CARBON FOOTPRINT OF THE UNIVERSITY OF MARYLAND
GREENHOUSE GAS INVENTORY 2010

UNIVERSITY OF MARYLAND

UNIVERSITY OF MARYLAND OFFICE OF sustainability

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PREFACE

This report is the 2010 update to the *Carbon Footprint of the University of Maryland, College Park: An Inventory of Greenhouse Gas Emissions, 2002-2008*[1] and follows on the 2009 update; it includes new data for Calendar Year (CY) 2010 as well as updated data for Fiscal Years 2002-2008, and Calendar Year 2009. In this report GHG emissions were calculated using the methodology from the 2002-2008 GHG Inventory Report with a few methodological updates and corrections to data from previous years that are detailed in Box 1 on page 13. Two new sections have been added to this year's GHG Inventory, the first one dealing with the impact of campus growth on GHG emissions and the second one dealing with renewable energy certificates (RECs) and other carbon sinks and buffers. The University of Maryland (UMD) is a charter signatory of the American College and University Presidents' Climate Commitment (Presidents' Climate Commitment, or the Commitment) and in accordance with this commitment the University launched a Climate Action Plan in September 2009. In order to monitor and underline opportunities to enhance progress toward the UMD's goal of carbon neutrality by 2050, the Office of Sustainability conducts an annual greenhouse gas inventory and reports results to the campus community and the public.

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The University of Maryland is a recipient of a 2011 Climate Leadership Award from the American College and University Presidents Climate Commitment. Frank Brewer, former Interim Vice President of Administrative Affairs, represented the University at the Awards Ceremony in Washington. At left, Frank is pictured with award recipients from other schools.

[1] http://sustainability.umd.edu/content/resources/resources_reports.php

EXECUTIVE SUMMARY

This report is an update of measured greenhouse gas emissions for the University of Maryland, College Park (UMD, the University). It includes GHG emission measurements for Fiscal Years 2002-2008 and Calendar Years 2009 and 2010. The annual inventory is a component of UMD's commitment to participate in the American College and University Presidents' Climate Commitment (Presidents' Climate Commitment, or ACUPCC). It measures UMD's progress toward emission reduction goals set forth in the *University of Maryland Climate Action Plan* (Climate Action Plan) which was approved by the Senate and President, and submitted to organizers of the ACUPCC in September of 2009.

Background

The Climate Action Plan is a forty-year strategic plan that lays out strategies that UMD will use to reduce GHG emissions to 15 percent below 2005 levels by 2012, 25 percent below 2005 levels by 2015, 50 percent below 2005 levels by 2020, and ultimately to carbon neutrality by 2050. Carbon neutrality is defined as reducing GHG emissions as much as possible and offsetting any emissions that remain, such that net GHG emissions to the atmosphere are zero.

This update follows the methodology used in previous inventories, except for small changes to the methodology used to estimate emissions from commuting (see Appendix B for details). The boundary of the inventory includes the College Park campus, the University of Maryland Golf Course, the Severn building, the Maryland Fire and Rescue Institute (MFRI), the College of Agriculture and Natural Resources' Research and Education Centers, and the Institute for Bioscience and Biotechnology Research (IBBR). In total the inventory includes emissions from 399 buildings comprising 14 million square feet of building space situated on 2,550 acres of land, and emissions from university-related transportation for members of the campus community. The scope includes the following GHG emission sources: natural gas and electricity consumption, commuting, air travel, fuel used for campus transportation, agriculture and landscaping practices, solid waste disposal, and fugitive refrigerant releases. The scope also includes the following GHG emission sinks and reductions: renewable energy certificates (RECs), composting, and buildings that produce more renewable energy than they consume. A standardized greenhouse gas calculator (Campus Carbon Calculator version 6.6, Clean Air-Cool Planet)[2] was used for all calculations.

Findings

- ***Total GHG emissions decreased*:** In CY 2010, UMD's carbon footprint was 251,956 metric tons of carbon dioxide equivalent (MT-CO_2e), an 11.1 percent reduction over CY 2009 emissions and a 21.6

[2] The Campus Carbon Calculator was modified slightly to include additional columns for refrigerants, an additional column for commuting by employees of the Institute for Bioscience and Biotechnology, and accounting for Maryland's Renewable Portfolio Standard in calculations regarding purchased electricity.

percent reduction over the FY 2005 Climate Action Plan baseline. The majority of the net reduction resulted from a decision to use funds from the University Sustainability Fund, solely supported by an undergraduate student fee, to purchase 66,000 renewable energy certificates (RECs). The REC purchase offset emissions from 62 percent of UMD's purchased electricity[3]. Without the REC purchase, 2010 GHG emissions would have been 292,426 MT-CO_2e which is a 3.2 percent increase over CY 2009 and an 8.9 percent decrease over FY 2005. To meet the Climate Action Plan target for 2012 without relying on RECs (or other offset products), an additional reduction of 6.1 percent (19,615 MT-CO_2e) is needed. Figure E.S.1 shows UMD's GHG emission trends since 2005.

