SWARTHMORE AREA GREENHOUSE GAS EMISSIONS INVENTORY AND ACTION PLAN PROJECT

A report prepared by: Center for Sustainable Communities at Temple University

VOLUME I: Greenhouse Gas Inventory (Base Year 2006)

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DECEMBER 2010

A report prepared by:

Center for Sustainable Communities
Temple University

On behalf of

Nether Providence Township, Rose Valley Borough, Rutledge Borough, Swarthmore Borough, Swarthmore College, and the Wallingford-Swarthmore School District

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EXECUTIVE SUMMARY

This report presents the results of the **Swarthmore Area Greenhouse Gas Emissions Inventory**, completed in 2010 with the technical assistance of Temple University's Center for Sustainable Communities (CSC) on behalf of the municipalities of Nether Providence Township, Rose Valley Borough, Rutledge Borough, and Swarthmore Borough (Delaware County, Pennsylvania). The report includes analysis of Greenhouse Gas (GHG) emissions by the four municipal governments and the community's residents and businesses. In addition, GHG inventories were performed for Swarthmore College and the Wallingford-Swarthmore School District. For each entity, analysis was completed for the years 2005, 2006, 2007, and 2008. The inventories — initiated by the township and borough councils, Swarthmore College, and the school board with the support of the communities' Environmental Advisory Councils (EACs) — set a baseline against which to measure future efforts to reduce GHG emissions.

Total GHG emissions in 2006 attributable to the residents, businesses, institutions, and municipal government operations in the four communities equaled 218,235 metric tons of carbon dioxide (CO_2) equivalents ($MTCO_2E$). The most significant emissions *sectors* in the four communities are Transportation (accounting for 41% of total GHG emissions) and Residential Home Energy Use (38%). The largest *sources* of GHG emissions are gasoline (35%) and electricity (30%).

The four municipal governments were responsible for 0.65% of the communities' 2006 GHG emissions, a total of 1,411 $MTCO_2E$. The major *sectors* of government emissions were Buildings and Facilities (36%), Vehicle Fleet (31%), and Streetlights and Traffic Signals (24%) and the two major *sources* of government emissions were electricity (46%) and gasoline (24%).

Swarthmore College was responsible for 16,768 $MTCO_2E$, about 8% of total community emissions. Energy use for buildings and facilities was the source of 96% of college emissions. The Wallingford-Swarthmore School District (WSSD) was responsible for 6,644 $MTCO_2E$ in 2006 (3% of total community emissions) and electricity use was the source of 40% of those emissions. Other significant sources were fuel oil for heating (25%) and motor fuels (gasoline, 21%, and diesel, 11%).

In addition to the detailed information on community, municipal government, college, and school district GHG emissions, this report also provides projections for the year 2025 when emissions are likely to be about 196,500 $MTCO_2E$, or 11% less than in 2006. Technical information concerning the data collection and analytical methods used are provided, as well as comparisons to emissions inventories completed in other communities in the region in recent years.

The use of the information provided in this document for planning energy consumption and GHG emissions reduction efforts will be discussed in a companion document entitled **A Multi-**

Municipal Climate Change Action Plan for Nether Providence Township, Rose Valley Borough, Rutledge Borough, and Swarthmore Borough.

~ Temple University Center for Sustainable Communities,

December 2010.

INTRODUCTION

This report presents the results of a Greenhouse Gas (GHG) Inventory that Temple University's Center for Sustainable Communities (CSC) conducted on behalf of four municipalities in Delaware County, Pennsylvania—Nether Providence Township, Rose Valley Borough, Rutledge Borough, and Swarthmore Borough—and Swarthmore College and the Wallingford-Swarthmore School District (WSSD). The inventory was initiated as part of a 2009 grant provided by the Pennsylvania Department of Environmental Protection (DEP) to the four municipalities. The DEP's Local Government Greenhouse Gas Pilot Grant was designed to assist municipalities in conducting emissions inventories and developing action plans for reducing emissions in future years. Applications from municipalities already actively working to reduce energy consumption and willing to collaborate on multi-municipal inventories and action plans were especially encouraged. Past efforts of the four communities and their 2006 collaboration on a multi-municipal comprehensive plan helped them successfully win the grant that funded this study.

This report is divided into four sections: a description of the approach and methods used to conduct this analysis; GHG emissions inventories for the four communities, their municipal governments, Swarthmore College and the Wallingford-Swarthmore School District; projections for future years; and comparisons of the project municipalities' emissions with other communities in the region, the state and the nation. Details for each municipality's government and community emissions are provided in the appendix of the report.

PROJECT PARTICIPANTS

The neighboring municipalities of Swarthmore, Rose Valley, Nether Providence, and Rutledge are located approximately ten miles west of the city of Philadelphia in Delaware County, Pennsylvania (see Figure 1). The region is characterized primarily by high and low density suburban residential neighborhoods, comprising about three-quarters of the area of the four municipalities, as well as institutional and commercial properties, and conservational woodlands. The communities' proximity to Philadelphia and other major regional destinations makes them a popular residential choice for people who desire a suburban lifestyle with good access to jobs, resources, and recreational opportunities with multiple modes of transportation.

The people who live in these communities are well-educated and affluent compared to the rest of the state. Of the 21,430 residents in 2000, 94% had attained at least a high school diploma, and 57% had gone on to achieve a bachelors degree or higher.[1] The average per capita income in 2000 was $36,564—a 10% increase from a decade earlier (adjusted for inflation) and $15,684 above the state average. Nevertheless, significant diversity exists within the four communities: measured by per capita income, Rose Valley was the tenth most affluent location in the state in

[1] Demographic and socio-economic data for the four communities are from the 2000 US Census using the American FactFinder tool.

2000 with an average per capita income of $54,202, while Rutledge was 602nd at $21,800. The majority of residents in the region (61%) are employed as educational, healthcare, social service, scientific, management, or financial professionals. Manufacturing and retail workers each made up 8% of the total working population.

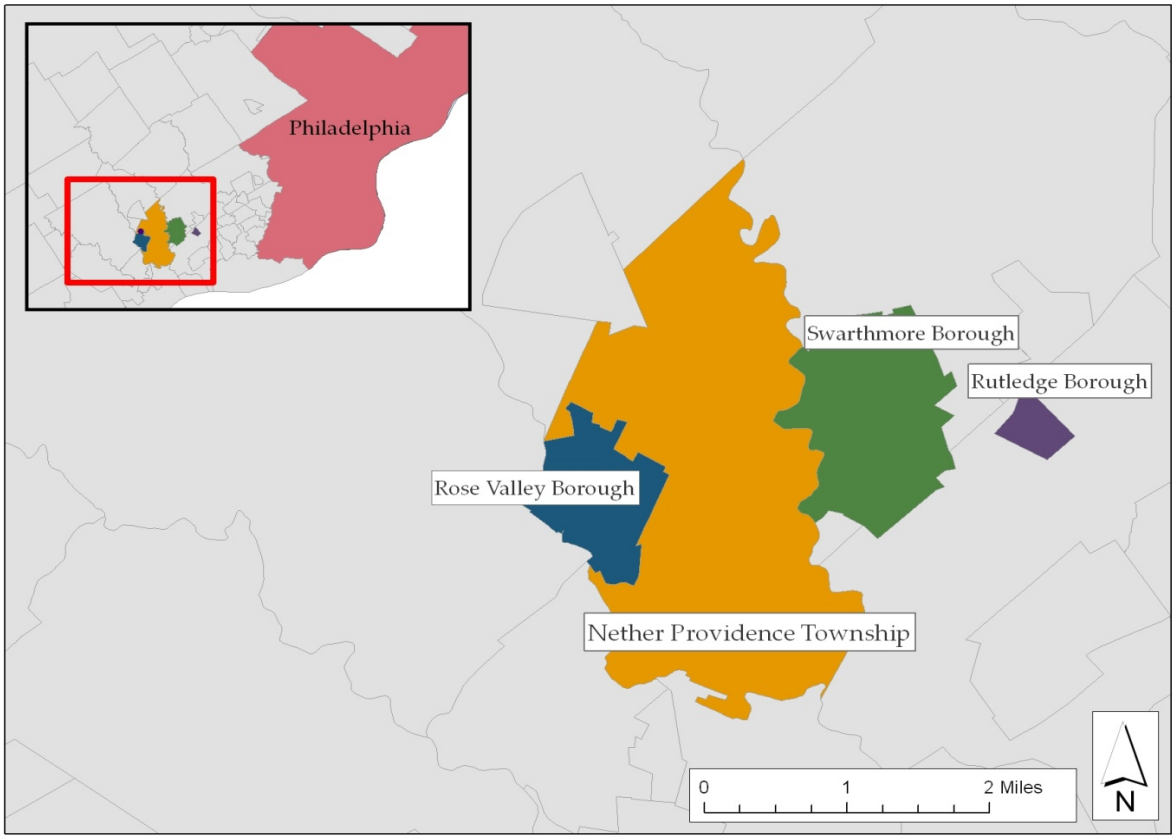

FIGURE 1 – THE FOUR COMMUNITIES PARTICIPATING IN THE PROJECT

In recent years the four municipalities have demonstrated a commitment to working together in planning, most notably through their collaboration on a 2006 *Multi-Municipal Comprehensive Plan*.[2] In addition, the communities have already taken actions targeted at creating more sustainable communities: Nether Providence Township created the first Environmental Advisory Committee in the state in 1978 and in 2007 committed to greenhouse gas reductions under the "Cool Cities" program of the Sierra Club. The Borough of Swarthmore is an EPA Green Power Partner. Both Nether Providence and Swarthmore are Pennsylvania Clean Energy Communities, and have received 1 kW solar systems as a reward for residents and businesses signing up to purchase clean energy. The Boroughs of Rutledge and Rose Valley—each a community

[2] Nether Providence Township, Rose Valley Borough, Rutledge Borough and Swarthmore Borough 2006 (see the References and Resources section of the report on page 43 for more details about this and other noted references).

of fewer than one thousand residents—have retrofitted streetlights and voluntarily developed recycling programs, even though such programs are not mandated for communities of their size.

Like many other communities in the Delaware Valley region, Nether Providence, Rose Valley, and Swarthmore have established Environmental Advisory Councils (EACs) to provide advice and leadership on environmental issues affecting their communities.[3] The EACs have formed a Multi-Municipal EAC that meets regularly. Although Rutledge Borough does not have an official EAC, members of their community take part in the meetings.

Environmental and Energy Challenges

The results of this GHG emissions inventory are designed to help planners, elected officials, residents, and business owners confront the significant challenges that climate change and growing global energy demand represent. Our modern economy is based upon the consumption of inexpensive energy for construction, communications, transportation, building operations, agriculture, industry, and commerce. Most of the energy consumed in the United States comes from non-renewable fossil fuels: petroleum refined into gasoline, diesel, jet fuel, kerosene, heating oil, and other fuels; coal; and natural gas. As fossil fuels are combusted to provide energy, gases are emitted, including carbon dioxide (CO_2), nitrogen oxides (NO_x), and methane (CH_4). These and other gases are commonly referred to as "greenhouse gases" for their heat-retaining quality that contributes to global climate change.

While some uncertainty remains in the scientific community as to the severity and timing of the impacts of climate change, there is no uncertainty that concentrations of greenhouse gases in the atmosphere are rising, global temperatures are warming, and human activities are contributing to these changes. Climate scientists believe these changes will have serious impacts on the natural environment and national and local economies. Human activities that emit greenhouse gases include not only the combustion of fossil fuels, but also agricultural production, the use of chemicals for building and vehicle cooling, the disposal of solid and liquid wastes and their subsequent decomposition, and the conversion of forests to other uses.[4]

Changing global and regional climates due to the emissions of GHGs from the use of fossil fuels for energy pose significant environmental challenges now and in coming years. These changes could have serious impacts on the economy of Pennsylvania and the quality of life for all of its residents. Some of the changes expected include increases in the number of summer days over 90 degrees, deteriorating air quality, reductions in cows' milk production, decreases in the yields of

[3] Authorized through PA Act 177 in 1996 and based on earlier legislation of Act 148 (1973), local municipalities may appoint 3-7 community residents to serve on an EAC. EACs advise the local planning commission, park and recreation board, and elected officials on the protection, conservation, management, promotion, and use of natural resources (Pennsylvania Environmental Council undated).

[4] Anderegg, Prall, Harold and Schneider 2010, IPCC 2007 (see the References and Resources section at the end of the report for full citations).

many crops, a shortening or cessation of snowmobiling and skiing seasons, and deteriorating conditions for prized hardwood trees.[5]

Reducing greenhouse gas emissions—by municipalities and other public institutions, businesses and non-profit organizations, and individuals—can be achieved through greater efficiency in the use of energy sources, including the most widely used: electricity, natural gas, motor fuels (gasoline and diesel), and fuel oil. Behavioral changes too can be effective in reducing GHG emissions and could include heating and cooling buildings more selectively, using shared and non-motorized forms of transportation for local travel, and eating a diet with less meat and processed foods.

There are many reasons to use resources more sustainably and to reduce or mitigate the negative impacts of economic activities on the natural environment. More efficient use of resources reduces pollution emissions into the air and water, and contributes fewer greenhouse gases to the atmosphere. Just as importantly, more sustainable use of resources can result in significant financial savings on energy, water, and waste-related costs, and contribute to greater stability and predictability in energy markets.

Accurately assessing the success of energy and GHG emissions reduction efforts requires precise measurements in a base year (or years). This report provides the baselines needed by residents, business owners, and municipal leaders in Nether Providence, Rose Valley, Rutledge, and Swarthmore in order to implement effective responses to climate change. Volume 2, the Climate Action Plan, provides specific action recommendations for residents, businesspeople, elected officials, and municipal, college, and school district employees.

[5] Union of Concerned Scientists 2008.

