Greenhouse Gas Inventory (2002 to 2008) for the College of William and Mary

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On behalf of the Scientific and Technical Advisory Committee
of the President's Committee on Sustainability

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I. Executive Summary

In 2008, President Reveley instituted a Sustainability Policy for the College and formed the Committee on Sustainability (CoS). One of the subcommittees of CoS, the Science and Technical Advisory Subcommittee (STAC), was tasked with creating a model of the greenhouse gas emissions on the Williamsburg campus. This report is an output of that modeling exercise. Here, we summarize anthropogenic greenhouse gas emissions from 2002 to 2008 and suggest initial actions that can be taken to decrease the emissions.

Summary of greenhouse gas emissions

From 2002 to 2008, the College of William and Mary was responsible for an average of nearly 74,000 metric tons of carbon dioxide equivalents annually. A little less than six and a half metric tons of carbon dioxide equivalents were emitted per person.

From 2002 to 2008, total greenhouse gas emissions from the campus have increased by approximately 4%; however, emissions per person have declined (by 2.5%) and emissions per developed area of campus have decreased notably by approximately 16%. Therefore, as the campus has grown and invested in more proactive energy efficiency policies, **William and Mary has decreased its greenhouse gas emissions relative to its physical size by almost 16%**. This is an encouraging trend.

The sector with the greatest contribution to our greenhouse gas emissions is purchased electricity (Scope 2), which is responsible for approximately half of annual emissions. Most of the reductions in the campus carbon footprint appear to have come from increased efficiency of our on-campus power plant (Scope 1). College-related travel (Scope 3) has increased slightly, with air travel and commuting contributing a significant proportion of total emissions.

Priority action items

As purchased electricity is our largest single contribution to greenhouse gas emissions, we suggest focusing on reducing use of carbon-derived electricity. Possible actions include:

- Further reducing electricity use on campus by behavioral and technological change
- Consider developing ways of producing useable, affordable, low-carbon energy on campus (such as solar arrays, geothermal energy, or biomass-derived energy), especially as buildings are renovated or planned *de novo*
- Partner with Dominion Power and the State (and other relevant entities) to increase the proportion of low-carbon electricity available for the College to purchase at an affordable price

Concurrently, we should also continue to invest in improving the efficiency of our own on-campus thermal generation and distribution infrastructure. This should include increasing the energy efficiency of buildings heated by steam from the on-campus boilers.

As student, faculty, and staff travel continues to increase, we should

- Research and publicize the real emissions benefits and economic costs of purchased offsets, as an option in association with international air travel, and document offset use
- Educate the William and Mary community on alternates to air travel to select destinations
- Better advertise car-pooling tools and incentives and promote use of mass-transit and public transit options to reduce personal car use per capita
- Promote Internet and other electronic forms of communication and collaboration that reduce the necessity for travel

II. Methodology

This report follows widely accepted standards for conducting a greenhouse gas emissions inventory. It uses the Clean Air – Cool Planet Campus Carbon Calculator, an Excel workbook adapted from the workbook issued by the Intergovernmental Panel on Climate Change for national emissions inventories. This calculator is the preferred tool for the American College and University President's Climate Commitment and is in use on over one thousand campuses nationwide.

The methodology used in the calculator was originally codified by the GHG Protocol Initiative. To identify operational boundaries and ascertain responsibility for emissions the GHG Protocol categorizes emissions within three scopes determined by the level of control an institution should have over them.

> ***Scope 1*** includes direct emissions from sources the campus owns or controls. Fuels burned in on-campus boiler plants fall in this category, as do emissions from the university fleet. Indirect emissions from products directly linked to campus energy consumption but not under control of the institution compose Scope 2.
>
> ***Scope 2*** consists only of purchased electricity.
>
> ***Scope 3*** includes emissions which the institution can influence but not control. Examples of Scope 3 sources are commuter travel or solid waste. The school does not directly cause these emissions but it has some degree of control.

Greenhouse gas emissions are measured for their contribution to the greenhouse effect compared to carbon dioxide. The gases studied here are carbon dioxide, methane, and nitrous oxide. The concept of a "carbon dioxide equivalent" (eCO2) is used as a unit of measure to standardize the impact of all emitted gases.

This audit focuses on emissions from 2002 to 2008. Data on emissions sources, particularly the campus' energy use, is unreliable before 2002 and would have produced an inadequate inventory composed overwhelmingly of estimates.