- ***Total Energy Use and Per Capita Energy Use increased*:** Energy use increased by 3 percent between CY 2009 and CY 2010 due to buildings that were added to campus, a rise in air travel, and an extremely hot summer in 2010. The increase negated some of the progress that has been made in reducing energy use compared to the 2005 baseline (as of 2009 a reduction of 11.4 percent had been achieved over the baseline and in 2010 the net reduction was lessened to 8.7 percent). Energy use per person also increased from 102.4 MMBtu in 2009 to 104.7 MMBtu in 2010.
- ***Per Area Energy Use and Emissions decreased:*** Despite a 4 percent increase in campus building space, energy use per area (kBtu per square foot of total building space) decreased by 1.3 percent. Thus, even without the reductions from RECs, GHG emissions per area (MT-CO_2e per square foot of total building space) decreased by 0.9 percent.
- ***Purchased electricity and use of individual boilers and generators increased:*** Emissions increased from purchased electricity (not counting the emission reduction associated with the REC purchase) and stationary sources other than the combined heat and power plant (CHP). Since the FY 2005 baseline year, emissions from purchased electricity have decreased by 3.4 percent but between 2009 and 2010 a 13.2 percent increase was seen (all of which was neutralized by the REC purchase). GHG emissions from non-CHP stationary sources increased by 26.5 percent over 2009 and 56.5 percent since 2005.
- ***GHG Emissions from Air Travel increased:*** Emissions from measured air travel[4] increased 15.9 percent between CY 2009 and CY 2010. Air travel comprises 52 percent of 2010 GHG emissions from transportation. Emissions from study abroad travel, business, and athletics have increased significantly since the FY 2005 baseline year (113.2 percent and 5.7 percent respectively).
- ***GHG Emission reductions were seen in a number of areas:*** Between CY 2009 and CY 2010, emission reductions were seen from the on-campus combined heat and power plant (CHP), commuting, agriculture & landscaping practices, solid waste management, and fugitive refrigerant

[3] A small portion (0.4 percent) of the renewable energy certificate purchase was financed by the University to offset emissions associated with purchased electricity for Knight Hall, the first University-owned LEED Gold building.

[4] The GHG inventory only measures a portion of business air travel. Thus, actual total air travel emissions are higher than the values given in this report.

emissions. The most impactful of these reductions was a 2.4 percent decrease in emissions from the CHP. Table E.S.1. gives a detailed breakdown of emissions from FY 2005, CY 2009 and CY 2010.

Figure E.S.1. Total UMD greenhouse gas emissions by source, FY 2005-2008 and CY 2009-2010.

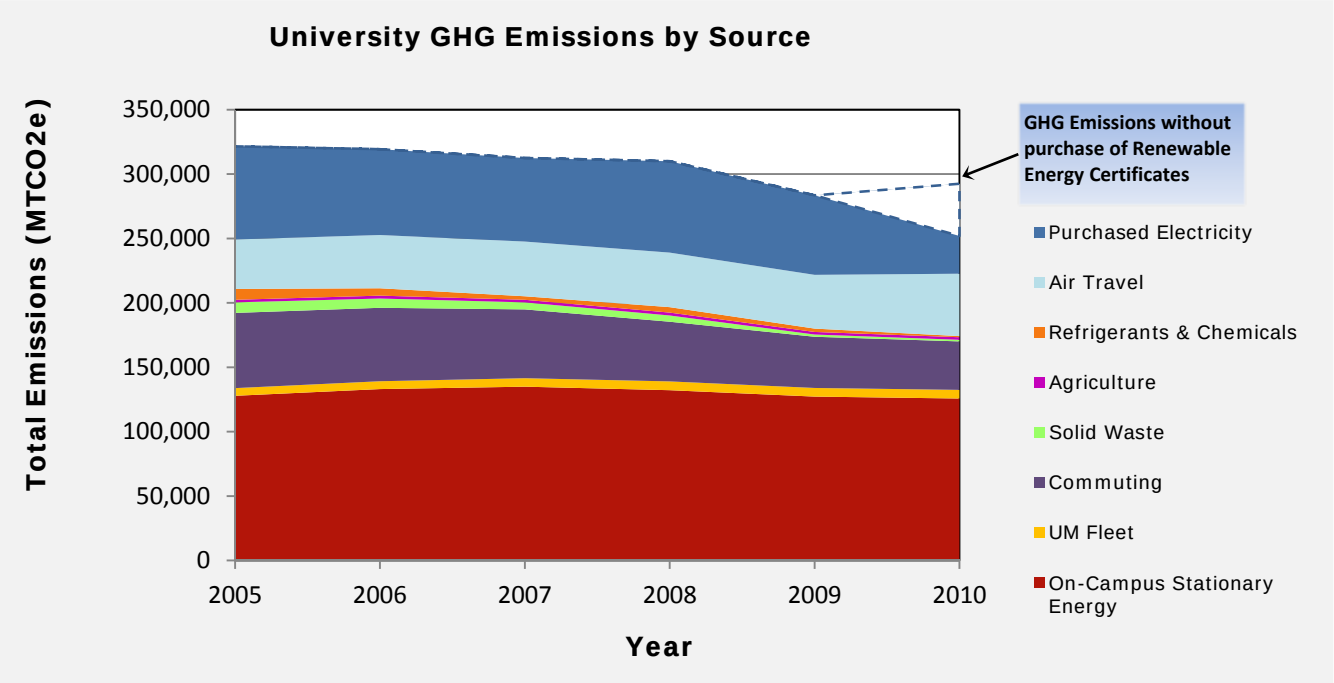


Table E.S.1. Comparison of GHG emissions by source for FY 2005, CY 2009 and CY 2010.