PROJECT APPROACH

This GHG Inventory was undertaken as a collaborative effort involving the technical skills of Temple University's Center for Sustainable Communities (CSC) and the knowledge and experience of municipal, college and school district staff-members, and Environmental Advisory Council members. CSC staff interviewed municipal employees by telephone and in-person and collected data from the township, boroughs, college, school district, and other sources in order to conduct the analyses that are documented in this report.

Data collected from the four municipalities, the college, and the school district (including building, street and traffic light electricity, natural gas, fuel oil, and solid waste bills, and records of gasoline and diesel purchases) were used to estimate municipal government emissions. Much of the data for the community emissions inventory came from the Delaware Valley Regional Planning Commission,[6] supplemented by state and national data for less common emissions sources. Data from other sources, such as the Delaware County Solid Waste Authority, were obtained, as needed.

Analysis for the GHG emissions inventory was accomplished using standard office computer software packages such as Microsoft Excel and through the use of the *Clean Air and Climate Protection* (CACP) software package distributed by ICLEI—Local Governments for Sustainability, an international membership organization of more than one thousand local communities working to address climate change and environmental sustainability.[7] Nether Providence Township is a member of ICLEI and has full access to the information, analytical, and training resources of the organization. Using the CACP software, and in consultation with ICLEI and the Delaware Valley Regional Planning Commission (DVRPC), emissions calculations were converted into a standard unit of measurement—metric tons of carbon dioxide equivalent ($MTCO_2E$).[8]

The analysis conducted in preparing this inventory allows GHG emissions to be categorized in terms of *sectors*, *sources,* and *scopes*.[9]

- *Sectors* are used to group emissions by type of end use. The *sectors* used in the community inventory are residential, non-residential (commercial, industrial, and institutional establishments), transportation, waste disposal (solid waste and wastewater emissions), and other.[10] Municipal government emissions are categorized in six sectors: buildings and facilities, streetlights and traffic signals, vehicle fleet, wastewater treatment, employee commute, and solid waste.

[6] Delaware Valley Regional Planning Commission 2009. Additional information came from DVRPC's Data Navigator tool (http://www.dvrpc.org/asp/mcddataNavigator/) and communications with DVRPC staff-members Robert Graff and Elizabeth Compitello.
[7] For more information about ICLEI—Local Governments for Sustainability, see http://www.icleiusa.org/.
[8] Because there are several important greenhouse gases that are accounted for in an inventory of this type, a conversion is made to carbon dioxide equivalents and the results are reported in metric tons (one metric ton of 1,000 kilograms is equal to 2,205 U.S. pounds, or 1.1 U.S. tons). Metric tons of CO_2 equivalents are usually abbreviated as $MTCO_2E$.
[9] Another important way to categorize emissions is between stationary and mobile sources. Stationary emissions are those associated with energy use at a specific location, while mobile emissions are related to motor fuels for cars, trucks, and other vehicles.
[10] "Other" consisted of emissions from the use of fluorinated gases for refrigerants and other similar equipment.

- *Sources* describe the type of fuel, energy source or material which produced the emissions. The *sources* of emissions cited in this report include those fuels that are primarily combusted in furnaces or vehicles (gasoline, diesel, fuel oil, natural gas, and coal), as well as electricity,[11] methane and nitrous oxide from wastewater treatment, solid waste, "fugitive" emissions of methane in natural gas transmission and sulfur hexafluoride in electricity transmission, and other sources such as Chlorofluorocarbons (CFCs) used as refrigerants.

- *Scopes* are used to identify three different levels of control and responsibility that community residents and municipal governments have over the quantities of GHG emissions.

    - Scope one emissions are those that are under the direct control of the user and are emitted where they are used (for example, the combustion of natural gas or fuel oil in home furnaces are controlled by residents and the CO_2 and other GHGs are emitted at the source).

    - Scope two emissions are from the use of electricity; users control the quantity of electricity used, but not the sources or carbon content of the fuel (or fuels) the utility uses to generate the electricity (such as coal, nuclear, or natural gas). While users are responsible for the emissions that result from the generation of electricity, they occur at the power plant, not in the residences, offices, and other places where electricity is used.

    - Finally, scope three emissions come from sources that the community or municipal government does not have direct control over, but for which they have indirect responsibility. An example of this in the government inventory is the motor fuel used by employees to commute to work.

The year 2006 was used as a baseline for this analysis and was complemented with analysis for the year 2005—the baseline year used in the recently completed Delaware Valley Regional Planning Commission's *Regional Greenhouse Gas Emissions Inventory* (DVRPC, 2009)—and the years 2007 and 2008.[12]

[11] Electricity is not directly a source of GHG emissions—turning on a lamp, using a computer or refrigerator, or operating an electric leaf blower does not generate emissions at the source of use. But electricity is considered a source category because the combustion of fuels used to generate electricity (for example, coal, natural gas, oil, and nuclear) result in GHG emissions. The average CO_2E emissions per kilowatt hour of electricity use can, thus, be calculated and reported in a GHG emissions inventory.

[12] Grant requirements specified 2006 as the base year for reporting; we have included the year 2005 because of the availability of detailed data from the 2009 Delaware Valley Regional Planning Commission's Regional Greenhouse Gas Emissions Inventory project, and 2007 and 2008 as a way of tracking recent changes in emissions.

GREENHOUSE GAS EMISSIONS INVENTORIES

Municipal-level inventories can accurately assess GHG emissions from what are in most communities the most significant sources: the combustion of motor fuels and the use of electricity, natural gas, and other heating fuels. Some sources of emissions are more difficult to measure at the municipal level, such as land use change, tree plantings, and use of chemicals for refrigeration and fire suppression. A*voided* emissions (from, for example, the recycling of some solid waste materials) can also be difficult to measure and analyze. In our analysis, we have included analysis and findings in which we have confidence and, where estimations were not reliable enough, we have excluded some (usually minor) sources of emissions.[13]

The municipal governments of the four participating communities, as well as Swarthmore College and the Wallingford-Swarthmore School District, have substantial control over their consumption of energy. The documentation of the sources, purposes, and types of energy use provides the information these institutions need to identify ways to reduce energy consumption and, consequently, energy costs and climate-changing greenhouse gas emissions. Municipal governments do not have direct control over the GHG emissions of residents and businesses, but the documentation of those emissions in this report sets a baseline by which all community members can identify emissions and assess efforts to reduce them.

This section of the report begins with presentation of GHG emissions attributable to the four communities as a whole, which are followed with sub-sections on municipal government, Swarthmore College, and Wallingford-Swarthmore School District GHG emissions.

[13] Details of data sources and methodological steps for each source of emissions are provided in the data and analysis files provided to the project sponsors.

Most activities that take place within the boundaries of any US municipality use large quantities of energy that contribute to the generation of greenhouse gas emissions. Lighting, heating and cooling buildings, transporting people, goods, and wastes, running commercial, industrial, and educational institutions, tending to yards, parks, and gardens, entertaining ourselves with television, movies, and Internet access, operating and maintaining sewer and water lines, repairing roads and sidewalks, and more all necessitate the combusting of gasoline, diesel, coal, heating oil, and other fuels for energy, with the result that large quantities of carbon dioxide and other greenhouse gases are emitted.

Using data available from utility providers, DVRPC, and other sources, we have calculated GHG emissions attributable to activities within the boundaries of the four communities of Nether Providence Township, Rose Valley Borough, Rutledge Borough, and Swarthmore Borough for the base year 2006. Results are presented in this section of the report for the four communities together; results for each community individually can be found in the Appendix to this volume.

	2005	2006	2007	2008
Residential	92,410	82,493	89,814	84,741
Non-Residential	37,488	36,619	38,112	36,780
Transportation	88,384	88,378	88,489	88,222
Waste	2,786	2,498	2,462	1,879
Other	8,136	8,248	8,601	8,840
Total	**229,202**	**218,236**	**227,477**	**220,462**

TABLE 1 – COMMUNITY EMISSIONS IN $MTCO_2E$, 2005 TO 2008

Residents, businesses, industries, institutions, government, and others in Nether Providence, Rose Valley, Rutledge, and Swarthmore[14] were responsible for 218,236 metric tons of CO_2 equivalent emissions ($MTCO_2E$) in 2006. The *sectors* with the highest emissions were transportation (40%) and residential home energy use (38%)—see Figure 2. The largest *sources* of GHG emissions were gasoline (35%) and electricity (30%)—see Figure 3.

In the transportation sector, the overwhelming majority of emissions, 98%, were from roadway vehicles (passenger vehicles and all kinds of trucks) and just 2% were from transit. Greenhouse gas emissions in 2006 caused by cars, trucks, buses, and other motor vehicles totaled 88,378 metrics tons of CO_2 equivalents, or about 4.2 $MTCO_2E$ per resident. DVRPC data for 2005 were updated for subsequent years using the reported increase in total highway VMT in Delaware

[14] When we refer to "community" emissions in the body of the report, we mean the four communities of Nether Providence Township and Rose Valley, Rutledge, and Swarthmore Boroughs combined.

County.[15] In 2006 the estimated VMT for the four communities was 135.5 million, a figure that reflects residential, commercial, governmental, and other transportation purposes.

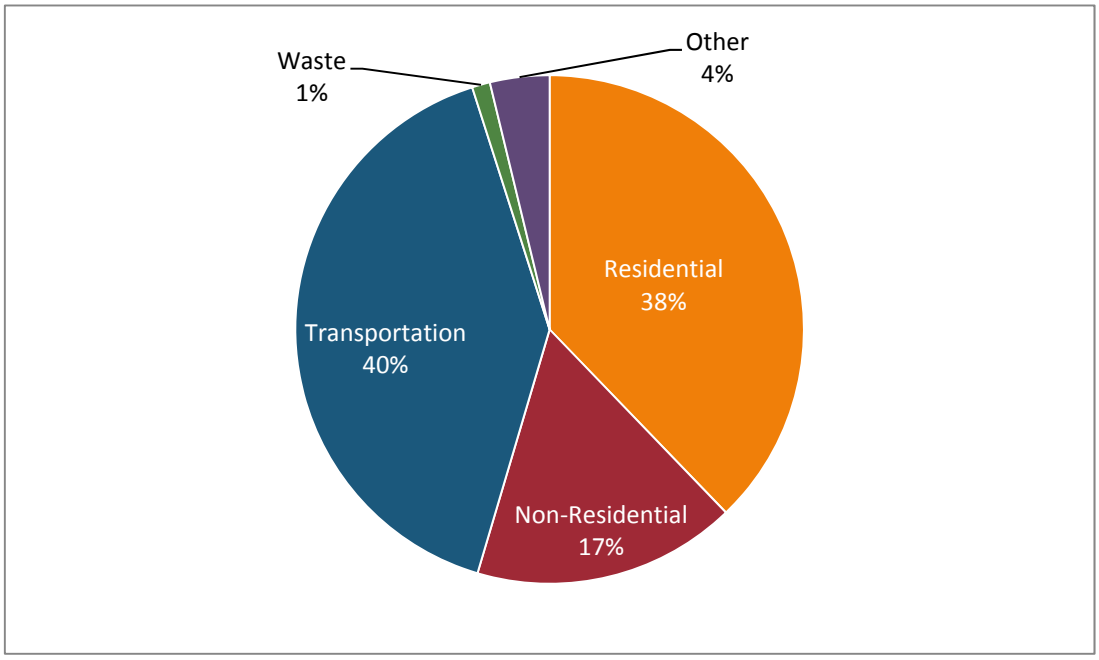

FIGURE 2 – TOTAL COMMUNITY EMISSIONS, CO_2 EQUIVALENT EMISSIONS (%) BY SECTOR, 2006

The sources of emissions in the residential sector are primarily electricity (52%) for home utilities, lighting, and heating, with significant shares from natural gas (25%) and fuel oil (21%).

Within the 17% of emissions from the "non-residential" sector, about 8% were attributable to Swarthmore College, 3% to the Wallingford-Swarthmore School District, and the other 6% to the remaining commercial and industrial establishments in the four communities.

[15] PennDOT Highway VMT Statistics for Delaware County, 2006 to 2008, were obtained from the PennDOT Planning and Research (Transportation Planning Division) web site at http://www.dot.state.pa.us/Internet/Bureaus/pdPlanRes.nsf/PlanningAndResearchHomePage.

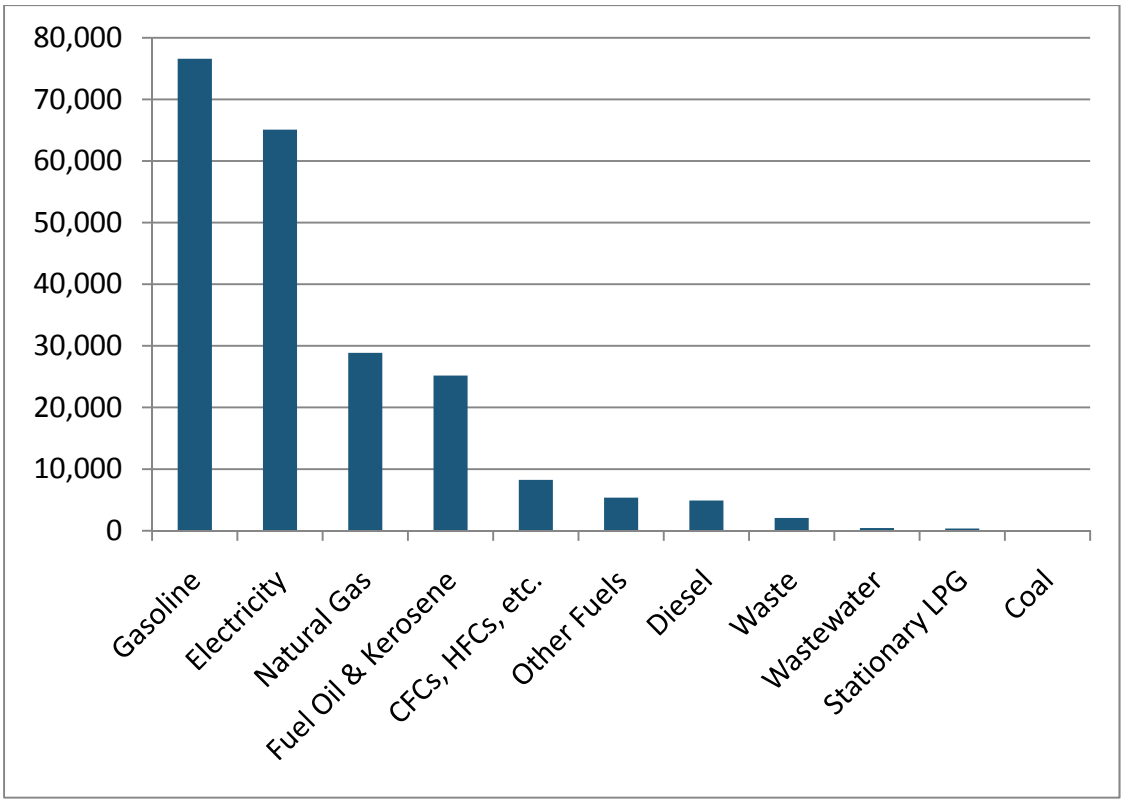

Figure 3 – Total $MTCO_2E$ Emissions by Source, 2006

OTHER EMISSIONS SOURCES

Although we were able to include most sources of greenhouse gas emissions from the four communities, there were some activities which have associated emissions that we were not able to count accurately. Some of these we estimate in this section, but the calculations require controversial methods, large assumptions, incomplete data, or all three and ultimately we cannot have a high level of confidence in the resulting estimations. Other sources we are unable to count at all because no data is available from which to estimate emissions.