The College Woods and Lake Matoaka were considered as neither a net source nor a net sink of greenhouse gas emissions. After consulting with various experts, it was decided that the emissions from the Lake and decaying trees in the College Woods were negated by the use of the College Woods as a carbon sink.

III. Scope 1 Emissions and Recommendations

The sources of Scope 1 emissions on campus are the fuel oils burned, hot water generators, steam boilers, the fuels used in the university fleet, and fertilizer applications.

The campus boilers burn a combination of natural gas, #2 fuel oil, #6 fuel oil (now phased out), and propane to heat campus and provide hot water. Data from the power plant was provided by Dan Patterson, the College's Energy Manager.

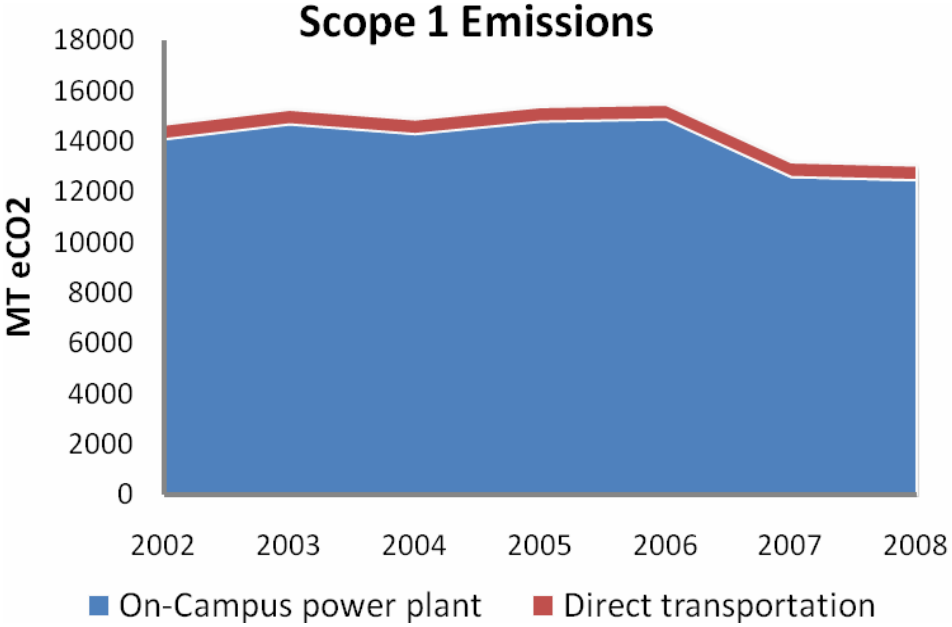
	MMBtu 1990	MMBtu 2002	MMBtu 2003	MMBtu 2004
Natural gas	184678	260737	216153	254724
#2 fuel oil	-	30732 gal	39095 gal	57290 gal
#6 fuel oil	334929 gal	-	244670 gal	22057 gal
Propane	-	4435 gal	5228 gal	4584 gal

	MMBtu 2005	MMBtu 2006	MMBtu 2007	MMBtu 2008
Natural gas	266058	264090	232302	235375
#2 fuel oil	58995 gal	35037 gal	12796 gal	2421 gal
#6 fuel oil	11928 gal	50840 gal	16000 gal	-
Propane	4737 gal	1425 gal	1124 gal	895 gal

Diana Tennis, the Business Manager in Auxiliary Services, is responsible for keeping records of the fuel usage for the university fleet. The automobiles owned by William and Mary used a total of 62,232 gallons of gasoline and 5,134 gallons of diesel in 2008. Data collection began only in 2008, so this was assumed to be a constant volume per year back to 2002.

Information on fertilizer applications was provided by John MacFarlane, Associate Director of Gardens and Grounds. An average of 6,556 pounds of synthetic fertilizer is applied to campus grounds every year. Exact data was unavailable for individual years but Mr. McFarlane accepted this estimate for 2002 to 2008. The fertilizer used is 22% nitrogen.

Between 2002 and 2008, Scope 1 emissions averaged 14,866 metric tons per year. Of this, direct transportation only emits slightly over 600 metric tons eCO2 and fertilizer use produces only six metric tons CO2. The remaining emissions are all from on-campus thermal production (hot water and steam), which is responsible for an average of 14,559 metric tons eCO2 each year.