University GHG Emissions by Source ($MT\text{-}CO_2e$)

	2005	2009	2010	*5 yr. trend*
On-campus CHP Plant	123,536	121,983	118,998	-3.7%
Purchased Electricity	72,288	61,687	69,800*	-3.4%
Directly Financed Air Travel	31,210	29,568	32,979	5.7%
Student Commuting**	26,437	21,582	19,758	-25.3%
Faculty/Staff Commuting**	19,852	18,181	17,847	-10.1%
Study Abroad Air Travel	7,240	12,209	15,439	113.2%
Other On-Campus Stationary	4,267	5,276	6,676	56.5%
University Fleet**	4,600	4,489	4,409	-4.2%
Shuttle-UM**	2,297	2,219	2,404	4.7%
Agriculture	1,932	2,047	1,959	1.4%
Solid Waste	8,251	1,686	1,623*	-80.3%
Refrigerants & Chemicals	8,438	2,553	899	-89.3%
Total Measured Emissions	321,544	283,480	292,792	-8.9%
Total with Emission Offsets	321,544	283,480	251,956	-21.6%

*Deductions from Renewable Energy Certificates are not included in the Purchased Electricity row and deductions from composting are not included in the Solid Waste row. Deductions are factored into the Total with Emission Offsets row at the bottom.

** For student commuting, faculty/staff commuting, UMD Fleet and Shuttle-UM data shown is for FY 2008, CY 2009 and CY 2010 because accurate data is not available from previous years. The two yr. trend for these categories is shown in black in place of a five yr. trend.

Discussion of CY 2010 Emission Trends:

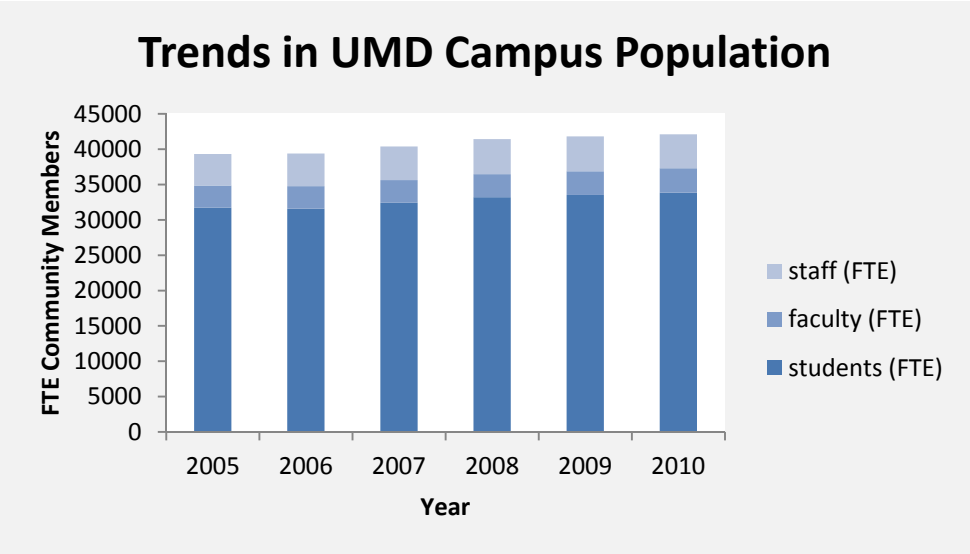
- ***Renewable Energy Certificates enabled continuation of UMD's trend of GHG emission reductions:*** UMD has surpassed the target date of 2012 for reaching a 15 percent reduction in GHG emissions over 2005 levels; without the contribution made by undergraduate students for offsetting a large portion of purchased electricity, UMD would not have reached this target early. Without a significant purchase of Renewable Energy Certificates (RECs) or another type of carbon offset product in 2011, UMD will likely fall below this 15 percent milestone. In 2012 and beyond, institutional innovation and creativity will be needed to enable UMD to meet its Climate Action Plan targets.
- ***Campus Growth is delaying progress toward GHG reduction targets:*** Two large, energy-intensive facilities were added to UMD in 2010: the Severn building and the Institute for Bioscience and Biotechnology Research (IBBR) in Rockville. Together these facilities account for 2.9 percent of UMD's 2010 GHG emissions. Most of the increase in energy use in 2010 is explained by the addition of these buildings. Without a plan to neutralize carbon emissions from campus growth, UMD's GHG emissions are not likely to decrease fast enough to meet Climate Action Plan targets.
- ***Increasing reliance on air travel is delaying progress toward GHG reduction targets:*** Between 2009 and 2010, the increase in GHG emission from air travel more than cancelled out reductions achieved in GHG emissions from the CHP and student, faculty and staff commuting. The Climate Action Plan calls for deeper exploration of strategies to reduce and offset emissions from transportation by 2012. Since air travel comprises the majority of transportation-related emissions, it may make sense for initial exploration to focus on approaches for eliminating and offsetting air travel emissions.
- ***Faculty and staff commuting remains relatively stagnant:*** Between 2009 and 2010, a very slight reduction of 334 MT-CO_2e was achieved in GHG emissions from faculty and staff commuting due to reductions in average commuting distances. However, a greater percentage of faculty and staff purchased commuter parking permits in 2010 than in 2009. This data may indicate that programs and incentives to date have not been successful at facilitating a shift by UMD employees toward alternative modes of transportation. An alternative explanation may be locked in the details of how often faculty and staff are actually using their permitted vehicles as opposed to using other modes to commute to campus. Efforts are underway to incorporate new sources of data into the annual GHG inventory to address questions about frequency of parking permit use.