Based on data from the community survey, we estimated emissions from wood, product lifecycle emissions from some foods consumed, and air travel (air travel emissions estimates are for aviation fuels for travel by residents of the four communities). In addition, we estimated emissions from electricity transmission losses and small engine equipment (such as leaf blowers and lawnmowers). These five sources yielded about 35,000 $MTCO_2E$ emissions in 2006, 16% of the emissions actually included in the inventory (see Table 2).

In addition to these rough estimates, there are emissions from recycling, product lifecycle emissions from other foods and other products, fire suppressants, the application of fertilizers and

pesticides to lawns and gardens, compressed natural gas and biofuels used in vehicles, and other sources not detailed here. Although we were unable to provide estimates for these sources, there are associated emissions, and there may be steps that can be taken to reduce these emissions even without being able to quantify them.

Sector, Activity (2006)	Source	Scope	Estimated $MTCO_2E$	% of total calculated emissions	% of sector
Residential			*82,493 $MTCO_2E$ calculated emissions*		
Wood (for home heating)	Wood	1	105	0.05%	0.1%
Transmission Loss	Electricity	3	3,857	1.68%	4.7%
Non-residential			*36,619 $MTCO_2E$ calculated emissions*		
Transmission Loss	Electricity	3	1,892	0.83%	5.2%
Other			*8,248 $MTCO_2E$ calculated emissions*		
Product life-cycle emissions from food / diet	Methane	3	4,969	2.17%	60.2%
Transportation			*88,378 $MTCO_2E$ calculated emissions*		
Air Travel	Jet Fuel	3	22,760	9.93%	25.8%
Small Equipment	Gasoline	1	1,604	0.70%	1.8%
Transmission Loss	Electricity	3	72	0.03%	0.1%
Uncounted Total			35,259	16.2%	NA
Counted total			*218,236 $MTCO_2E$ calculated emissions*		

TABLE 2 –ESTIMATED EMISSIONS FROM UNCOUNTED SOURCES, 2006

SINKS AND AVOIDED EMISSIONS

Some human activities, rather than contributing to the production of additional GHG emissions, actually *reduce* or *avoid* emissions by absorbing carbon dioxide from the atmosphere or preventing emissions that would otherwise occur. These activities include tree planting, purchasing wind credits, and recycling. DVRPC data on land use, land use change, and forestry (LULUCF), for example, was used to estimate that 1,965 $MTCO_2E$ were removed from the atmosphere in 2005 in the four project communities. "These emissions and removals of CO_2 are due to the loss or gain in

the amount of carbon stored in trees and other plants in forests, parks, streets, and private property."[16]

Recycling reduces emissions from incinerating solid waste, but produces some emissions during the recycling process itself. We were unable to calculate the emissions generated during the recycling process. However, by knowing the quantity of waste that was recycled we calculated the emissions from incineration that would have occurred *if the materials had not been recycled*. In 2006, 5,826 tons of waste was recycled in the four municipalities. If those recyclables had been incinerated instead, 2,017 $MTCO_2E$ of emissions would have occurred and total community GHG emissions would have been almost 1% higher than they were.

Municipality and Year	Wind kWh	Avoided $MTCO_2E$ Emissions	% Avoided of Total Counted $MTCO_2E$ Emissions
2007			
Nether Providence	1,048,015	555	1.4%
Rose Valley	130,021	68	2.4%
Rutledge	49,276	26	1.7%
Swarthmore	1,105,439	574	2.6%
TOTAL	**2,332,751**	**1,222**	**1.8%**
2008			
Nether Providence	1,272,581	661	1.7%
Rose Valley	127,078	66	2.4%
Rutledge	50,801	26	1.8%
Swarthmore	1,496,889	778	3.6%
TOTAL	**2,947,349**	**1,531**	**2.4%**
2009			
Nether Providence	1,230,201	639	1.7%
Rose Valley	124,411	65	2.3%
Rutledge	50,784	26	1.8%
Swarthmore	1,455,154	756	3.7%
TOTAL	**2,860,550**	**1,486**	**2.4%**

TABLE 3 – ESTIMATED AVOIDED EMISSIONS FROM WIND ENERGY PURCHASES, 2007-2009

During the years of analysis many residents and businesses purchased some or all of their electricity through PECO's[17] wind energy program. Utility customers signed up for 100 kWh blocks of electricity from wind power for a slightly higher electricity fee and PECO invested the additional money into purchasing more power from wind. Customers purchasing wind energy were not directly getting electricity generated from wind turbines, however. They have the same generation mix as everyone else on the electric grid, whether or not they are enrolled in PECO Wind. However,

[16] DVRPC, 2009, p. 30.
[17] PECO is the local electricity and natural gas utility for the four project communities.

the more customers who signed up for the program, the more wind power was purchased for the grid as a whole, thus lowering the carbon content of the electricity generated in the entire region.[18]

Nether Providence Township and Swarthmore Borough have done significant outreach to utility customers in their jurisdiction to enroll them in PECO Wind. Although it does not decrease the emissions as calculated in the main community analysis, it is worth noting that about 2.3 million kWh of PECO wind energy credits were purchased by residents and businesses within the four communities (in 2007, the earliest year for which complete data are available) and that amount increased to 2.9 million kWh in 2008 and 2009. These wind power purchases represented the equivalent of 1,222 $MTCO_2E$ of *avoided* conventionally-produced electricity generation emissions in 2007 (1.8% of actual community electricity use), and 1,531 and 1,486 $MTCO_2E$ in 2008 and 2009 (2.4% of actual in both years; see Table 3).

[18] As PECO customers are allowed to switch electricity providers in 2011, additional sources of renewable energy will be available to them.

EMISSIONS TRENDS: 2005 TO 2008

Emissions in the communities over the four-year period, 2005 to 2008, have remained relatively stable. Most of the fluctuation that can be seen in Figure 4 below can likely be attributed to normal variations which are expected due to weather differences between the years. 2005 had the highest emissions, at 229,202 $MTCO_2E$, but that is only 5% above the low year, 2006, at 218,236 $MTCO_2E$.

The year 2005 was a year of greater weather extremes, with more "heating degree" days and "cooling degree" days than any of the other years.[19] The higher the number of heating degree and cooling degree days in a year, all else being equal, the higher the consumption of electricity, natural gas, and other heating fuels should be. [20]

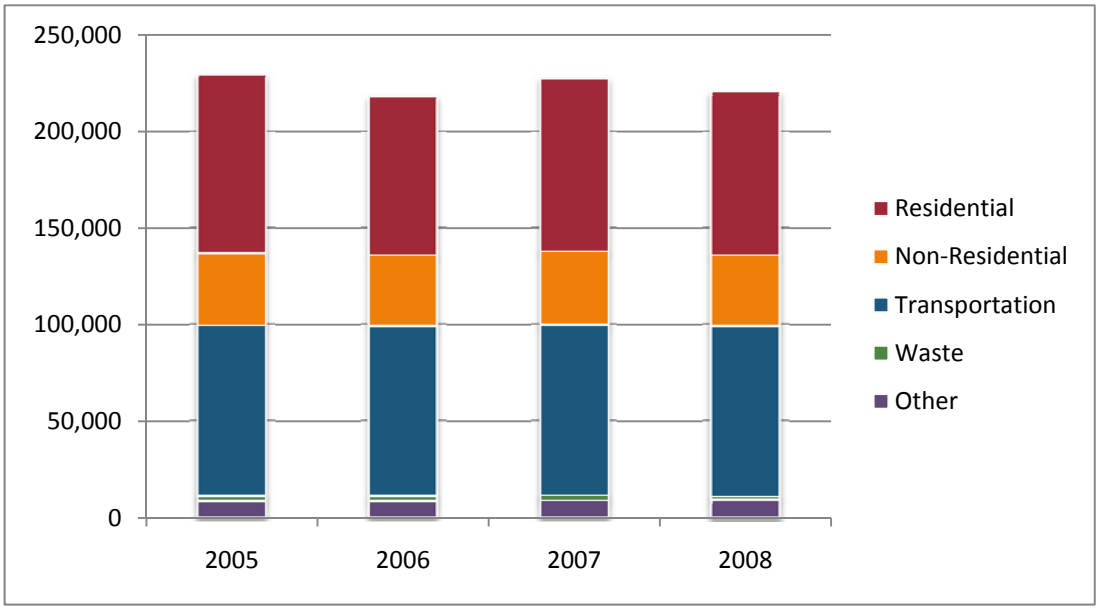

FIGURE 4 – CO_2 EQUIVALENT EMISSIONS BY SECTOR AND YEAR, 2005-2008

The population of the four communities remained largely unchanged over this time period, so *per capita* emissions also showed little change. In 2005, they were 10.9 $MTCO_2E$, in 2007 10.8 $MTCO_2E$, and in 2006 and 2008, 10.4 $MTCO_2E$.

[19] *Heating degree* and *cooling degree* days are measures used by analysts to compare months, seasons, or years by identifying time periods in which more very cold or very hot days occurred, creating higher demand for building heating and air conditioning.
[20] Data on heating and cooling degree days were obtained from the National Climatic Data Center, Marcus Hook weather station. 2007 data was incomplete.

Municipal government facilities and operations in Nether Providence, Rose Valley, Rutledge, and Swarthmore were responsible for 1,411 $MTCO_2E$ in 2006 (0.65% of total greenhouse gas emissions in the four communities). Although government emissions varied on an annual basis, they remained relatively stable throughout the four years (the low of 1,347 $MTCO_2E$ was emitted in 2008, while the high of 1,470 $MTCO_2E$ was emitted in 2007). For greater details on the GHG emissions attributable to each municipal government, please see the appendix to this volume.

Municipal government emissions come from police, fire, public works, code enforcement, administrative, and other functions. Most of the GHG emissions accounted for in this section of the report are also accounted for in total community emissions which were detailed in the previous section of the report.[21]

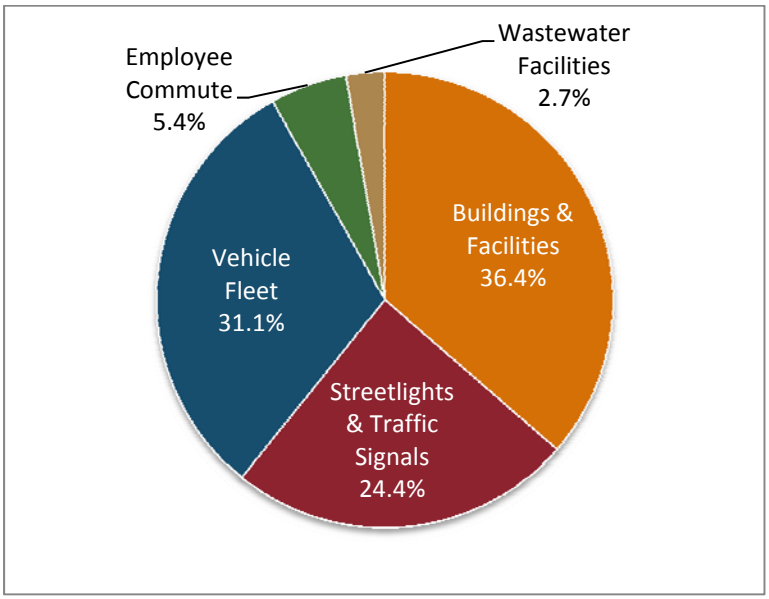

FIGURE 5 – MUNICIPAL GOVERNMENTS' **TOTAL** CO_2 EQUIVALENT GHG EMISSIONS (%) BY SECTOR, 2006

The four municipal governments have government buildings, vehicles, parks, streetlights, and traffic signals which account for portions of municipal energy use and GHG emissions. During the time period of this inventory, Rose Valley Borough owned a wastewater treatment facility which it has since sold. Libraries and fire companies fall outside of the direct *operational* control of these municipal governments, but the two libraries and four fire companies in these communities are financially supported primarily by the municipal governments and, so, are included in this inventory.

[21] Estimates of total community transportation-related GHG emissions are calculated using data from the Delaware Valley Regional Planning Commission (DVRPC) which represent different allocations of travel than our municipal government travel estimates. These differences are small, however, and do not substantially affect the results reported here.

