_2e	CO_2	CH_4	N_2O			
	Purchased Electricity	1536.8	1529.5	0.0535	0.02 36			
	Purchased Natural Gas	845.5	843.7	0.0798	0.00181			
	Total Indirect Emissions	2382.3	2373.2	0.133	0.0254			

Streetlights and Traffic Signals					
SCOPE 2		CO_2e	CO_2	CH_4	N_2O
	Purchased Electricity	757.5	753.0	0.0263	0.0113
	Total Indirect Emissions	757.5	753.0	0.0263	0.0113
INDICATORS	Number of Traffic Signals = 100 (based on 100 on-site electricity meters)				
	Number of Underpasses = 7				

Water Delivery Facilities					
SCOPE 2		CO_2e	CO_2	CH_4	N_2O
	Purchased Electricity	1549.5	1540.4	0.0535	0.0236
	Purchased Natural Gas	193.2	193.2	0.0181	0.000454
	Total Indirect Emissions	1742.7	1733.6	0.0716	0.024054
INDICATORS	Gallons of Drinking Water Treated = 7 million gallons/day average				

Wastewater Facilities					
SCOPE 1		CO_2e	CO_2	CH_4	N_2O
	Fugitive Emissions	1318.1	0	48.0	1.00
	Total Direct Emissions	1318.1	0	48.0	1.00
SCOPE 2		CO_2e	CO_2	CH_4	N_2O
	Purchased Electricity	2141.0	2129.2	0.0739	0.0327
	Purchased Natural Gas	384.6	383.7	0.0363	0.000907
	Total Indirect Emissions	2525	2512.9	0.1102	0.033607
INDICATORS	Gallons of Wastewater Treated = 20 million gallons/day average				

Vehicle Fleet					
SCOPE 1		CO_2e	CO_2	CH_4	N_2O
	Stationary Combustion	2170.9	2139.1	0.075	0.0972
	Fugitive Emissions	37.2	0	0	0
	Total Direct Emissions	2208.1	2139.1	0.075	0.0972
INDICATORS	Number of On-road Vehicles = 212				
	Vehicle Miles Traveled = 2,665,188 miles/year				

Employee Commute					
SCOPE 3		CO_2e	CO_2	CH_4	N_2O
	Stationary Combustion	438.2	429.1	48.1	55.3
	Total Direct Emissions	438.2	429.1	48.1	55.3
INDICATORS	Average Distance from City Hall = 4.32 miles				
	Average Vehicle Fuel Efficiency = 21.7 miles/gal				

Total Emissions								
		CO_2e	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6
	SCOPE 1	3527.1	2140	48.08	1.097	0.000919	0	0
	SCOPE 2	7407.5	6392.1	0.341	0.0831			
	SCOPE 3	438.2	429.1	48.1	55.3			

*Note that within the main report, amounts are presented in tons. Here, they are presented in metric tons in keeping with the convention of Standard Inventory Reports.

Global Warming and Ozone Depletion Potentials

Common Name	Formula	Chemical Name	GWP
Carbon dioxide	CO_2		1
Methane	CH_4		21
Nitrous oxide	N_2O		310
Sulfur hexafluoride	SF_6		23,900
Hydrofluorocarbons (HFCs)			
HFC-23	CHF_3	trifluoromethane	11,700
HFC-32	CH_2F_2	difluoromethane	650
HFC-41	CH_3F	fluoromethane	150
HFC-43-10mee	$C_5H_2F_{10}$	1,1,1,2,3,4,4,5,5,5-decafluoropentane	1,300
HFC-125	C_2HF_5	pentafluoroethane	2,800
HFC-134	$C_2H_2F_4$	1,1,2,2-tetrafluoroethane	1,000
HFC-134a	$C_2H_2F_4$	1,1,1,2-tetrafluoroethane	1,300
HFC-143	$C_2H_3F_3$	1,1,2-trifluoroethane	300
HFC-143a	$C_2H_3F_3$	1,1,1-trifluoroethane	3,800
HFC-152	$C_2H_4F_2$	1,2-difluoroethane	43*
HFC-152a	$C_2H_4F_2$	1,1-difluoroethane	140
HFC-161	C_2H_5F	fluoroethane	12*
HFC-227ea	C_3HF_7	1,1,1,2,3,3,3-heptafluoropropane	2,900
HFC-236cb	$C_3H_2F_6$	1,1,1,2,2,3-hexafluoropropane	1,300*
HFC-236ea	$C_3H_2F_6$	1,1,1,2,3,3-hexafluoropropane	1,200*
HFC-236fa	$C_3H_2F_6$	1,1,1,3,3,3-hexafluoropropane	6,300
HFC-245ca	$C_3H_3F_5$	1,1,2,2,3-pentafluoropropane	560
HFC-245fa	$C_3H_3F_5$	1,1,1,3,3-pentafluoropropane	950*
HFC-365mfc	$C_4H_5F_5$	1,1,1,3,3-pentafluorobutane	890*
Perfluorocarbons (PFCs)			
Perfluoromethane	CF_4	tetrafluoromethane	6,500
Perfluoroethane	C_2F_6	hexafluoroethane	9,200
Perfluoropropane	C_3F_8	octafluoropropane	7,000
Perfluorobutane	C_4F_{10}	decafluorobutane	7,000
Perfluorocyclobutane	$c\text{-}C_4F_8$	octafluorocyclobutane	8,700
Perfluoropentane	C_5F_{12}	dodecafluoropentane	7,500
Perfluorohexane	C_6F_{14}	tetradecafluorohexane	7,400