CAMPUS GHG EMISSIONS

CAMPUS OVERVIEW

The total population at UMD in 2010 was 46,752 people, including 37,641 students, 4,123 faculty, and 4,988 staff. Estimates of GHG emissions per capita are based on full-time equivalents (FTE) (part-time students and employees are not considered to contribute the same amount of emissions as full-time students and employees). In FTE, the campus population in calendar year 2010 was 42,109 people: 33,838 students, 3,472 faculty, and 4,799 staff. Between 2009 and 2010, the campus FTE population increased by 297 FTEs; additions included 320 FTE students and 100 FTE faculty; losses included 123 FTE staff members. Since 2005, the UMD FTE population has been growing at an average rate of 1.4 percent per annum (Figure 1).

Figure 1. Full time equivalents (FTEs), FY 2005-2008 and CY 2009-2010.



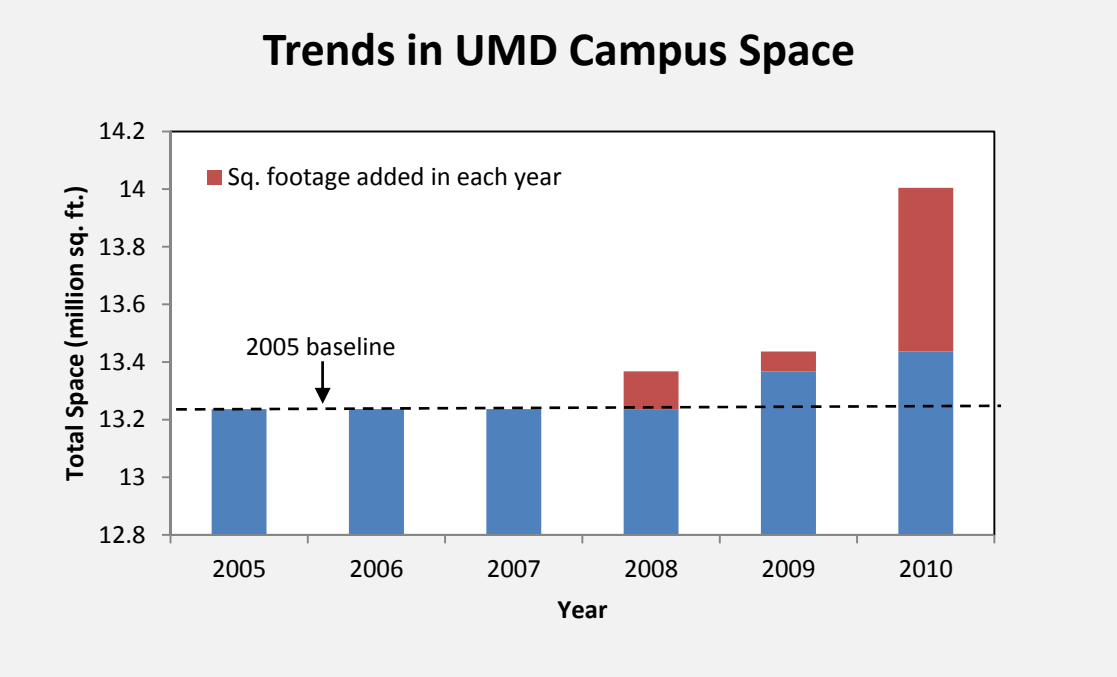
The GHG inventory includes UMD's main campus in College Park, the Severn Building, the Maryland Fire and Rescue Institute (MFRI) consisting of the College Park Headquarters and five regional training centers throughout the state, the Maryland Agricultural Experiment Station (MAES) managed by the College of Agriculture and Natural Resources at Research and Education Center sites around the state[5], and the Institute for Bioscience and Biotechnology Research (IBBR) facility in Rockville. The main campus in College Park includes 263 buildings comprised of classrooms, laboratories, libraries, residence halls, dining facilities, athletic and recreational facilities, performance centers, office