Buildings and Facilities make up the largest share of municipal government emissions for the four communities at 36%. **Vehicle Fleet** (31%) and **Streetlights and Traffic Signals** (24%) make up the bulk of the rest of their GHG emissions (see Figure 5 above). **Employee Commuting**, reflecting fuel used by employees to travel to and from work, estimated using the results of surveys conducted in all four municipal offices, is responsible for 5.4% of municipal government GHG emissions, and **Wastewater Facilities** (in Rose Valley only) are responsible for the remaining 2.7% of emissions.[22]

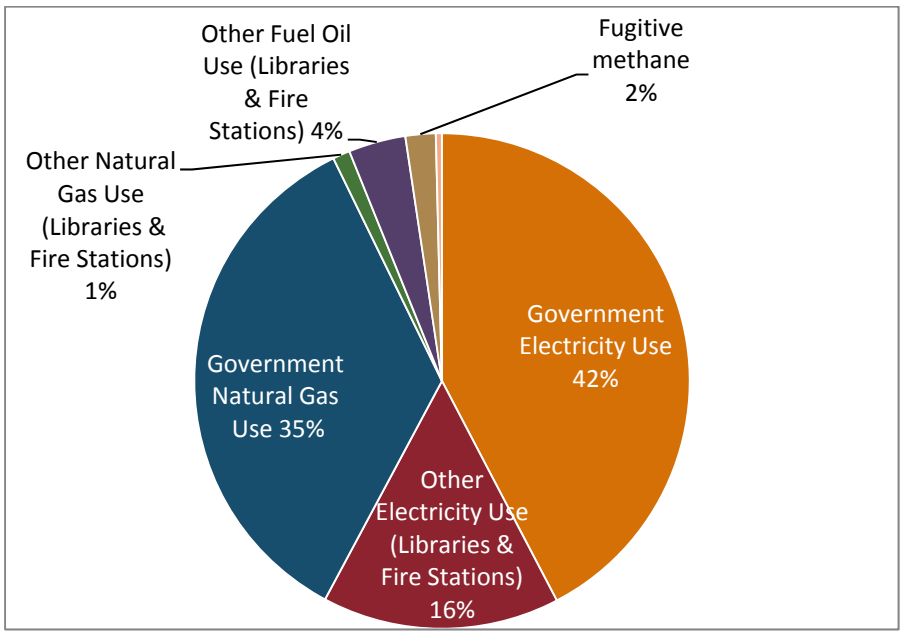

FIGURE 6 – DISTRIBUTION OF EMISSIONS FROM **BUILDINGS & FACILITIES SECTOR** (36% OF TOTAL MUNICIPAL GOVERNMENT EMISSIONS), 2006

GHG emissions attributable to the Buildings and Facilities sector come from the use of electricity, natural gas, and fuel oil in government owned buildings and facilities, as well as in libraries and fire stations that receive significant funding from the government. Within the buildings and facilities sector, electricity for municipal government-owned buildings and facilities is the largest share, followed by natural gas for government-owned buildings. Emissions from electricity used in libraries and fire stations represent the third largest share (Figure 6).

The vehicle fleet sector includes fuel used for vehicles and off road equipment (such as lawn mowers) owned by the municipal government. It also includes emissions from fire department vehicles, and from business travel by municipal employees. In the vehicle fleet sector, gasoline for municipally owned vehicles represents more than half of the emissions. Diesel for municipal vehicles (12%) and fire vehicles (13%) are the next largest shares (Figure 7).

[22] Solid Waste generated by municipal government operations has not been accurately tracked by the municipal governments and their waste haulers and, therefore, reliable data were largely unavailable. Limited data available showed solid waste accounted for only 0.01% of total municipal government emissions, but this is clearly an underestimate.

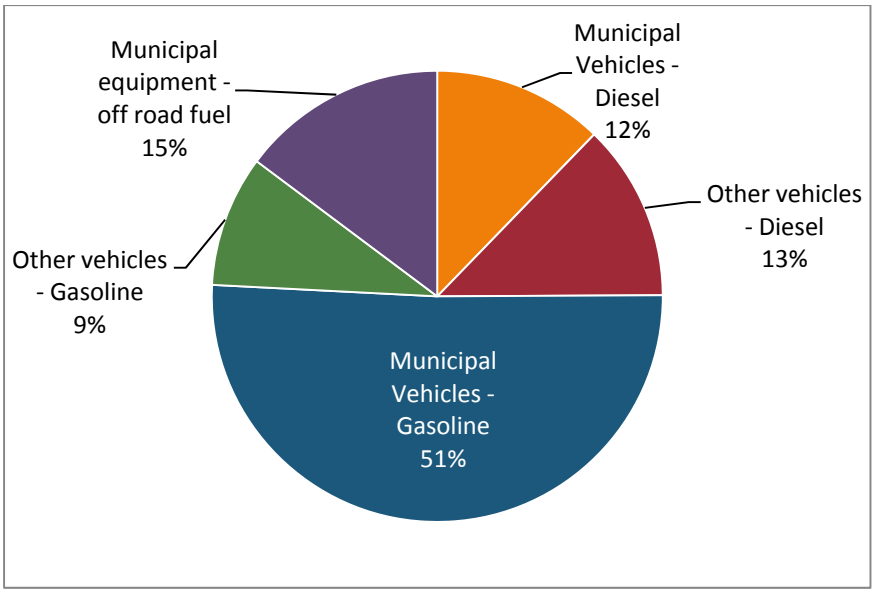

FIGURE 7 – DISTRIBUTION OF EMISSIONS FROM **VEHICLE FLEET SECTOR** (31% OF TOTAL MUNICIPAL GOVERNMENT EMISSIONS), 2006

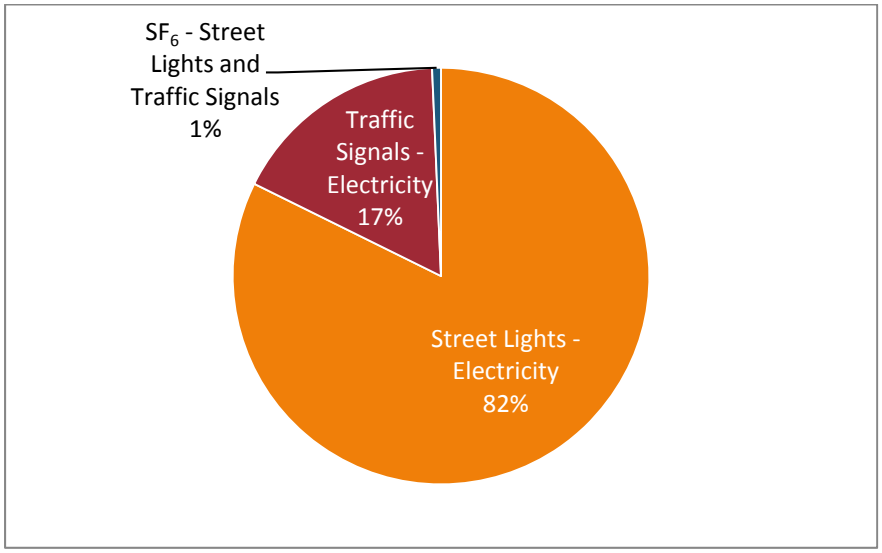

FIGURE 8 – DISTRIBUTION OF EMISSIONS FROM **STREET LIGHTS & TRAFFIC SIGNALS SECTOR** (24% OF TOTAL MUNICIPAL GOVERNMENT EMISSIONS), 2006

GHG emissions from streetlights and traffic signals are attributable to electricity use and from sulfur hexafluoride (SF_6) used in electricity transmission. The vast majority of emissions from this sector are from electricity for streetlights (82%) (Figure 8).

FUEL SOURCES OF EMISSIONS

The use of many different sources of energy–such as natural gas, motor fuels, heating oils, and electricity–contribute to the emissions for each sector described in the preceding section. The two *primary* sources of GHG emissions attributable to municipal government facilities and operations are electricity and gasoline (see Figure 9). PECO, the electricity supplier for the four communities, uses coal, nuclear power, oil, natural gas, and other fuels and energy sources to supply electricity to the region. The municipal governments' electricity use—for municipal buildings and facilities and streetlights and traffic signals—is responsible for 46% of total municipal government greenhouse gas emissions. Gasoline makes up more than 24%, and natural gas used for heating water and buildings represents 14%.

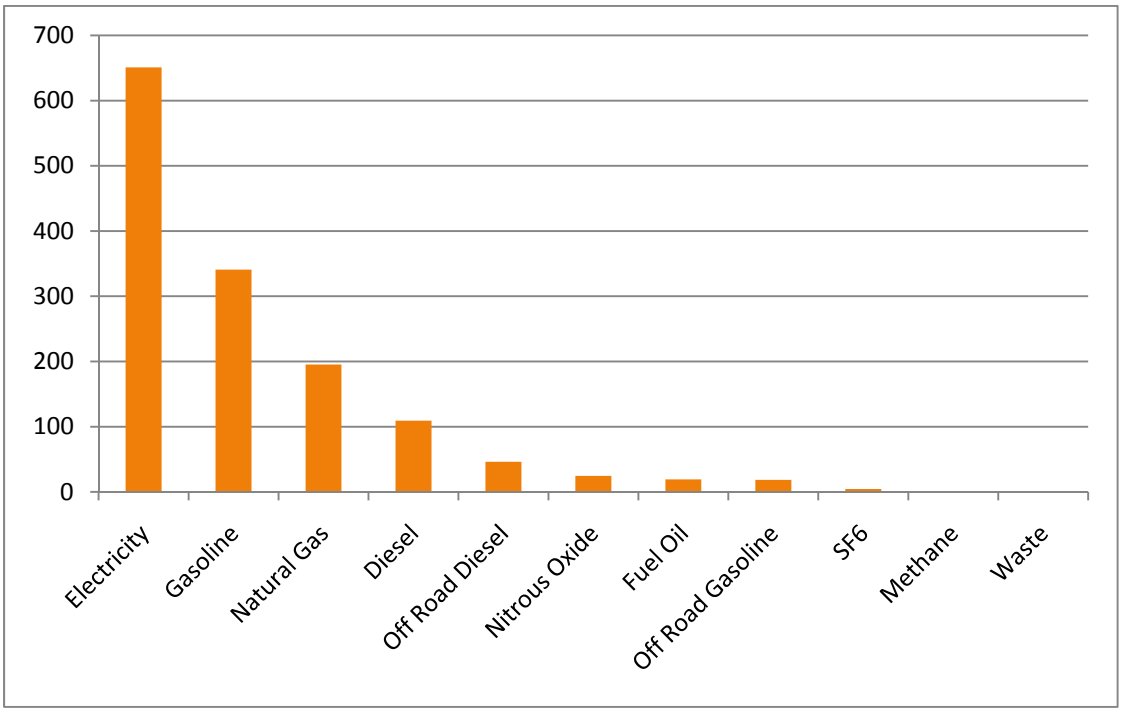

FIGURE 9 – MUNICIPAL GOVERNMENTS' CO_2 EQUIVALENT GHG EMISSIONS BY SOURCE, 2006

The electricity used by municipal governments is primarily for street lights and traffic signals (53%), followed by government-owned buildings and facilities (33%) (Figure 10).

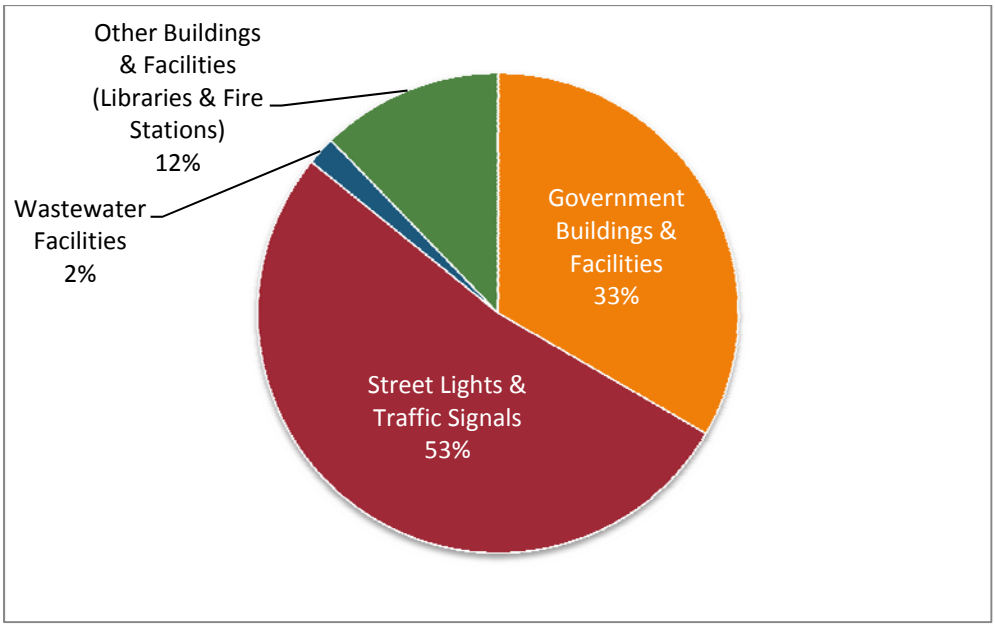

FIGURE 10 – MUNICIPAL GOVERNMENTS' CO_2 EQUIVALENT GHG EMISSIONS FROM ELECTRICITY USE, 2006

Gasoline in the government sector is primarily for municipal vehicles (65%), with 23% representing employee commute (Figure 11). Significant reductions in the municipal government's greenhouse gas emissions are possible primarily through reductions in the use of electricity and vehicle fuels, as these are the principal sources of GHG emissions.