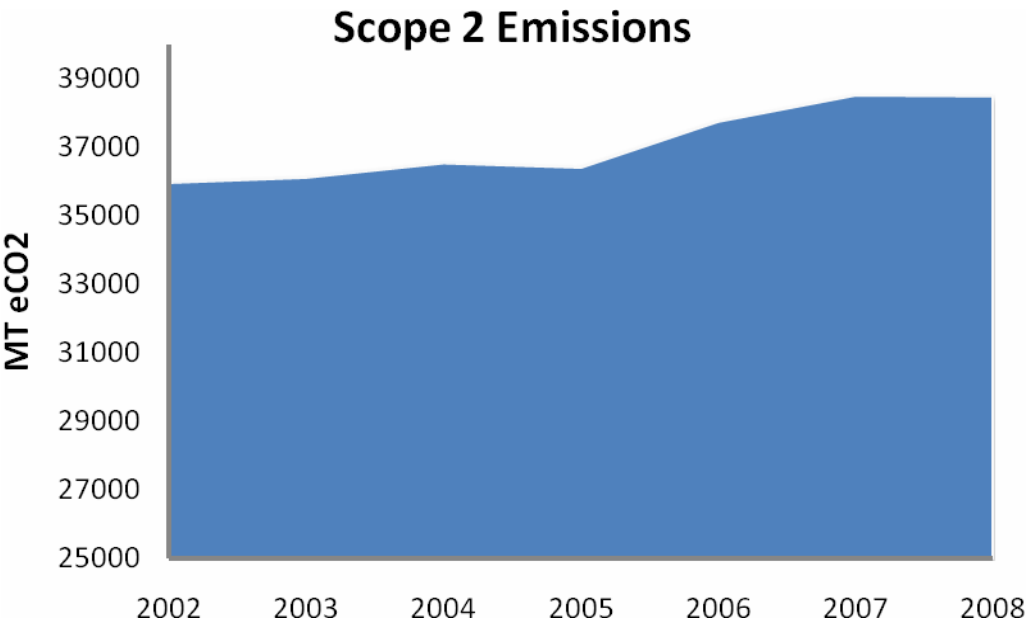
Scope 1 emissions have decreased over time. Greenhouse gas emission equivalents from the on-campus boilers have decreased by approximately 11.5% from 2002 to 2008, somewhat mirroring the overall trend for decreases in emissions per square foot from 2002 to 2008 (see section VI).

As seen in the graph above, the greatest source of greenhouse gas emissions from on-campus sources are the boilers Emissions from the university fleet (direct transportation) make a slight contribution, and the emissions from fertilizer applications are negligible (so not plotted, for simplicity). Much of the overall campus reductions in greenhouse gas emissions per square foot (see section VI) appear to be explained by the increased efficiency of our on-campus thermal production and dissemination systems, which are sources for almost all of the heating and domestic hot water throughout campus.

Further increasing the efficiency of the boilers and improving the insulation and energy efficiency of the buildings would have substantial impact in reducing Scope 1 emissions.

IV. Scope 2 Emissions and Recommendations

The College of William and Mary does not produce any of its own electricity. It purchases energy from Dominion Power; the electricity from Dominion is the only source of Scope 2 emissions on campus.



From 2002 to 2008, the College used an average of 68,683,680 kilowatt hours of energy per year. This translates to average emissions of 37, 105 metric tons eCO2 every year. A clear upward trend is visible in the seven years studied.

We estimated the approximate fuel mix used by Dominion to produce the purchased energy and, therefore, derived an estimation of the emissions produced under Scope 2. 48.5% of the electricity comes from burning coal, most of which is burned at the nearby Yorktown Power Station. The Surry Nuclear Power Station provides campus with emissions-free nuclear power, which is 36.3% of the fuel mix. Approximately 7.20% of the electricity is produced by burning natural gas and another 7.2% is produced by burning distillate oil. A small portion of the energy purchased for campus, 0.8%, is hydroelectric.

Scope 2 sources are by far the largest single source of emissions on campus. Targeting reductions in Scope 2 emissions would be the most effective way of reducing the College's greenhouse gas emissions overall. There are several non-mutually exclusive options that we could consider. The first is to reduce on-campus energy use through behavioral change. Students living in on-campus housing used from 20% to 28% of purchased energy on campus from 2005 to 2008. Efforts to reduce their use by promoting sustainable personal practices could have a positive effect on energy use on campus and they are an easy audience to reach. To date, efforts encouraging students to decrease their personal energy use have been relatively unsuccessful, but now that several individual buildings are metered for electricity use and there is greater awareness of sustainability issues on campus, we feel there is much that can be gained by systematic and targeted campaigns.