[5] There are eight MAES sites around the state including the Western Maryland Research and Education Center (REC) in Washington County, the Wye REC in Queen Anne's County, the Lower Eastern Shore REC In Wicomico County, and the Central Maryland REC which includes a headquarters in Ellicott City, a facility in Clarksville, a facility in Upper Marlboro, a facility in College Park, and the Beltsville Agricultural Research Center (BARC). The operations of all of these are included in the GHG inventory except for BARC which is funded and operated by the U.S. Department of Agriculture.

buildings, and a combined heat and power plant (CHP), as well as gardens, an arboretum, parking garages and surface lots, roadways and walkways that occupy 1,250 acres of land in Prince George's County. The MAES Research and Education Centers occupy an additional 1,300 acres throughout the State.

During 2010 UMD's building space expanded more significantly than it has since measurement of GHG emissions began. By year's end, UMD was responsible for 399 buildings throughout Maryland, totaling 14,004,247 million square feet; this is an increase of one building (four large buildings were added and three smaller buildings were decommissioned) and 567,864 square feet compared to campus building space at the end of 2009. The average annual growth rate since 2005 is 1.1 percent, with a 4.2 percent change between 2009 and 2010 (see Figure 2). For more information about building additions and the effect of growth on GHG emissions, please refer to the section titled *Campus Growth and GHG Emissions* (beginning on page 11).

Figure 2. Total campus space, FY 2005-2008 and CY 2009-2010.



EMISSION TRENDS

In Calendar Year 2010, UMD's measured GHG emissions were 251,956[6] metric tonnes of carbon dioxide equivalent ($MTCO_2e$) which is a reduction of 31,524 $MT\text{-}CO_2e$ or 11.1 percent compared to UMD's 2009 carbon footprint. In order of the size of contribution, the major sources of emissions were:

- Fuels burned to generate energy in on-campus equipment for electric power, heating, and air-conditioning of buildings, cooking, and scientific research;
- Air travel for UMD business, athletic competitions, and study abroad;
- Daily commuting by students, faculty and staff; and,
- Purchased electricity from the regional power grid.

Figure 3 shows UMD's annual measured emissions in metric tons of carbon dioxide equivalents ($MT\text{-}CO_2e$) beginning with Fiscal Year 2005, which is the baseline year for targets set in the *University of Maryland Climate Action Plan* (Climate Action Plan). Emissions decreased from 321,544 $MT\text{-}CO_2e$ in 2005 to 251,956 $MT\text{-}CO_2e$ in 2010, a reduction of 21.7percent[7]. The majority of this five year reduction is due to a decision in 2010 to purchase renewable energy certificates (RECs) to offset emissions from purchased electricity. In spring 2010, the Student Advisory Committee to the University Sustainability Council recommended that the approximately $100,000 in funds from the first year of the undergraduate Student Sustainability Fee be used to purchase RECs for the campus. As a result, UMD spent student fee money on 66,000 MWh of RECs that were generated by wind farms in the mid-Atlantic region. UMD purchased an additional 250 MWh of RECs to offset a portion of the emissions from purchased electricity for Knight Hall, a newly commissioned LEED Gold building. Without the 66,250 MWh in RECs, UMD's 2010 GHG emissions would have been 292,426 $MT\text{-}CO_2e$, which is 3.2percent greater than GHG emissions in 2009 and an 8.4percent reduction in emissions compared to the 2005 Climate Action Plan baseline year.

[6] The University's 2010 carbon footprint is equivalent to the GHG emissions from using 28, 246, 188 gallons of gasoline (based on an estimate from the EPA's Greenhouse Gas Equivalencies Calculator at www.epa.gov/cleanenergy/energy-resources/calculator.html).
[7] For updated numbers on GHG emissions by source from 2002-2009 please refer to Appendix A.

Figure 3. Total UMD greenhouse gas emissions by source, FY 2005-2008 and CY 2009-2010.