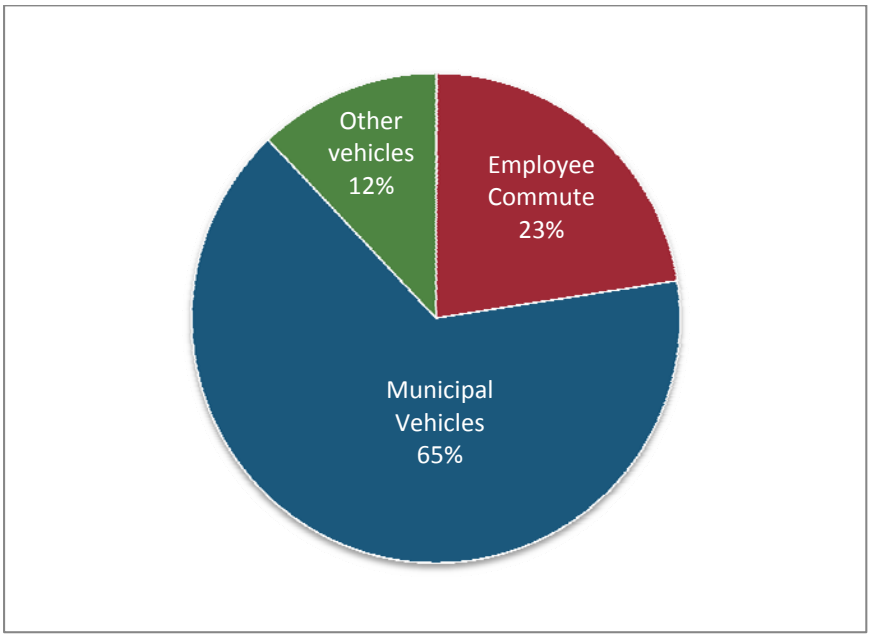

FIGURE 11 – EMISSIONS FROM MUNICIPAL GASOLINE USE BY USE (%), 2006

Purchasing more energy-efficient building heating and cooling systems and office equipment, using less electricity through maximum heating and minimum cooling temperatures, turning off computers, lights, and other appliances when not in use, and purchasing wind energy credits are the main alternatives for reducing electricity-related GHG emissions. Buying more fuel-efficient vehicles, reducing mileage driven and relying on shared and non-motorized forms of transportation, where possible, are the principal alternatives for reducing motor fuel-related GHG emissions. These options will be discussed in greater detail in volume two of this report.

SCOPES OF EMISSIONS

The emissions detailed above are all related to the local governments' facilities and operations, but the municipal governments do not have the same level of control over each one of them. For example, governments have a high level of control over the natural gas used to heat a municipal building that they own, and much less control over their employees' commuting habits. In order to understand these differences, this section assesses greenhouse gas emissions in three categories designated "Scopes," in order to help understand the level of control that municipal governments have over GHG emissions. The concept of scopes and the definitions of each level used here are from ICLEI's Local Government Operations Protocol (LGOP)[23].

Scope One emissions are those that a municipal government has the most direct control over, such as the quantities of gasoline and diesel used in municipal vehicles. In these cases, the municipal governments control both the quantity and the type of fuels used. In Nether Providence, Rose Valley, Rutledge, and Swarthmore, Scope One emissions are attributable to natural gas and fuel oils used in municipal buildings and motor fuels used for the operation of police, public works, and other vehicles. Combined, these Scope One emissions equal 38.2% of all government emissions in 2006 (Table 4).

Scope One Emissions Source	$MTCO_2E$ Emissions	% of Total Emissions
Building Natural Gas and Fuel Oil	179	12.7%
Municipal Vehicle Fleets	335	23.7%
Wastewater Emissions	26	1.8%
Total Scope One Emissions	***540***	***38.2%***

TABLE 4 – MUNICIPAL GOVERNMENTS SCOPE ONE EMISSIONS, 2006

Scope Two emissions are those that a municipal government controls in terms of the quantities used, but not the sources. The four municipal governments determine the amount of electricity used for municipal operations, for example, but do not control the sources of fuel used in

[23] The *Local Government Operations Protocol for the quantification and reporting of greenhouse gas emissions inventories* (2010) was developed by the California Air Resources Board, California Climate Action Registry, ICLEI – Local Governments for Sustainability, and the Climate Registry.

generating the electricity that PECO provides. Electricity used for government-owned buildings, streetlights, and traffic signals account for 40.4% of all government emissions in 2006 (Table 5). Scope One and Two emissions should be the first places to look for greenhouse gas emission reductions, since these are under the direct control of the local governments.

Scope Two Emissions Source	$MTCO_2E$ Emissions	% of Total Emissions
Building Electricity	217	15.4%
Streetlights	283	20.1%
Traffic Lights	56	4.0%
Wastewater Electricity	13	0.9%
Total Scope Two Emissions	***569***	***40.4%***

TABLE 5 – MUNICIPAL GOVERNMENTS SCOPE TWO EMISSIONS, 2006

Scope Three emissions come from sources that the municipal government does not have direct control over, but for which it has indirect responsibility. In 2006 Scope Three emissions come primarily from motor fuel used by municipal employees for their commutes to work, motor fuels used by the fire departments, and the library's energy use for its building. Scope three sources account for 21.4% of total government emissions (Table 6).

Scope Three Emissions Source	$MTCO_2E$ Emissions	% of Total Emissions
Fire Departments and Companies	138	9.8%
Furness Library	57	4.1%
Municipal Employees' Commute	71	5.0%
Business Travel	0.2	0.0%
Rental Space	5	0.4%
Shared Police Department	7	0.5%
Shared Vehicles	7	0.5%
Other	6	0.4%
Total Scope Three Emissions	***302***	***21.4%***

TABLE 6 – MUNICIPAL GOVERNMENTS SCOPE THREE EMISSIONS, 2006

COST

The municipal governments spent $334,183 in 2006 on energy for five categories of operations: $133,416 for the electricity to power streetlights and traffic signals, $100,280 on energy for buildings and facilities, $93,538 on gasoline and diesel for the municipalities' vehicle fleets and equipment, $5,038 on electricity for wastewater processing, and $1,911 on solid waste

disposal (Figure 12). For streetlights and traffic signals, municipal governments pay $390 for every metric ton of CO_2E that is emitted. In the buildings and facilities sector, that figure is $200 per metric ton. For vehicle fleet, the cost is $214 per metric ton.

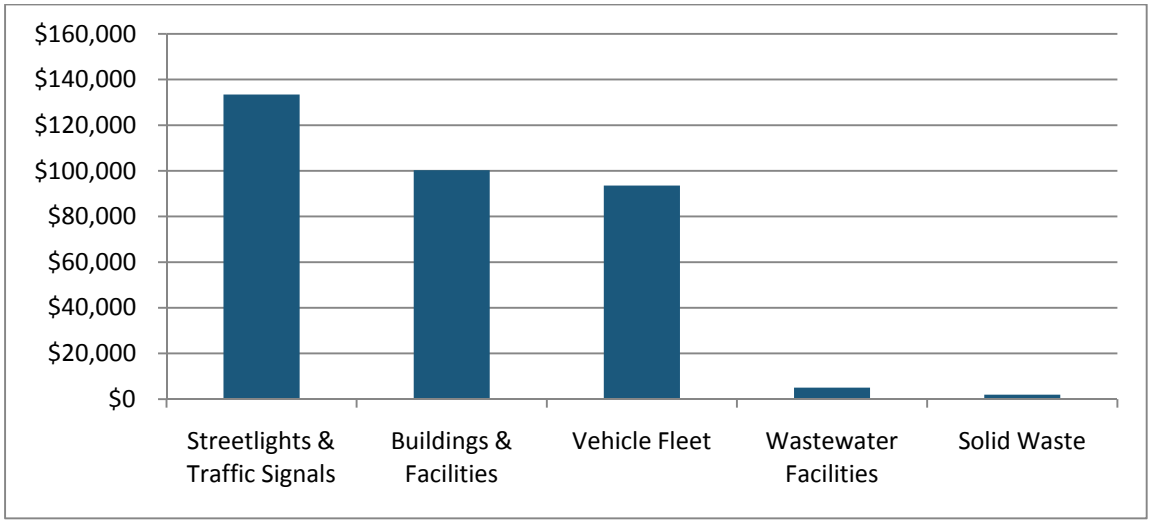

FIGURE 12 – GOVERNMENT ENERGY COSTS ($), 2006

OTHER EMISSIONS SOURCES, SINKS, AND AVOIDED EMISSIONS

Although we were able to include most sources of greenhouse gas emissions from the four municipal governments, there were some activities which have associated emissions that we were not able to count accurately or, in some cases, at all. For example, refrigerants used in motor vehicles are significant sources of greenhouse gas emissions. However, it is difficult to measure the amount of such refrigerants lost from vehicle air conditioning systems. When properly used, refrigerant recovery equipment can ensure that used refrigerants are recaptured and disposed of properly. But accurate estimates of the total amount of new refrigerants used in municipal vehicles are unavailable as are estimates of the recapture rate when refrigerants are replaced.

Mobile refrigerant losses are one example of emissions that likely occurred due to operations and facilities management of the four communities' municipal governments during the time period 2005 to 2008, but that are impossible to accurately estimate. There are a number of other sources which have greenhouse gas emissions but, for similar reasons, are not detailed in this inventory.

- Although the fire companies in these four communities primarily use water to fight fires, there are small amounts of other fire suppressants used, some of which cause GHG emissions.
- Rose Valley Borough hires contractors to mow lawns and maintain government-owned parks. The fuel used in that equipment is not included in this inventory.

- All four communities hire contractors to plow after snowstorms. The fuel used in these contracted vehicles is not included.
- During the road repaving process, fuel is used in contractors' vehicles. In addition, components of the cement and asphalt used in the construction, reconstruction, and repair of roads within municipal boundaries emit greenhouse gases.
- In most of the municipal governments, quantities of government trash are not tracked. Thus, the emissions associated with the disposal of these solid wastes cannot be included.
- Recycling is beneficial for many reasons, but there are some GHG emissions associated with the reprocessing of materials that occur when paper, glass, and metals are recycled. These GHG emissions are not included in this report.
- The application of fertilizers and pesticides to lawns and gardens results in GHG emissions. The quantities of these chemical products used by the four municipal governments are unknown.
- Every item that is purchased by the municipal government embodies energy and associated emissions in the materials, manufacturing, and shipping of the product. These Product Lifecycle Emissions, as they are known, present significant challenges to estimate accurately and are not included in this report.

The management of municipal government facilities and operations can, in some cases, help avoid GHG emissions. Tree planting programs, for example, or landscape maintenance of public properties can sometimes result in net reductions in GHG emissions. Our analysis does not permit detailed estimations of changes in quantities of CO_2 equivalent emissions from municipal government operations separate from those made by DVRPC and described in the "sinks and avoided emissions" discussion in the Community Greenhouse Gas Emissions section above.

SWARTHMORE COLLEGE AND WALLINGFORD-SWARTHMORE SCHOOL DISTRICT GREENHOUSE GAS EMISSIONS

Swarthmore College occupies a significant share of the land and represents an important percentage of the residents, energy use, and emissions for Swarthmore Borough and the surrounding area. Swarthmore College President Rebecca Chopp recently signed the American College & University Presidents' Climate Commitment, which commits the college to conducting a detailed greenhouse gas emissions inventory within one year. Included in this report is a summary of the largest GHG emissions sources that can serve as a basis for the President's Climate Commitment inventory. Swarthmore College's own emissions reductions efforts will feature a more detailed inventory, including more difficult to count and smaller emissions sources.

We were able to obtain detailed building data from the college for the years 2005, 2006, 2007, and 2008: electricity, natural gas, and fuel oil are all summarized. The vehicle fleet data is for grounds, maintenance, security, food service, and custodial services. There are additional vehicles, however, owned by athletic teams and academic departments which are not included in this report because we could not obtain the necessary data. A rough estimate of the fuel used in the vans which run approximately hourly between Swarthmore College and Bryn Mawr and Haverford Colleges is included. These vans are operated by Bryn Mawr College. We estimated employee commute data based on the commutes of Swarthmore Borough employees. We have not included any information about student travel, or faculty and staff business or professional travel in this inventory because the necessary data were not available. We recommend that the College undertake periodic surveys from which to estimate these emissions in future years.

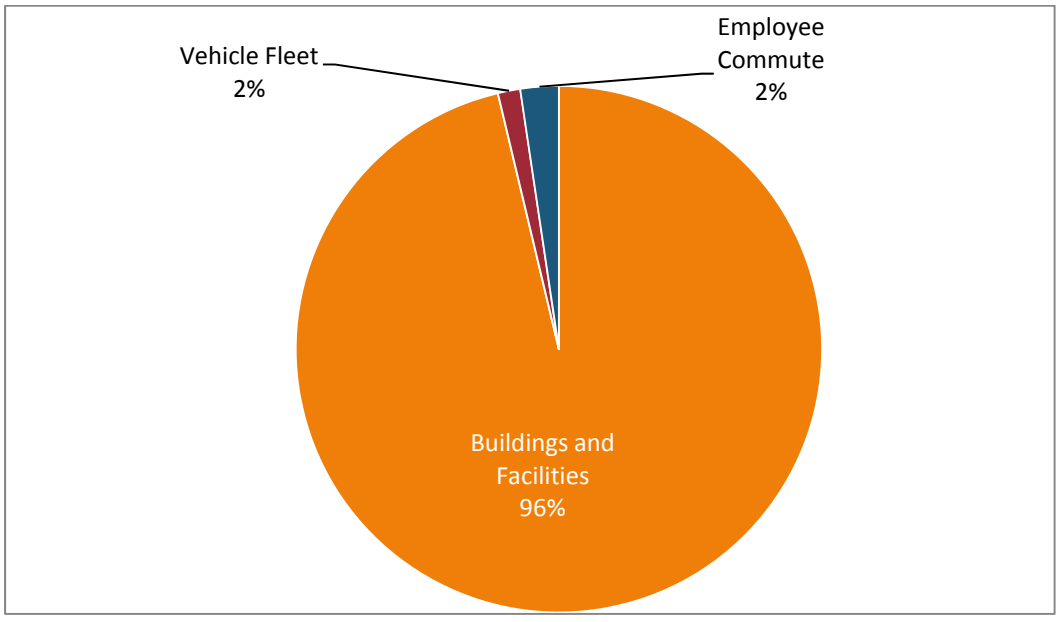

FIGURE 13 – SWARTHMORE COLLEGE'S CO_2 EQUIVALENT GHG EMISSIONS (%) BY SECTOR, 2006

Total emissions from Swarthmore College were 16,768 $MTCO_2E$ in 2006. Buildings and facilities was overwhelmingly the largest emissions sector in 2006, representing 96% of the college emissions. (See Figure 13). Emissions from Swarthmore College are primarily from Electricity (51%), Residual Fuel Oil, also known as number 6 fuel oil or bunker fuel (25%), and Natural Gas (19%) (Figure 14).