Source: Intergovernmental Panel on Climate Change (IPCC) Second Assessment Report published in 1995, unless no value was assigned in the document. In that case, the GWP values are from the IPCC Third Assessment Report published in 2001 (those marked with *). GWP values are from the Second Assessment Report (unless otherwise noted) to be consistent with international practices. Values are 100-year GWP values.

Source: LGOP Guide, Table E.1 "GWP Factors for Greenhouse Gases", p. 166.

Refrigerant Blend	Global Warming Potential
R-401A	18
R-401B	15
R-401C	21
R-402A	1,680
R-402B	1,064
R-403A	1,400
R-403B	2,730
R-404A	3,260
R-406A	0
R-407A	1,770
R-407B	2,285
R-407C	1,526
R-407D	1,428
R-407E	1,363
R-408A	1,944
R-409A	0
R-409B	0
R-410A	1,725
R-410B	1,833
R-411A	15
R-411B	4
R-412A	350
R-413A	1,774
R-414A	0
R-414B	0
R-415A	25
R-415B	105
R-416A	767
R-417A	1,955
R-418A	4
R-419A	2,403
R-420A	1,144
R-500	37
R-501	0
R-502	0
R-503	4,692
R-504	313
R-505	0
R-506	0
R-507 or R-507A	3,300
R-508A	10,175
R-508B	10,350
R-509 or R-509A	3,920

Source: ASHRAE Standard 34

Source: LGOP Guide, Table E.2 "GWP Factors for Refrigerant Blends", p. 167.

Coefficient Sets Used

Emissions from Electricity (for eGrid region NYUP):

CO_2 (lb/MWh)	N_20 (lb/MWh)	CH_4 (lb/MWh)	NO_x (lb/MWh)	SO_x (lb/MWh)	CO (lb/MWh)	VOC (lb/MWh)	PM10 (lb/MWh)
720.8	0.01119	0.02482	1.057	3.338	1.038	0.1166	0.9023

Natural Gas and Motor Vehicle Fuels:

Fuel Type	Heat Content	Carbon Content (Per Unit Energy)	Fraction Oxidized	CO_2 Emission Factor (Per Unit Energy)	CO_2 Emission Factor (Per Unit Mass or Volume)
Coal and Coke	**MMBtu / Short ton**	**kg C / MMBtu**		**kg CO_2 / MMBtu**	**kg CO_2 / Short ton**
Anthracite Coal	25.09	28.26	1.00	103.62	2,599.83
Bituminous Coal	24.93	25.49	1.00	93.46	2,330.04
Sub-bituminous Coal	17.25	26.48	1.00	97.09	1,674.86
Lignite	14.21	26.30	1.00	96.43	1,370.32
Unspecified (Residential/ Commercial)	22.05	26.00	1.00	95.33	2,102.29
Unspecified (Industrial Coking)	26.27	25.56	1.00	93.72	2,462.12
Unspecified (Other Industrial)	22.05	25.63	1.00	93.98	2,072.19
Unspecified (Electric Utility)	19.95	25.76	1.00	94.45	1,884.53
Coke	24.80	31.00	1.00	113.67	2,818.93
Natural Gas (By Heat Content)	**Btu / Standard cubic foot**	**kg C / MMBtu**		**kg CO_2 / MMBtu**	**kg CO_2 / Standard cub. ft.**
975 to 1,000 Btu / Std cubic foot	975 – 1,000	14.73	1.00	54.01	Varies
1,000 to 1,025 Btu / Std cubic foot	1,000 – 1,025	14.43	1.00	52.91	Varies
1,025 to 1,050 Btu / Std cubic foot	1,025 – 1,050	14.47	1.00	53.06	Varies
1,050 to 1,075 Btu / Std cubic foot	1,050 – 1,075	14.58	1.00	53.46	Varies
1,075 to 1,100 Btu / Std cubic foot	1,075 – 1,100	14.65	1.00	53.72	Varies
Greater than 1,100 Btu / Std cubic foot	> 1,100	14.92	1.00	54.71	Varies
Weighted U.S. Average	1,029	14.47	1.00	53.06	0.0546
Petroleum Products	**MMBtu / Barrel**	**kg C / MMBtu**		**kg CO_2 / MMBtu**	**kg CO_2 / gallon**
Asphalt & Road Oil	6.636	20.62	1.00	75.61	11.95
Aviation Gasoline	5.048	18.87	1.00	69.19	8.32
Distillate Fuel Oil (#1, 2 & 4)	5.825	19.95	1.00	73.15	10.15
Jet Fuel	5.670	19.33	1.00	70.88	9.57
Kerosene	5.670	19.72	1.00	72.31	9.76
LPG (average for fuel use)	3.849	17.23	1.00	63.16	5.79
Propane	3.824	17.20	1.00	63.07	5.74
Ethane	2.916	16.25	1.00	59.58	4.14
Isobutene	4.162	17.75	1.00	65.08	6.45
n-Butane	4.328	17.72	1.00	64.97	6.70
Lubricants	6.065	20.24	1.00	74.21	10.72
Motor Gasoline	5.218	19.33	1.00	70.88	8.81
Residual Fuel Oil (#5 & 6)	6.287	21.49	1.00	78.80	11.80
Crude Oil	5.800	20.33	1.00	74.54	10.29
Naphtha (<401 deg. F)	5.248	18.14	1.00	66.51	8.31
Natural Gasoline	4.620	18.24	1.00	66.88	7.36
Other Oil (>401 deg. F)	5.825	19.95	1.00	73.15	10.15
Pentanes Plus	4.620	18.24	1.00	66.88	7.36
Petrochemical Feedstocks	5.428	19.37	1.00	71.02	9.18
Petroleum Coke	6.024	27.85	1.00	102.12	14.65
Still Gas	6.000	17.51	1.00	64.20	9.17
Special Naphtha	5.248	19.86	1.00	72.82	9.10
Unfinished Oils	5.825	20.33	1.00	74.54	10.34
Waxes	5.537	19.81	1.00	72.64	9.58