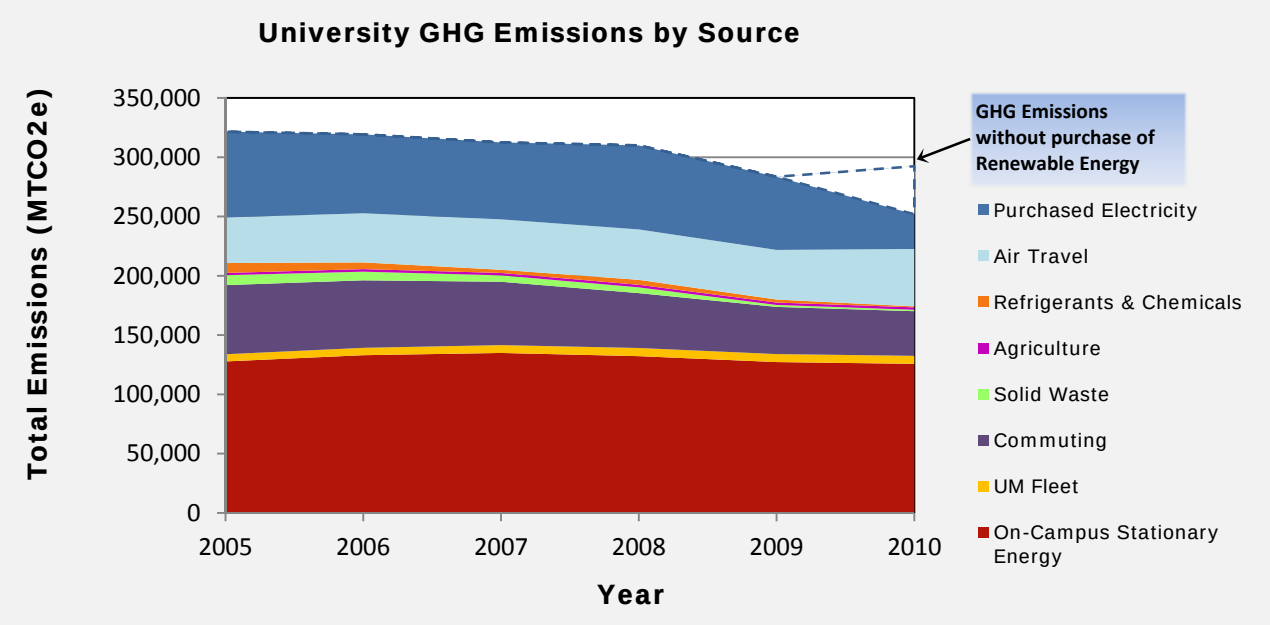


Table 1 shows heating and cooling degree days for FY2005-2008 and CY2009-2010. A degree-day is a measure of how outside temperature differs from a standard of 65 degrees Fahrenheit. Degree-days give an indication of how weather patterns impact GHG emissions. The number of heating degree-days is relative to the amount of energy required for heating campus buildings, and the number of cooling degree-days is relative to the amount of energy required for air-conditioning.

Table 1. Heating Degree Days (HDD) and Cooling Degree Days (CDD) for the State of Maryland & DC[8].

	FY 2005	FY 2006	FY 2007	FY 2008	CY 2009	CY 2010
Heating Degree-Days	4,766	4,345	4,533	4,456	4,851	4,722
Cooling Degree-Days	1,010	1,282	1,221	1,250	944	1,423

UMD consumes over 4 trillion Btu's of energy on an annual basis for operation of facilities and transportation (see Table 2 for an indication of energy use and GHG emission intensities over the last five years). Total energy use has decreased by 8.8percent since 2005 but it has increased by 2.9 percent over 2009. The increase in energy use between 2009 and 2010 outpaced the increase in the campus population, and as a result energy use per capita increased by 2.2 percent and GHG emissions per capita increased by 2.4 percent. This small increase can be explained in part by the extremely hot summer weather in 2010, in part by the addition of two energy-intensive buildings (Severn and IBBR), and in part by an increase in University-sponsored air travel. Relative to 2005, energy use per capita is

[8] Source: National Climatic Data Center, U.S. Department of Commerce, http://www.ncdc.noaa.gov/oa/documentlibrary/hcs/hcs.html.

down by 16.0 percent and GHG emissions per capita are down by 16.3 percent. Campus buildings continue to grow more energy-efficient as energy conservation measures are implemented by the Facilities Management (FM) Department and energy conservation behaviors are adopted by members of the campus community. In 2010, implementation of an Energy Performance Contract for nine campus buildings expanded upon the initial work that was completed in 2009. Energy use and GHG emissions per square foot of building space decreased by 1.3 percent and 1.0 percent respectively between 2009 and 2010, and 13.8 percent and 14.0 percent respectively between 2005 and 2010. Student commuting is also becoming more energy-efficient because more students are carpooling and/or choosing to forgo a parking permit altogether in favor of alternative modes of transportation like carpooling, public transit, biking and walking. Faculty and Staff commuting also became more energy-efficient in the last year because their average commute distances decreased slightly (this could indicate that more faculty and staff are choosing to live closer to campus). These shifts in commuting also contributed to the decrease in energy use and GHG emissions per square foot of building space on campus. Changes in agriculture and landscaping practices, modernization of air-conditioning equipment and refrigerants, more thorough recycling practices and less solid waste also contributed to the reductions in GHG emissions per square foot of building space. Refer to the section titled *GHG Emissions by Source* (beginning on page 13) for more detailed information about GHG emissions by category.

Table 2. Trends in energy use, GHG emissions, and GHG emissions intensity emissions from FY 2005-2008 and CY 2009-2010.