The second option is to increase energy efficiency of the buildings on campus. Installing variable speed fan drives in buildings is one way William and Mary is already increasing its efficiency. Methods such as this reduce energy use by decreasing the amount of electricity needed for campus activities.

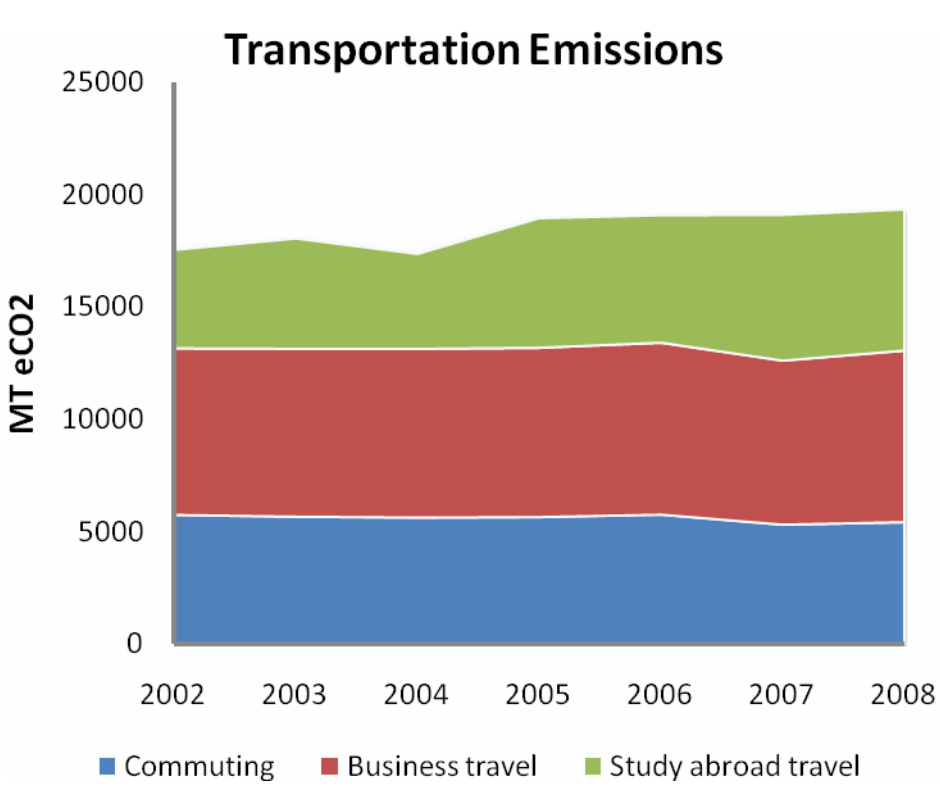
The third option is to reduce the amount of carbon-based electricity used by increasing the amount of renewable, low emissions energy generated on campus, such as solar and geothermal energy. The Committee on Sustainability has already funded a solar array project for the renovation of Small Hall and other similar projects should be encouraged. Especially as buildings are renovated or built as new, the College should take a proactive stance on investigating the suitability and economic consequences of alternative energy production on campus. For example, there are some areas of campus that appear suitable for generating geothermal energy and others that are better suited for solar. We recommend systematic investigations of ways in which William and Mary could invest in low-emissions energy production on campus, with the caveat that there will not be a single solution that can be applied in all cases.

The fourth option is the most difficult to achieve but may have the greatest impact on our carbon footprint. If William and Mary can partner with Dominion Power and state government to increase the percentage of "clean" energy purchased from Dominion in a cost-effective manner, we can directly reduce our greenhouse gas emissions. The state of Virginia currently has a voluntary renewable energy standard for utilities. If this standard became mandatory William and Mary's greenhouse gas emissions should decrease dramatically, but we need to be cognizant of any energy price increases this may impose on the College as non-coal based energy tends to be more expensive. Lobbying Richmond for a mandatory renewable energy standard that keeps costs manageable and discussing purchasing possibilities for renewable energy with Dominion Power are two ways the College could attempt to increase its use of renewable energy sources.