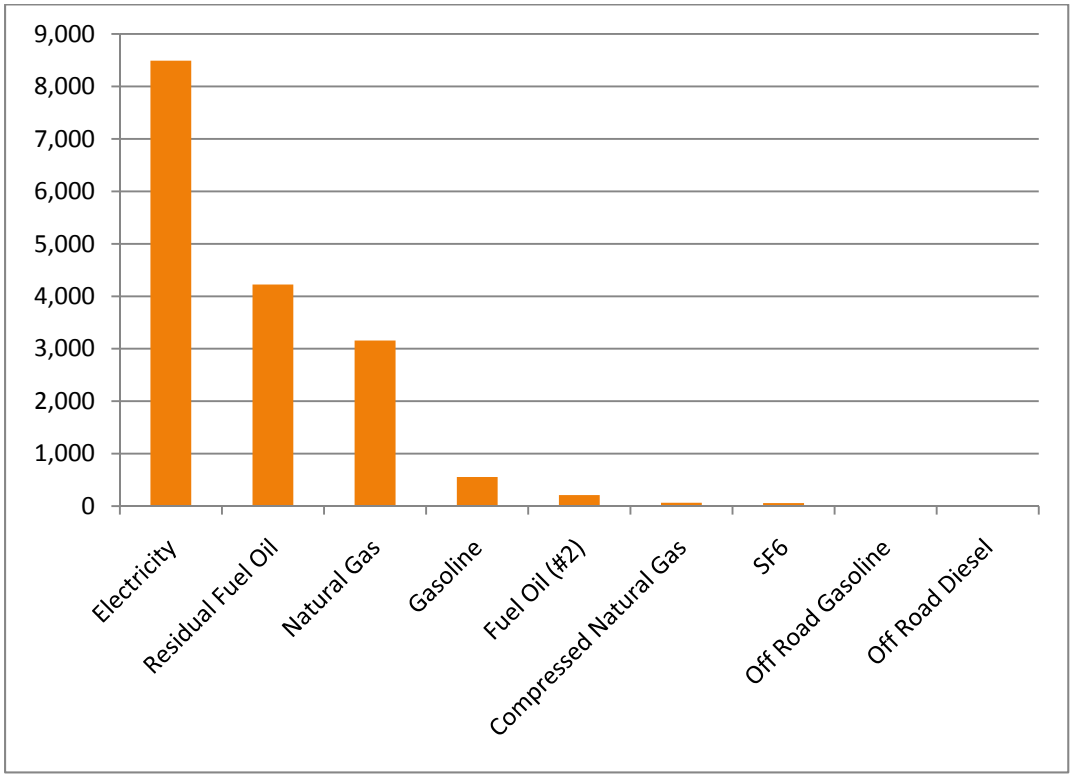

FIGURE 14 – SWARTHMORE COLLEGE $MTCO_2E$ EMISSIONS BY SOURCE (%), 2006

Emissions from Swarthmore College have changed significantly over the four year time period of this study, as shown in Figure 15. Reductions in both the use of electricity and residual fuel oil largely explain this change. Swarthmore College has the ability to choose between natural gas or residual fuel oil for the heating of buildings and water on campus and, because of the lower carbon content of natural gas compared to fuel oil, the choice of natural gas results in lower GHG emissions. In recent years, this choice has been made based on the relative costs of the two fuels and if the price of natural gas increases in relation to fuel oil, the college administration will face a difficult decision in balancing financial costs against greenhouse gas emissions.

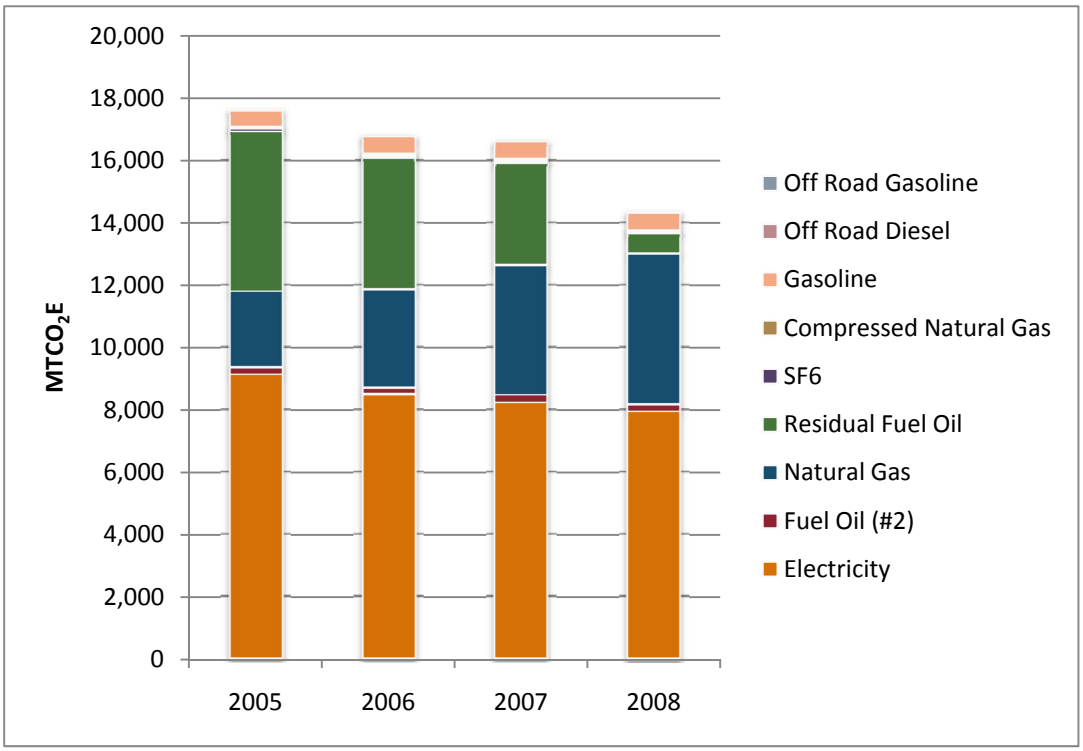

FIGURE 15 – SWARTHMORE COLLEGE EMISSIONS BY SOURCE, $MTCO_2E$, 2005-2008

The communities of Nether Providence, Rose Valley, Rutledge, and Swarthmore make up the Wallingford-Swarthmore School District (WSSD). The district includes five schools: a high school (Strath Haven High School), a middle school (Strath Haven Middle School), and three elementary schools (Nether Providence Elementary School, Wallingford Elementary School, and Swarthmore-Rutledge Elementary School). In the 2008-2009 school year, records indicated there were 3,568 students enrolled in the school district.

With assistance from staff members in the Transportation, Human Resources, Operations, and Finance departments of the school district, we obtained data for this GHG emissions inventory. We obtained records for electricity, natural gas, and fuel oil use data for all school district sites. We also obtained data related to the school district's diesel and gasoline tanks, which fuel the district's school buses, as well as vehicles from Swarthmore Fire Department, Nether Providence Township and Police Department, Garden City Fire Department, South Media Fire Department, and Children & Adult Disability and Educational Services.[24]

[24] The Transportation Office provided us invoices, tank refueling records, and bus fueling logs. However, because these records were incomplete for several years, we have had to make estimations of total motor fuels use and the shares attributable to the school district and other users.

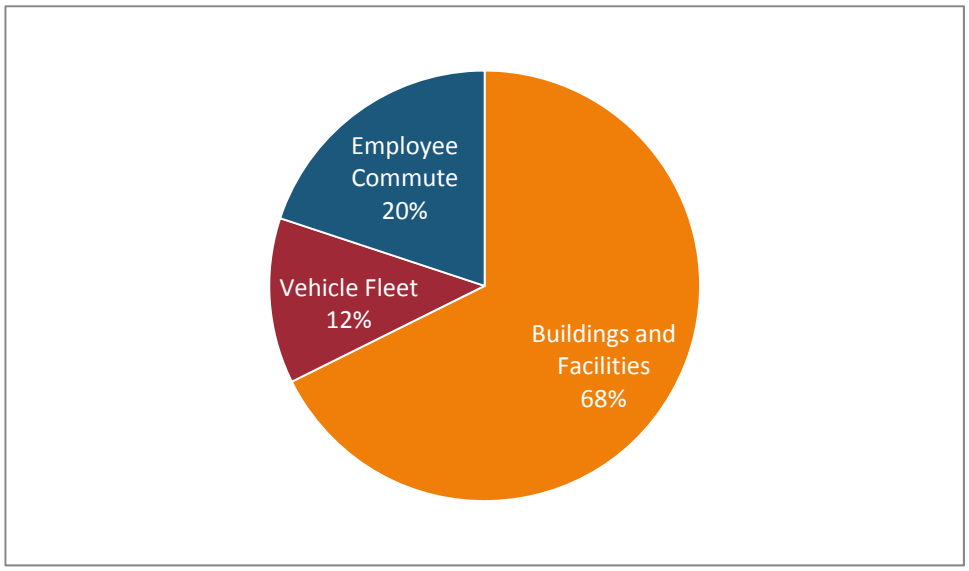

FIGURE 16 – WALLINGFORD-SWARTHMORE SCHOOL DISTRICT'S CO_2 EQUIVALENT EMISSIONS (%) BY SECTOR, 2006

While we received data for 2007 and 2008 recycling, we did not include any information on solid waste because none was collected by the school district. In addition, we sent out an employee commute survey to all faculty and staff that work for the school district. Using our responses, we were able to calculate total employee travel in the same way we did for the municipal governments.

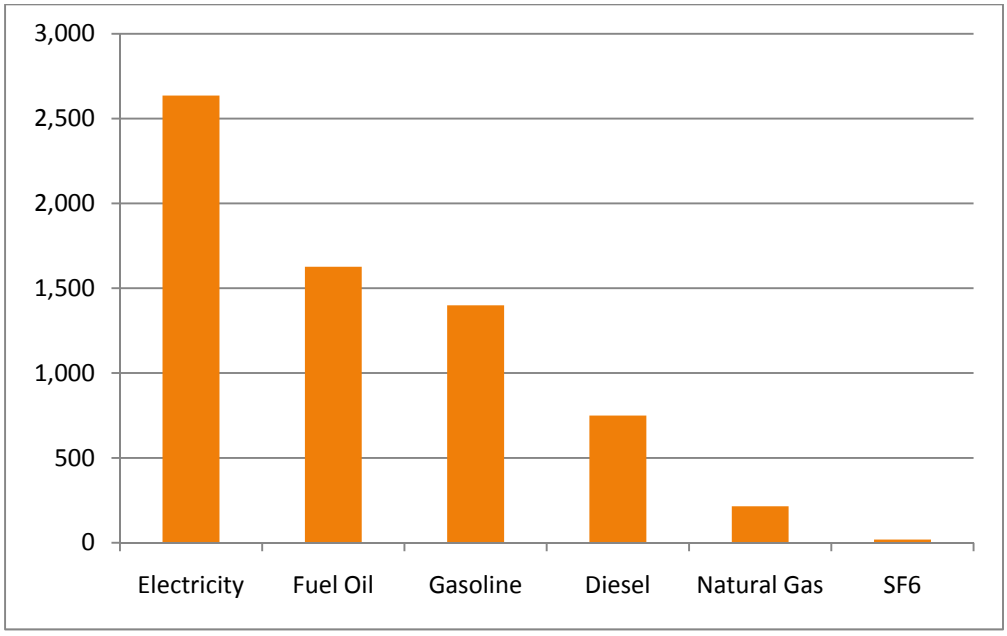

FIGURE 17 – WALLINGFORD-SWARTHMORE SCHOOL DISTRICT $MTCO_2E$ EMISSIONS BY SOURCE (%), 2006

In the Wallingford-Swarthmore School District, electricity use is responsible for 40% of emissions. Other significant emissions sources include Fuel Oil (25%), Gasoline (21%), and Diesel (11%) (Figure 17).

	Swarthmore College		Wallingford-Swarthmore School District	
Scope One	$MTCO_2E$	%	$MTCO_2E$	%
Building Natural Gas & Fuel Oil	7,429	44.3	1,830	27.5
Vehicle Fleet	168	1.0	826	12.4
Total Scope One	***7,597***	***45.3***	***2,656***	***40.0***
Scope Two	$MTCO_2E$	%	$MTCO_2E$	%
Building Electricity	8,491	50.6	2,636	39.7
Total Scope Two	***8,491***	***50.6***	***2,636***	***39.7***
Scope Three	$MTCO_2E$	%	$MTCO_2E$	%
Employee Commute	395	2.4	1,323	19.9
Intercampus Van	63	0.4	n/a	n/a
Other	222	1.3	29	0.4
Total Scope Three	***680***	***4.1***	***1,352***	***20.4***

TABLE 7 – SWARTHMORE COLLEGE AND WALLINGFORD-SWARTHMORE SCHOOL DISTRICT SCOPE ONE, TWO AND THREE EMISSIONS, 2006

OTHER EMISSIONS SOURCES, SINKS, AND AVOIDED EMISSIONS

Although we were able to include most sources of greenhouse gas emissions attributable to college and school district operations and facilities, as with the communities and municipal governments emissions estimates, there were some sources of emissions which we could not accurately estimate. These sources include:

- Building refrigerants/coolants
- Business air travel (Swarthmore College only)
- Other business travel
- Fertilizers and pesticides use
- Fire suppressants
- Mobile refrigerants
- Paving (asphalt)
- Product lifecycle emissions
- Snow plowing

Combined, these emissions could represent a significant share of total Swarthmore College and Wallingford-Swarthmore School District GHG emissions, but it is impossible to determine a reliable figure. Using as few of these products and services as is necessary for effective operations of the college and schools and choosing alternatives, where possible, with lower associated energy and resource inputs (for example, rail transport over air travel for business trips) will help to reduce overall GHG emissions.