	FY 2005	FY 2006	FY 2007	FY 2008	CY 2009	CY 2010
Energy Use & Emissions						
Total energy use (trillion Btu)	4.83	4.76	4.73	4.69	4.28	4.41
Change from previous year	1.5%	-1.6%	-0.6%	-0.8%	-8.7%	2.9%
GHG Emissions (MT-CO_2e)	321,544	319,309	312,474	309,997	283,480	292,426*
Change from previous year	1.7%	-0.7%	-2.1%	-0.8%	-8.6%	3.2%
Emissions Intensity Indices						
Population (FTE)	38,775	39,525	39,562	40,797	41,812	42,109
Energy use (MMBtu/capita)	124.7	120.4	119.5	115.0	102.4	104.7
Emissions (MT-CO_2e/capita)	8.3	8.1	7.9	7.6	6.8	6.9*
Total Area (million sq. ft.)	13.24	13.24	13.24	13.37	13.44	14.00
Energy use (kBtu/sq. ft.)	365.2	359.4	357.1	350.9	318.7	314.7
Emissions (kg- CO_2e/sq. ft.)	24.3	24.1	23.6	23.2	21.1	20.9*

*GHG emission numbers for 2010 do not include reductions for purchased Renewable Energy Certificates (RECs). RECs can be applied to reduce GHG emissions but not energy use. With the 2010 REC purchase, Total GHG Emissions are 251,956 MT-CO_2e which is a change of -11.1% from the previous year and GHG Emissions intensities are 6.0 MT-CO_2e/capita and 18.0 kg-CO_2e/sq. foot .

CAMPUS GROWTH AND GHG EMISSIONS

It is challenging to reconcile UMD's goal of carbon neutrality with institutional needs for new and expanded building space. To account for the ongoing tension between growth and climate change mitigation, we have added a new section to the annual GHG inventory. The purpose of this section is to list all new buildings (constructed, purchased, and otherwise acquired) and their approximate contributions to the campus carbon footprint. In future inventories we also plan to include a running tally of building additions and buildings that have been demolished, decommissioned, sold, or out-leased in recent years.

New Buildings

In January 2010, UMD opened two new buildings: Knight Hall (an academic office and classroom building) and South Campus Commons 7 (a student housing facility). These are the first LEED Certified buildings on campus and energy-saving features were incorporated into the design of each. Nonetheless, these new buildings are not carbon neutral. Knight Hall, home to the Philip Merrill College of Journalism, is the first UMD owned LEED Gold Building on campus. It incorporated dozens of features that reduce energy and water consumption, including a large number of windows to allow 75 percent of the building to be lit by natural light. We do not have a reliable way to estimate how Knight Hall's energy usage translates into precise GHG emissions, but its contribution is certainly well under 1 percent of UMD's overall carbon footprint. South Campus Commons 7 was constructed through a Public-Private Partnership and is leased to Capstone Development Corporation to operate. The development team collaborated closely with UMD to design and construct the building with CO_2 emissions reduction and other environmental goals in mind. Since UMD does not maintain administrative or financial responsibility for the operations of this new residential facility, its GHG emissions are not included in the campus inventory.

In March 2010, UMD purchased the Severn Building on Greenbelt Road in College Park. Severn is a large, warehouse-style building (326,769 square feet) that was constructed in 1998 to serve as a printing plant for The Washington Post. Eventually it will be used to house most of UMD's FM Department, as well as several other departments currently on campus. From April to December 2010, Severn consumed 4,198 MMBtu of natural gas; 4,622 gallons of #2 fuel oil; and 3,426 MWh of electricity. Once it is fully occupied, Severn's energy consumption will increase significantly. UMD most recently contracted with Washington Gas Energy Services (WGES) to install solar panels on the roof of Severn so that a portion of the building can be powered with renewable electricity that does not create carbon emissions. Severn's 2010 carbon footprint is 2,489.3 $MTCO_2e$ which represents 1 percent of UMD's total footprint in 2010.

In 2009, the University System of Maryland (USM) Board of Regents approved a restructuring of the University of the Maryland Biotechnology Institute (UMBI) and as a result, in 2010 administrative responsibility for UMBI's five research centers was divided between several USM Institutions. As of April 2010, UMD owns and operates IBBR—a joint research collaboration with the University of Maryland, Baltimore (UMB) and the National Institute of Standards and Technology (NIST). In addition to office and laboratory space on the College Park campus, IBBR occupies three buildings (228,991 square feet) adjacent to the University at Shady Grove in Rockville, MD. From May-December 2010 the IBBR facilities in Rockville consumed 29,839.81 MMBtu of natural gas; 230 gallons of #2 fuel oil; and 4,988 MWh of electricity. Use of fertilizer for landscaping, solid waste disposal, and employee commuting also made small contributions to IBBR's carbon footprint, while composting accounted for a subtraction of 3.1 $MTCO_2e$. IBBR's 2010 GHG emissions were 4,818.9 $MTCO_2e$ which represents approximately 1.9 percent of UMD's total 2010 footprint. At 21.0 MT-CO_2e per square foot, IBBR has approximately the same emissions intensity as the campus average of 20.9 MT-CO_2e per square foot.