V. Scope 3 Emissions and Recommendations

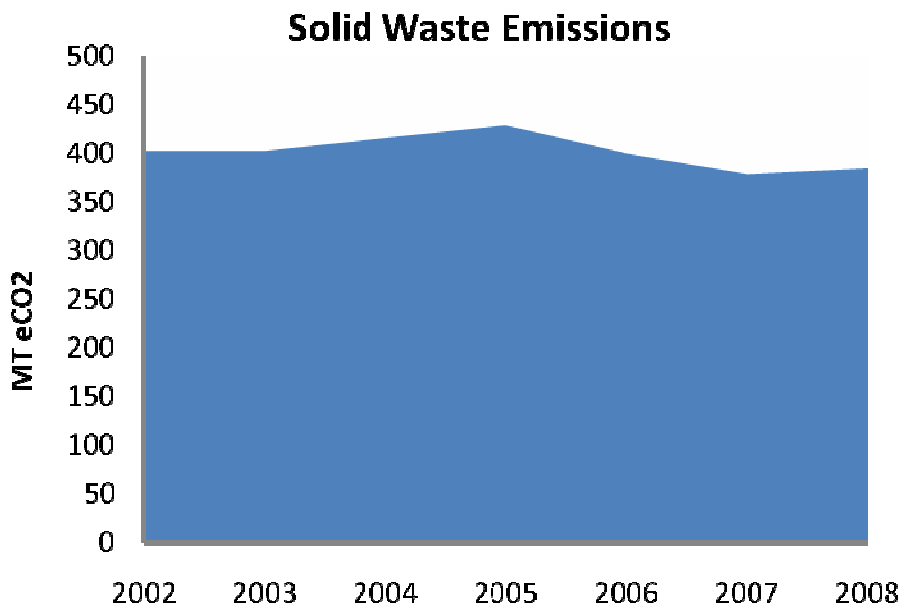
Scope 3 has a diverse range of sources. Commuting and business travel are considered Scope 3 emissions because while such forms of travel are personal choices, the College can influence people's decisions. Emissions from solid waste treatment by an outside vendor are included in Scope 3.

Data on transportation emissions were compiled from an online survey. The survey was sent to faculty, staff, and students at the College and asked questions concerning driving habits, usual vehicle use, and frequency of business travel. The survey was disseminated in the spring of 2009 but we assumed that people's travel habits have remained the same over the past six years. We plan to reissue the survey in subsequent years.



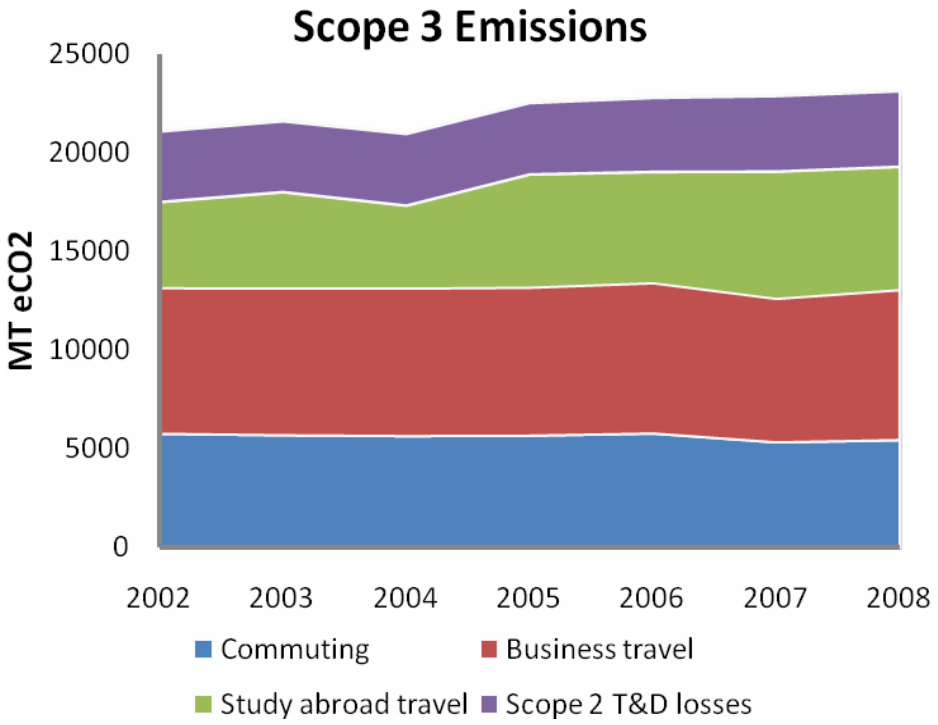
The average greenhouse gas emissions from daily commuting were an average of 5,581 metric tons eCO2 per year. Travel for business caused 7,524 metric tons of eCO2 per year, the majority of which came from air travel.