As with community and municipal government GHG calculations, Swarthmore College and Wallingford-Swarthmore School District facilities and operations management can avoid GHG emissions or sequester carbon. For example, a significant portion of Swarthmore College land is comprised of the Scott Arboretum, a source for the storage of carbon as trees and plants grow. In addition, Swarthmore College has two notable initiatives that also result in avoided emissions: a significant recycling effort and the purchase of PECO wind energy credits. Recycling efforts eliminated 900 tons of waste (in 2008, the most recent year for which data are available),[25] avoiding about 300 $MTCO_2E$ of GHGs that would have been emitted had these materials been incinerated or landfilled (Table 8). Swarthmore College Renewable Energy Credits purchased in 2008 reflect the avoidance of 3,611 $MTCO_2E$ of GHG emissions, had the equivalent kWh of electricity been generated with conventional fuels (see Table 14 and Table 15 in the appendix).

	2005	2006	2007	2008
Paper Products	67	63	61	52
Food Waste	0	0	0	12
Plant Debris	0	155	155	160
Wood or Textiles	44	35	65	12
All Other Waste	62	72	139	664
Total Waste (tons)	**173**	**325**	**420**	**900**
Avoided Emissions ($MTCO_2E$)	35	50	82	309

TABLE 8 – SWARTHMORE COLLEGE RECYCLING (IN TONS WITH CALCULATED AVOIDED GHG EMISSIONS IN $MTCO_2E$)

[25] The significant increase in recycling in 2008, compared to the three previous years, was due to the inclusion of construction / demolition materials and asphalt recycling.

PROJECTIONS

The Energy Information Agency of the U.S. Department of Energy forecasts a 2.25% drop in total metric tons of CO_2 equivalent emissions in the United States between 2007 and 2020, decreasing from 5,986 million $MTCO_2E$ in 2007 to 5,851 million $MTCO_2E$ in 2020.[26] Because population is expected to increase 13.3% over that time from 302 million to 343 million, this analysis forecasts a reduction in per capita emissions of 13.7% from 19.8 $MTCO_2E$ in 2007 to 17.1 $MTCO_2E$ in 2020.

Greenhouse Gas Emissions, Actual, 2005-2008						
	2005	**2006**	**2007**	**2008**		
Per capita emissions (USA) in MTCO2E1	20.1	19.6	19.8	19.0		
Population, four communities2	21,106	21,059	21,071	21,103		
Per capita emissions (project communities) , in MTCO2E	10.9	10.4	10.8	10.4		
Total emissions, four communities, in MTCO2E3	229,202	218,236	227,477	220,462		
Greenhouse Gas Emissions, Projections, 2010-2035						
	2010	**2015**	**2020**	**2025**	**2030**	**2035**
Per capita emissions (USA) in MTCO2E1	17.7	17.5	17.1	16.8	16.5	16.2
Forecast emissions reduction (compared to 2008)	-6.9%	-7.9%	-10.3%	-11.9%	-13.4%	-15.0%
Population, four communities2	21,240	21,280	21,318	21,354	21,388	21,419
Per capita emissions (project communities), in MTCO2E	9.7	9.6	9.4	9.2	9.0	8.9
Total emissions, four communities, in MTCO2E3	206,647	204,805	199,797	196,536	193,432	190,111
% change in projected community emissions (2006 base)	-5.3%	-6.2%	-8.4%	-9.9%	-11.4%	-12.9%

[1] Source: US Department of Energy's Energy Information Agency Annual Energy Outlook reports for 2008 and 2010.
[2] Source: DVRPC Data Navigator, accessed at http://www.dvrpc.org/asp/mcddataNavigator/, Aug 2010.
[3] Source: 2005-2008, Temple University Center for Sustainable Communities calculations. 2010 onwards, Projections.

TABLE 9 – TOTAL AND PER CAPITA GHG EMISSIONS, ACTUAL AND PROJECTED, 2005-2035

These reductions are expected to come in the form of more efficient use of energy due to rising energy prices and the implementation of stricter energy efficiency standards for home appliances, new building construction, cars and light duty trucks, and other products. Compounding the reductions will be the decreasing carbon intensity of energy used in residences, businesses,

[26] U.S. Energy Information Agency, 2010.

factories, and other buildings, as renewable sources of energy—wind, solar, tidal, and others—and nuclear power make up greater shares of electricity generation.

The four communities of Nether Providence, Rose Valley, Rutledge, and Swarthmore are expected to have a small population increase of 0.6%, from an estimated 21,059 in 2006 to a forecast population of 21,318 in 2020 and 21,354 in 2025. If the per capita emissions for the four communities change at the same rate forecast for the United States as a whole, total GHG emissions will decrease from 218,236 $MTCO_2E$ in 2006 to 199,797 $MTCO_2E$ in 2020; an 8.4% drop in total emissions.

COMPARISONS

AMONG THE FOUR COMMUNITIES

Within the four communities, 2006 per capita emissions ranged from a low of 7.3 $MTCO_2E$ per capita in Rutledge Borough to 12.5 $MTCO_2E$ in Swarthmore Borough (Figure 18). Per capita emissions vary between the municipalities primarily in the non-residential sector. Non-residential stationary emissions range from 0.3 $MTCO_2E$ per capita in Rutledge to 3.8 $MTCO_2E$ in Swarthmore Borough. This accounts for a great deal of the variation, but not all. Residential emissions vary from a low of 3.3 in Swarthmore Borough to a high of 5.3 in Rose Valley.

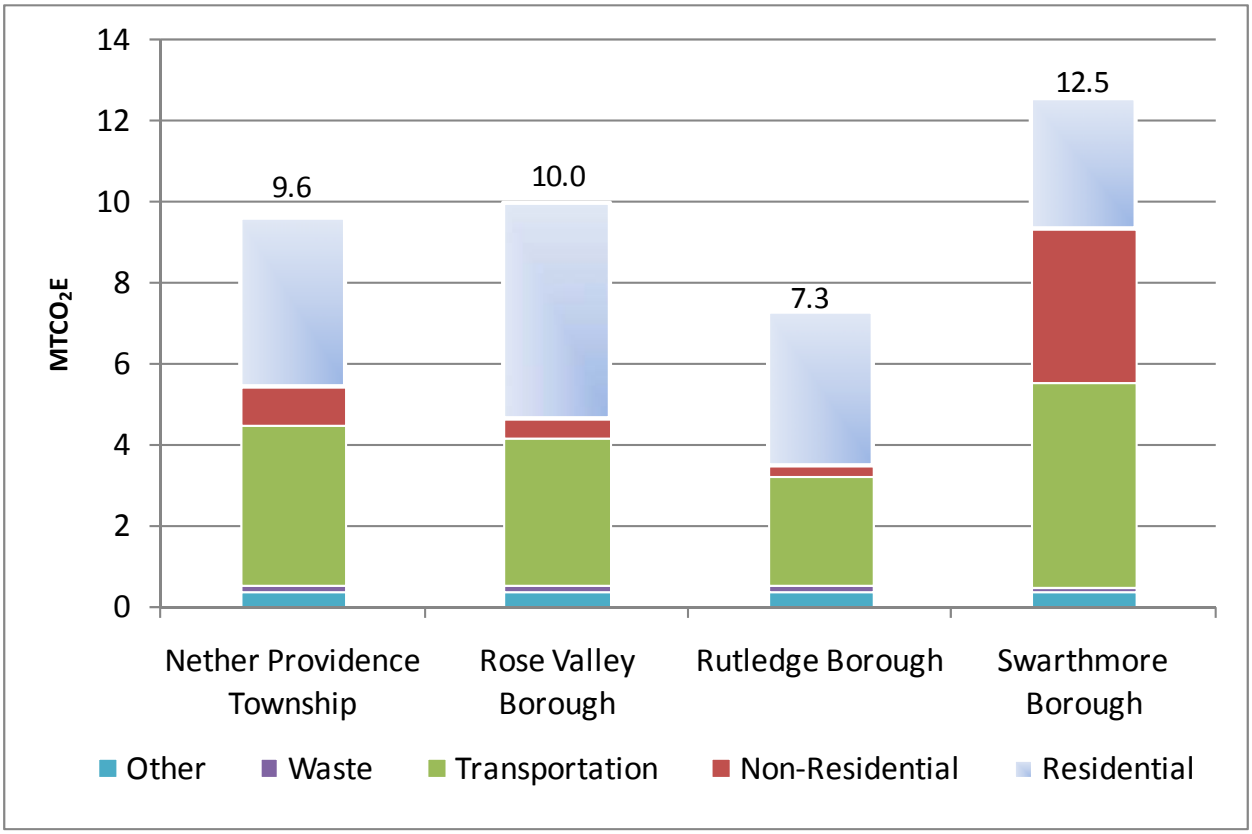

FIGURE 18 – COMPARING PER CAPITA MUNICIPAL EMISSIONS BY SECTOR, 2006 ($MTCO_2E$)

While many factors contribute to the variability in per capita emissions of greenhouse gases in each community, household income clearly has an effect. As incomes rise, the ability to purchase larger homes and more vehicles rises too, leading to higher levels of GHG emissions. Rutledge Borough, with the lowest 1999 median household incomes of $60,972, has the lowest per capita emissions. Per capita emissions in Swarthmore Borough (1999 median household income of $82,653) are heavily influenced by the presence of Swarthmore College and, were college emissions

removed from the calculations, per Swarthmore Borough capita emissions would be 9.7 $MTCO_2E$, slightly lower than Rose Valley (1999 median household income of $114,373) per capita emissions of 10.0 $MTCO_2E$.

GHG emissions attributable to each municipal government (see Figure 19) reflect the relative sizes of the communities' residential populations and the facilities and operations associated with each municipal government.

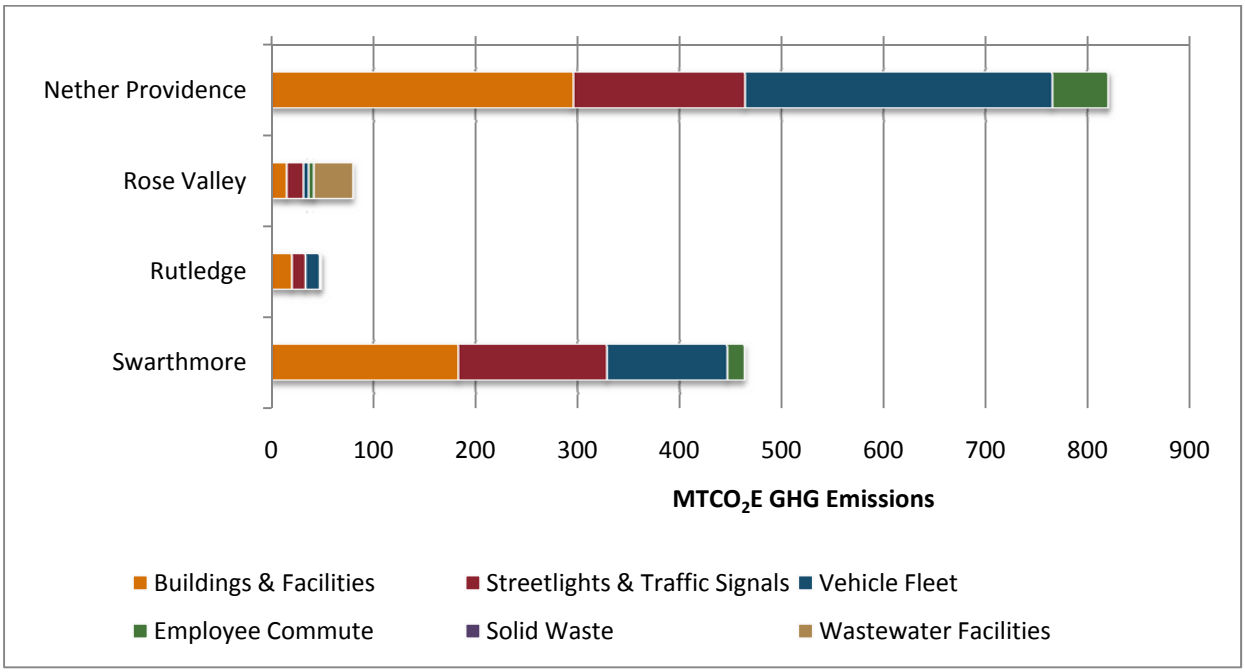

FIGURE 19 – GREENHOUSE GAS EMISSIONS BY MUNICIPAL GOVERNMENT ($MTCO_2E$), 2006

REGIONAL, STATE, AND NATIONAL INDICATORS

Overall, regional per capita emissions of 16.5 $MTCO_2E$[27] were significantly higher than Nether Providence, Rose Valley, Rutledge, and Swarthmore's average per capita emissions of 10.4 $MTCO_2E$ (Figure 20). Non-residential emissions for the region are substantially higher on a per capita basis than they are in the four project communities, explaining much of the difference (6.3 $MTCO_2E$ per capita for the region in 2005 versus 1.8 $MTCO_2E$ in the four project communities). In addition, apart from Swarthmore Borough, transportation-related emissions are lower in the project communities than they are in the region as a whole.

[27] DVRPC 2009.