Source: LGOP Guide, Table G.1 "Default Factors for Calculating CO_2 Emissions From Combustion of Fossil Fuels", p. 170. *Note that not all possible fuel types listed here were represented in the inventory.*

Vehicle Types and Model Years:

Vehicle Type and Year	N_2O (g/mi)	CH_4 (g/mi)
Gasoline Passenger Cars		
Inventory Year 1999	0.05372	0.05035
Inventory Year 2000	0.05080	0.04648
Inventory Year 2001	0.04711	0.04248
Inventory Year 2002	0.04364	0.03886
Inventory Year 2003	0.04011	0.03542
Inventory Year 2004	0.03630	0.03251
Inventory Year 2005	0.03413	0.02990
Inventory Year 2006	0.02940	0.02780
Gasoline Light Trucks (Vans, Pickup Trucks, SUVs)		
Inventory Year 1999	0.09029	0.06059
Inventory Year 2000	0.08665	0.05701
Inventory Year 2001	0.07795	0.05158
Inventory Year 2002	.07095	0.04700
Inventory Year 2003	0.06295	0.04236
Inventory Year 2004	0.05593	0.03811
Inventory Year 2005	0.04935	0.03451
Inventory Year 2006	0.04331	0.03146
Gasoline Heavy-Duty Vehicles		
Inventory Year 1999	0.12126	0.26243
Inventory Year 2000	0.12262	0.23709
Inventory Year 2001	0.12546	0.21149
Inventory Year 2002	0.12721	0.19053
Inventory Year 2003	0.12685	0.17253
Inventory Year 2004	0.11780	0.15537
Inventory Year 2005	0.10984	0.13826
Inventory Year 2006	0.10310	0.12351

Vehicle Type and Year	N_2O (g/mi)	CH_4 (g/mi)
Diesel Passenger Cars		
Inventory Year 1999	0.001	0.0005
Inventory Year 2000	0.001	0.0005
Inventory Year 2001	0.001	0.0005
Inventory Year 2002	0.001	0.0005
Inventory Year 2003	0.001	0.0005
Inventory Year 2004	0.001	0.0005
Inventory Year 2005	0.001	0.0005
Inventory Year 2006	0.001	0.0005
Diesel Light Trucks (Vans, Pickup Trucks, SUVs)		
Inventory Year 1999	0.00144	0.00094
Inventory Year 2000	0.00145	0.00095
Inventory Year 2001	0.00146	0.00096
Inventory Year 2002	0.00147	0.00097
Inventory Year 2003	0.00147	0.00097
Inventory Year 2004	0.00148	0.00098
Inventory Year 2005	0.00148	0.00098
Inventory Year 2006	0.00149	0.00099
Diesel Heavy-Duty Vehicles		
Inventory Year 1999	0.0048	0.0051
Inventory Year 2000	0.0048	0.0051
Inventory Year 2001	0.0048	0.0051
Inventory Year 2002	0.0048	0.0051
Inventory Year 2003	0.0048	0.0051
Inventory Year 2004	0.0048	0.0051
Inventory Year 2005	0.0048	0.0051
Inventory Year 2006	0.0048	0.0051

Source: LGOP Guide, Table G.13 "Alternative Methodology CH_4 and N_20 Emission Factors for Highway Vehicles by Model Year", p. 180.

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