We also obtained information from the Reves Global Education Office concerning study abroad travel. Students' travel to destinations and home again resulted in an average of 5,356 metric tons of eCO2 each year, with notable increases in recent years as the College has actively promoted study abroad opportunities.



The solid waste information was assembled from estimates by Facilities Management and the College's contract with Waste Management, Inc., the outside vendor. There were no data available for 2002 so it was assumed that the tonnage would be similar to the weight of waste specified in the contract for 2003. Including that estimate, the average weight of waste created by the College was 2,496 tons in one year. This emitted an average of 401 metric tons of eCO2.

Wastewater, a source included in some greenhouse gas inventories, was not accounted for in this audit. Aerobic treatment of wastewater does not produce methane, which is the only possible greenhouse gas concerned with wastewater. Upstream emissions, which are technically included in Scope 3, are a challenge to incorporate in a greenhouse gas inventory because of the diversity of sources. In this audit, only emissions caused by the purchase of office/copier paper were considered. The emissions factor for paper is relatively low, however, and the contribution of paper to our institution's greenhouse gas emissions is extremely minor. We did not plot data from solid waste or paper on the graph below as they contribute so little emissions.



Scope 3 emissions as a whole averaged 22,130 metric tons equivalent of CO2 per year from 2002 to 2008. Directly financed business travel (particularly air travel), daily commuting and study abroad related emissions account for a large proportion of the College's total greenhouse gas emissions. Reducing emissions from any one of these sectors would decrease William and Mary's greenhouse gas emissions.

The emissions contribution from solid waste is much smaller than any of these three sectors and while other options for processing waste or methods for reducing the overall amount of solid waste (e.g., product reuse, increased recycling) should be considered, efforts should initially focus where they can have the greatest impact—which is on transportation.

Focusing on transportation emissions, business travel emissions and study abroad emissions are difficult to reduce, since decreasing the number of trips would sometimes conflict with William and Mary's academic and educational goals. For some destinations, forms of travel with less emissions than air travel, particularly mass transit such as trains, could be suggested. For destinations where it is impractical or impossible to avoid traveling by plane, purchasing carbon offsets is a possibility.

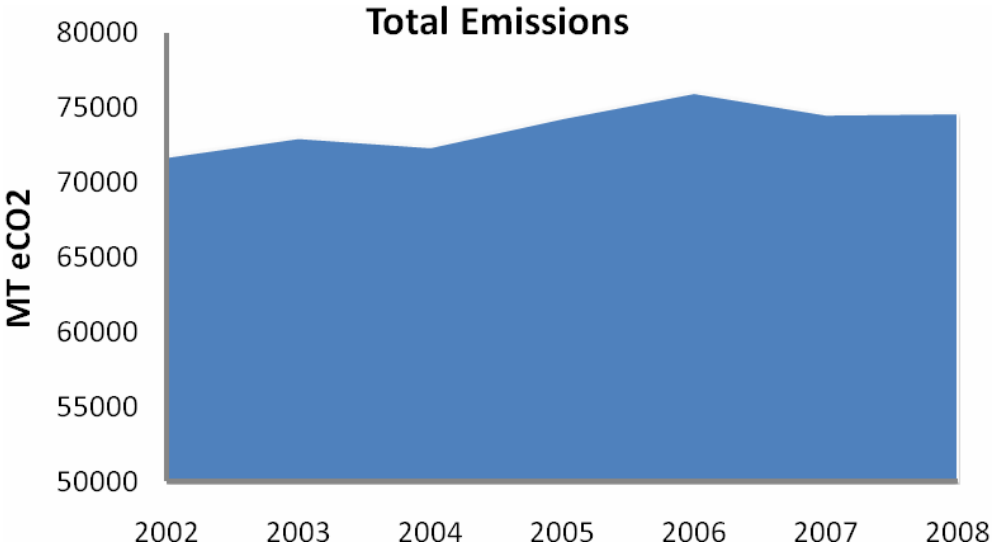
Carbon offsets are a contentious piece of any greenhouse gas emissions inventory. We offer two reasons why purchasing offsets should be a lower priority for the College. First, reducing emissions through decreased energy use will actually save the College money, whereas offsets cost money to purchase. Second, it is questionable whether purchased offsets are effective. Climate experts disagree over the effectiveness of purchased offsets and care should be taken to purchase them from a reputable vendor, if they are deemed necessary. The Chicago Climate Exchange is an internationally recognized venue for trading offsets and could be a good place for the College to obtain offsets.