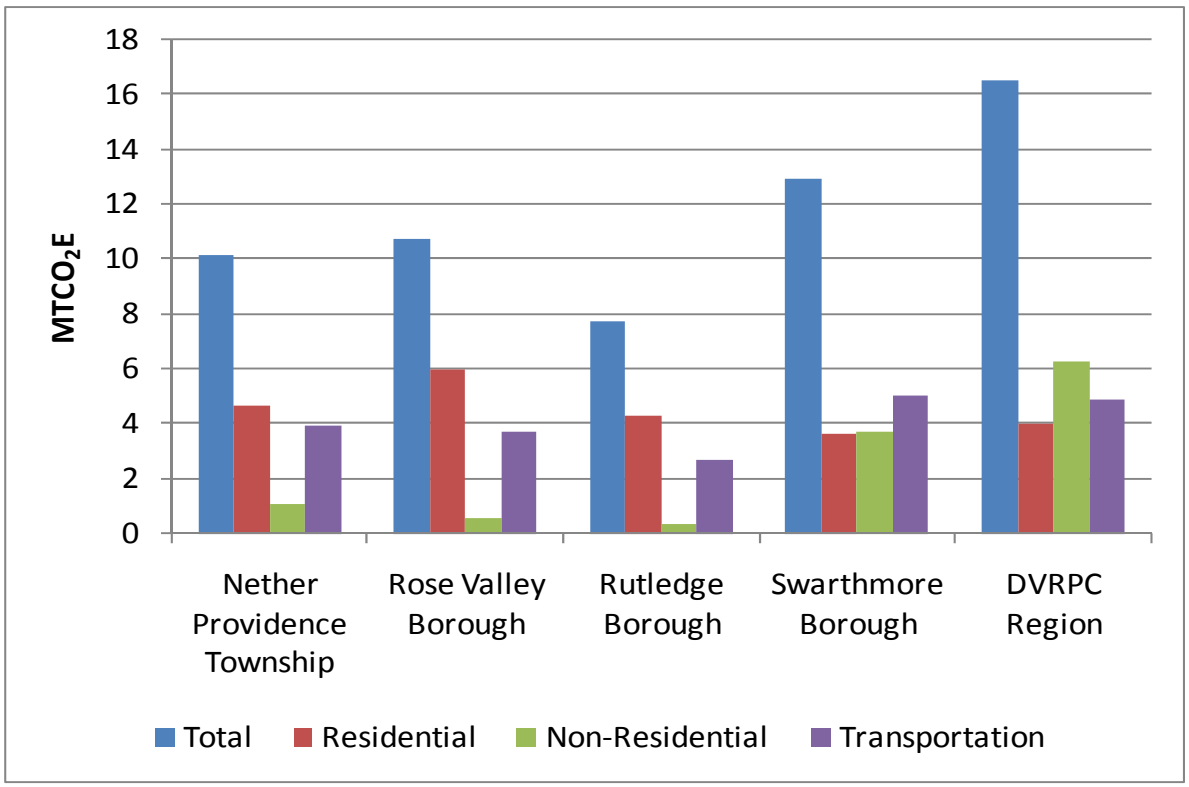

FIGURE 20 – PER CAPITA GHG EMISSIONS ($MTCO_2E$) COMPARISON TO REGION, 2005

The project communities' per capita emissions are also significantly lower than the state of Pennsylvania's—21.8 $MTCO_2E$—or the United States'—20.3 $MTCO_2E$.[28] The significantly higher state and national per capita emissions are attributable in large part to the industrial and agricultural emissions that are not directly present in the communities of Nether Providence, Rose Valley, Rutledge, and Swarthmore, but are indirectly present (though uncounted) in produce lifecycle emissions for consumer products purchased and used by residents and businesses in the four communities.

[28] The 2010 U.S. Greenhouse Gas Inventory Report (http://www.epa.gov/climatechange/emissions/usinventoryreport.html) reports net emissions of 6,100.7 Tg CO_2E for 2006 when the US population was 300.13 million. The national per capita emissions were thus 20.33 $MTCO_2E$. For Pennsylvania, 2006 emissions were 271.05 Million $MTCO_2E$ for a population of 12,440,621 (see http://www.epa.gov/climatechange/emissions/downloads/CO2FFC_2007.pdf). This is an average of 21.78 $MTCO_2E$.

MUNICIPAL GOVERNMENTS' TABLES AND GRAPHS

TABLE 10 – NETHER PROVIDENCE GOVERNMENT EMISSIONS, 2005-2008

	2005			2006			2007			2008		
	CO_2e (tonnes)	CO_2e %	cost	**CO_2e (tonnes)**	CO_2e **%**	**cost**	CO_2e (tonnes)	CO_2e %	Cost	CO_2e (tonnes)	CO_2e %	cost
Buildings & Facilities	280.98	35%	$42,417	295.67	36%	$45,253	321.49	38%	$48,620	338.46	45%	$59,292
Streetlights & Traffic Signals	165.89	21%	$53,923	168.73	21%	$58,892	169.40	20%	$60,058	149.29	20%	$56,078
Vehicle Fleet	293.55	37%	$41,802	301.11	37%	$61,450	308.48	36%	$75,552	213.29	28%	$62,151
Employee Commute[29]	54.18	7%	$0	54.10	7%	$0	54.06	6%	$0	54.02	7%	$0
Solid Waste	0.12	0%	$820	0.12	0%	$864	0.12	0%	$861	0.12	0%	$336
Total Nether Providence Township	*794.71*	*100%*	*$138,962*	*819.73*	*100%*	*$166,459*	*853.54*	*100%*	*$185,091*	*755.19*	*100%*	*$177,857*

[29] The cost of employee commute is paid by employees as a personal expense, rather than by the municipality as a government expense and, therefore, is not reported in this table.

TABLE 11 – ROSE VALLEY GOVERNMENT EMISSIONS, 2005-2008

	2005			2006			2007			2008		
	CO_2e (tonnes)	CO_2e %	cost	**CO_2e (tonnes)**	CO_2e **%**	**cost**	CO_2e (tonnes)	CO_2e %	cost	CO_2e (tonnes)	CO_2e %	cost
Buildings & Facilities	15.15	19%	$3,680	14.93	19%	$3,981	14.27	18%	$3,908	17.70	22%	$5,142
Streetlights & Traffic Signals	16.00	20%	$6,749	16.01	20%	$7,234	13.96	18%	$6,222	13.96	17%	$6,253
Vehicle Fleet	5.46	7%	$771	5.00	6%	$1,173	5.56	7%	$1,377	4.44	6%	$1,202
Employee Commute[30]	5.35	7%	$0	5.34	7%	$0	5.34	7%	$0	5.34	7%	$0
Solid Waste	0.03	0%	$1,042	0.03	0%	$1,047	0.03	0%	$1,047	0.03	0%	$1,047
Wastewater Facilities	38.95	48%	$4,836	38.44	48%	$5,038	40.01	51%	$5,584	38.72	48%	$5,987
Total Rose Valley Government	*80.94*	*100%*	*$17,078*	*79.75*	*100%*	*$18,473*	*79.18*	*100%*	*$18,138*	*80.20*	*100%*	*$19,631*

TABLE 12 – RUTLEDGE GOVERNMENT EMISSIONS, 2005-2008

	2005			2006			2007			2008		
	CO_2e (tonnes)	CO_2e %	cost	**CO_2e (tonnes)**	CO_2e **%**	**cost**	CO_2e (tonnes)	CO_2e %	cost	CO_2e (tonnes)	CO_2e %	cost
Buildings & Facilities	26.11	47%	$6,676	19.85	41%	$6,009	26.45	50%	$7,385	27.93	51%	$7,845
Streetlights & Traffic Signals	14.97	27%	$6,363	13.33	28%	$6,699	13.31	25%	$6,738	13.31	25%	$6,861
Vehicle Fleet	13.23	24%	$2,931	14.01	29%	$3,666	12.46	23%	$3,424	12.23	23%	$4,123
Employee Commute[24]	0.82	1%	$0	0.82	2%	$0	0.82	2%	$0	0.82	2%	$0
Total Rutledge Government	*55.13*	*100%*	*$15,970*	*48.00*	*100%*	*$16,374*	*53.03*	*100%*	*$17,547*	*54.29*	*100%*	*$18,829*

[30] The cost of employee commute is paid by employees as a personal expense, rather than by the municipality as a government expense and, therefore, is not reported in this table.

TABLE 13 – SWARTHMORE GOVERNMENT EMISSIONS, 2005-2008

	2005			2006			2007			2008		
	$MTCO_2E$	CO_2E (%)	cost	$MTCO_2E$	CO_2E (%)	cost	$MTCO_2E$	CO_2E (%)	cost	$MTCO_2E$	CO_2E (%)	cost
Buildings & Facilities	183.83	39%	$41,318	183.00	40%	$45,037	199.90	41%	$48,067	185.52	41%	$52,234
Streetlights & Traffic Signals	146.99	31%	$56,170	145.81	31%	$60,591	146.86	30%	$61,612	144.88	32%	$62,426
Vehicle Fleet	122.65	26%	$22,453	117.96	25%	$27,249	120.56	25%	$30,929	110.29	24%	$31,811
Employee Commute[31]	16.50	4%	$0	16.46	4%	$0	16.43	3%	$0	16.41	4%	$0
Total Swarthmore Government	*469.97*	*100%*	*$119,941*	*463.23*	*100%*	*$132,877*	*483.76*	*100%*	*$140,608*	*457.11*	*100%*	*$146,471*

TABLE 14 – SWARTHMORE COLLEGE EMISSIONS, INCLUDING EMISSIONS FROM RENEWABLE ENERGY PURCHASES, 2005-2008

	2005			2006			2007			2008		
	$MTCO_2E$	CO_2E (%)	cost	$MTCO_2E$	CO_2E (%)	cost	$MTCO_2E$	CO_2E (%)	cost	$MTCO_2E$	CO_2E (%)	cost
Buildings & Facilities	16,998	96.50%	$573,623	16,142	96.30%	$977,551	15,970	96.20%	$975,492	13,710	95.70%	$1,093,667
Vehicle Fleet	222	1.30%	$41,262	231	1.40%	$49,426	234	1.40%	$56,845	225	1.60%	$64,614
Employee Commute[25]	395	2.20%	$0	395	2.40%	$0	395	2.40%	$0	395	2.80%	$0
Total Swarthmore College	17,615	100%	$614,885	16,768	100%	$1,026,977	16,598	100%	$1,032,337	14,329	100%	$1,158,281

[31] The cost of employee commute is paid by employees as a personal expense, rather than by the municipality as a government expense and, therefore, is not reported in this table.

TABLE 15 – SWARTHMORE COLLEGE EMISSIONS, EXCLUDING EMISSIONS FROM RENEWABLE ENERGY PURCHASES, 2005-2008

	2005			2006			2007			2008		
	$MTCO_2E$	CO_2E (%)	cost	$MTCO_2E$	CO_2E (%)	cost	$MTCO_2E$	CO_2E (%)	cost	$MTCO_2E$	CO_2E (%)	cost
Buildings & Facilities	16,580	96.4%	$570,084	15,302	96.0%	$972,961	12,955	95.3%	$970,568	10,099	94.1%	$1,084,672
Vehicle Fleet	222	1.3%	$41,262	245	1.5%	$49,426	249	1.8%	$56,845	233	2.2%	$64,614
Employee Commute[25]	395	2.3%	$0	395	2.5%	$0	395	2.9%	$0	395	3.7%	$0
Total Swarthmore College	17,197	100%	$611,346	15,942	100%	$1,022,387	13,599	100%	$1,027,413	10,727	100%	$1,149,286

TABLE 16 – WALLINGFORD-SWARTHMORE SCHOOL DISTRICT EMISSIONS, 2005-2008

	2005		2006		2007		2008	
	CO_2e (tonnes)	CO_2e (%)	**CO_2e (tonnes)**	CO_2e (%)	CO_2e (tonnes)	CO_2e (%)	CO_2e (tonnes)	CO_2e (%)
Buildings & Facilities	4,199.67	67.20%	4,495.63	67.66%	4,421.98	66.93%	10,037.39	82.75%
Vehicle Fleet	725.65	11.61%	825.77	12.43%	863.09	13.06%	771.69	6.36%
Employee Commute	1324.2	21.2%	**1322.8**	**19.2%**	1,321.78	20.01%	1,320.91	10.89%
Total WSSD	6,249.50	100%	6,644.24	100%	6,606.85	100%	12,129.99	100%

TABLE 17 – FOUR COMMUNITY EMISSIONS, $MTCO_2E$

	2005	2006	2007	2008
Residential	92,410	82,492	89,814	84,741
Non-Residential	37,488	36,619	38,111	36,781
Transportation	88,383	88,378	88,489	88,222
Waste	2,785	2,499	2,462	1,879
Other	8,136	8,247	8,600	8,840
Total	***229,202***	***218,236***	***227,477***	***220,462***

TABLE 18 – INDIVIDUAL COMMUNITY EMISSIONS, $MTCO_2E$, 2005-2008

	2005	2006	2007	2008
Nether Providence Township				
Residential	61,226	54,782	59,577	56,270
Non-Residential	13,922	12,993	13,430	13,736
Transportation	51,967	51,980	52,046	51,889
Waste	1,727	1,735	1,714	1,254
Other	5,094	5,174	5,389	5,540
Subtotal	*133,936*	*126,664*	*132,155*	*128,689*
Rose Valley Borough				
Residential	5,476	4,880	5,301	5,116
Non-Residential	498	444	460	407
Transportation	3,389	3,362	3,366	3,356
Waste	120	119	116	79
Other	355	360	376	389
Subtotal	*9,837*	*9,164*	*9,619*	*9,347*
Rutledge Borough				
Residential	3,555	3,152	3,390	3,223
Non-Residential	251	208	202	204
Transportation	2,204	2,204	2,206	2,200
Waste	112	126	126	143
Other	321	325	338	347
Subtotal	*6,443*	*6,015*	*6,262*	*6,117*
Swarthmore Borough				
Residential	22,153	19,679	21,546	20,132
Non-Residential	22,817	22,974	24,020	22,433
Transportation	30,824	30,832	30,871	30,777
Waste	827	518	506	403
Other	2,366	2,389	2,498	2,564
Subtotal	*78,986*	*76,392*	*79,441*	*76,309*
Total	***229,202***	***218,236***	***227,477***	***220,462***

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