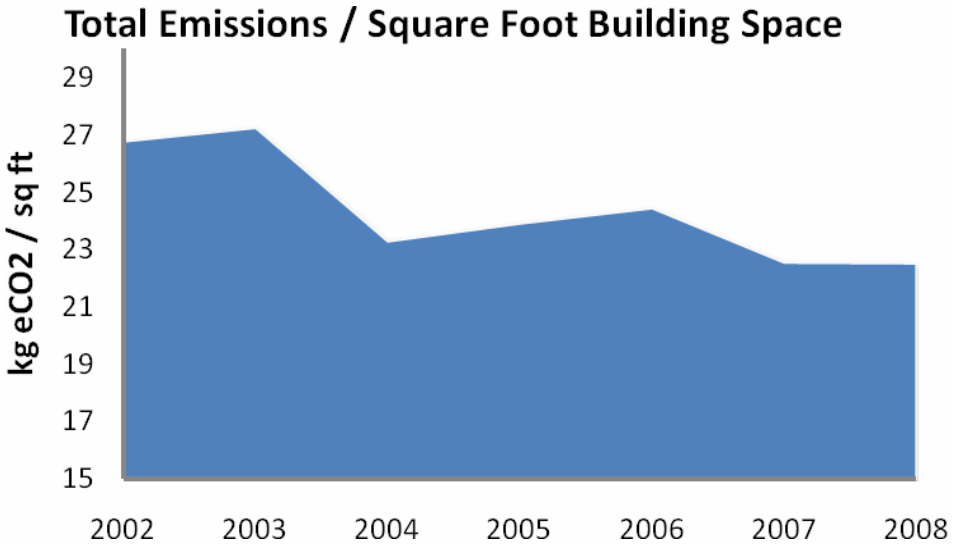
There are many approaches to reducing the greenhouse gas emissions caused by daily commuting. Students cause nearly half of the College's commuting emissions. Encouraging student carpooling or increasing the use of buses would decrease these emissions. A long term solution could be to increase the amount of student housing offered on campus. Carpooling or riding the bus could also reduce the emissions from staff members and faculty commuting to work. To promote carpooling, the College could offer various incentives to those who share rides to campus. Having a recognized system for matching commuters to viable carpools would be an effective start. An official network such as Zimride could fill the current void. With Zimride, William and Mary would purchase a license to use the software which members of the college community would use to find suitable carpools. The service claims to engage 10 to 20% of the population and is partners with institutions such as Stanford University and Cornell University. Increasing the use of buses in the Williamsburg area would also decrease emissions due to commuting. Currently, William and Mary students pay for unlimited use of the City's bus system but rarely use it. STAC is currently engaged in analyzing a student survey of bus use with the aim of producing recommendations that will lead to increased local bus use.

In addition to changing how people travel, we can also help develop alternatives to traveling. For example, by promoting the use of Internet and other electronic forms of communication and collaboration, we could reduce the need for physical visits to offsite work locations.

VI. Total Emissions and General Recommendations

From 2002 to 2008, William and Mary emitted an average of approximately 73,794 metric tons of carbon dioxide equivalents ever year. The total emissions increased over time, but the size of the campus and the population did as well, resulting in a substantial reduction in emissions per square foot of campus.



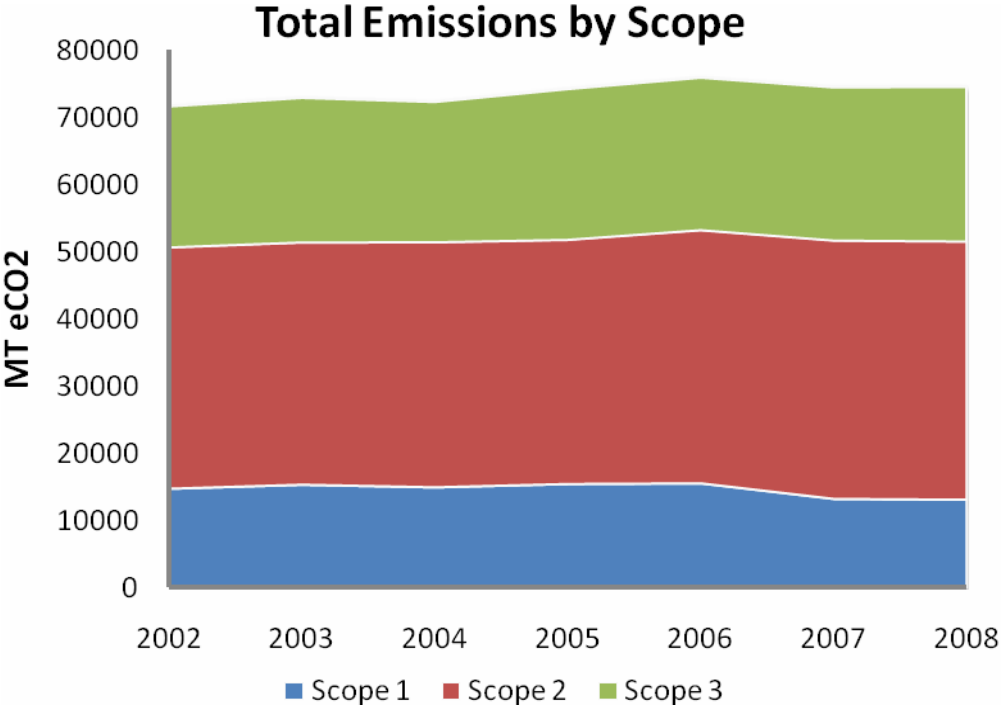


Total emissions have increased by approximately 4% from 2002 to 2008.

However, the College has also grown during that time. Once we standardize emissions for the square footage of building space on campus, we can see that emissions have declined consistently. Emissions per square foot of campus have reduced by approximately 16% from 2002 to 2008.

From 2002 to 2008, there were an average 6.4 metric tons of carbon dioxide equivalents emitted every year for each member of the William and Mary community—students, faculty, and staff. This level of emissions has decreased slightly (by 2.5%) over the years of this study. However, notably, the **greenhouse gas emissions per developed square foot of campus have decreased by approximately 16% from 2002 to 2008**. This downward trend is encouraging and demonstrates that the energy efficiency policies (particularly through new/renovated building efficiencies and on-campus hot water) have made a real difference to William and Mary's overall carbon footprint. As the College has grown

in its facilities, it has become more energy efficient and lowered its emissions relative to its physical footprint.



Scope 2 (purchased energy) has consistently been the greatest source of emissions on campus and emissions have increased somewhat over time. Scope 1 has decreased, while the transportation contributions to Scope 3 have increased small amount.

Greenhouse gas emissions on campus come primarily from purchased energy (Scope 2). This is where William and Mary can make the greatest reductions, but it is also where they have the least amount of control. Dominion is currently the only option for purchasing energy, unless the College is able to find renewable solutions for on-campus energy production. A more viable solution may be to invest in continuing energy efficiencies on campus.

Appendix 1: Contacts

Data	Source	Contact Info
Population & Physical Size	Dr. Susan Bosworth, Assoc. Provost, Office of Strategic Planning & Analysis; Dr. Daina Henry, Assoc. Director, Institutional Research, Office of Strategic Planning & Analysis, ; Data from 1998 – 2009 available at http://web.wm.edu/ir/CDS/cds.html	slbosw@wm.edu 757-221-3584 dphenr@wm.edu 757-221-2571
Budget – operating & research	Glenda White, Director of the Budget	gewhit@wm.edu 757-221-2566
Budget – energy; Custom Fuel Mix	Dan Patterson, Energy Manager	dppatt@wm.edu 757-221-1754
University Fleet	Diana Tennis, Business Manager	drtenn@wm.edu 757-221-2500
Fertilizer	John McFarlane, Assoc. Director for Gardens & Grounds	jdmcfa@wm.edu 757-221-2256
Study Abroad	Guru Ghosh, Director of the Global Education Office	gxghos@wm.edu 757-221-3595
Outsourced Travel	Survey created by Andrew Pike and John Swaddle	aapike@wm.edu; jpswad@wm.edu
Solid Waste	Dave Shepard, Acting Assoc. Vice President, Facilities Management	dpshep@wm.edu 757-221-1205

Appendix 2: Resources

Chicago Climate Exchange
http://www.chicagoclimatex.com/

Clean Air – Cool Planet, Inc.
http://www.cleanair-coolplanet.org/

Zimride
http://zimride.com/university_carpool_system