Knight Hall, the new home for the Philip Merrill College of Journalism, opened its doors in January 2010. It is the first UM owned LEED Gold building. By incorporating a large number of windows to let in natural light, the building's design team greatly reduced the need for electric-powered lighting. *Photograph is copyright of John Consoli.*

Box 1. Quality Assurance for Maryland's Sustainability Metrics

As UMD expands its approach to assessing performance on environmental goals and monitoring progress toward sustainability targets, the Office of Sustainability (the Office) is working to streamline annual metrics and improve data and calculation methodologies. For the sake of consistency and quality of UMD's sustainability-related data, several changes and updates have been made in this updated GHG inventory:

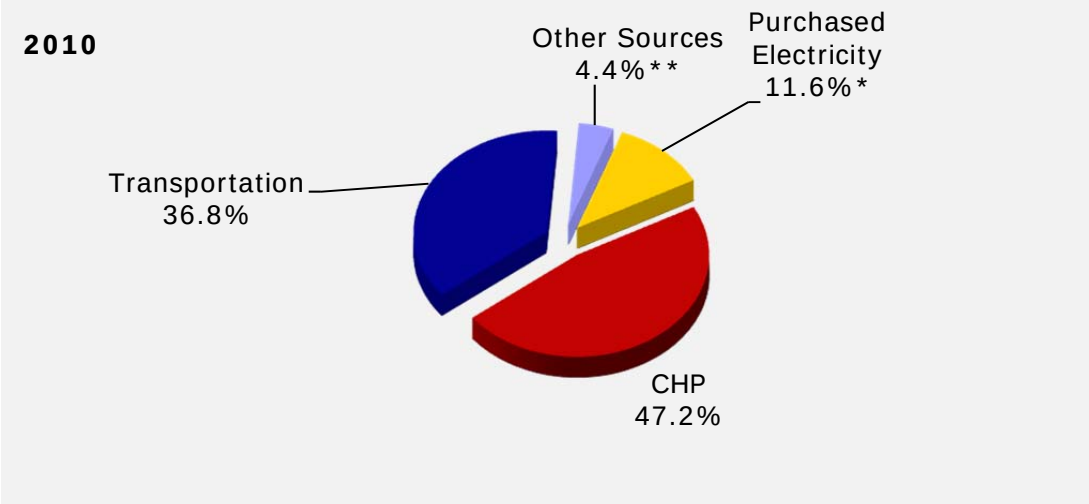
- In 2007 the Intergovernmental Panel on Climate Change (IPCC) updated the global warming potentials (gwp) for methane (CH4) and nitrous oxide (N20) from 23 to 25 and 296 to 298 respectively. Previous UMD GHG Inventories relied on the old gwp for each of these gases; this version and future versions will rely on the current figures for gwp. Emissions from 2002-2009 have also been recalculated using the new gwp figures and this report includes only the recalculated emission estimates.
- The Office of Institutional Research, Planning and Assessment (IRPA) has a standardized method for calculating the campus population in FTEs, and all per capita calculations in the Sustainability Metrics Report rely on IRPA's FTE calculations. Previous versions of the GHG Inventory relied on a default method for calculating student FTEs that was different from IRPA's approach, and based per capita GHG estimates on total faculty and staff (instead of FTEs). This version and future versions will rely on IRPA's standard FTE numbers for the campus population. In this report, per capita emissions from 2002-2009 have also been recalculated using IRPA's FTE estimates.
- This report includes corrected emissions estimates from refrigerant releases in 2002-2009 and from landfilled solid waste in 2009. Corrections were made in light of better data regarding refrigerant-related emissions calculations, solid waste hauling and landfill practices.
- Approximating emissions from commuting is perhaps the most difficult task involved in compiling the annual GHG Inventory. The Department of Transportation Services (DOTS) and the Office are collaborating to improve valuation methodology with the aim of making emissions estimates as accurate and thorough as possible. In this year's inventory, improvements were made to the methodology for using number of commuter parking permits to estimate GHG emissions, and for incorporating survey data about carpooling. For more detail on changes and assumptions related to commuting emissions, Appendix B on page 30.

GHG EMISSIONS BY SOURCE

Energy used to power vehicles, buildings, and outdoor lighting is the source of 99 percent of the UMD's 2010 GHG emissions. The remaining 1 percent was produced by agriculture and landscaping practices (animal husbandry and nitrogen fertilizer application), solid waste decomposition, and refrigerant releases from air conditioning equipment. Figures 4 and 5 show the relative contributions of various

sources to UMD's overall 2010 carbon footprint. Table 3 shows how emissions have changed over the last five years.

Figure 4. Contribution of major sources to UMD's GHG emissions, CY 2010.



*Purchased electricity includes a 40,470 MT-CO_2e deduction for Renewable Energy Certificates (RECs).

** Other sources (specifically solid waste) include a 366 MT-CO_2e deduction for composting.

Figure 5. Detailed breakdown of emissions by source, CY 2010.

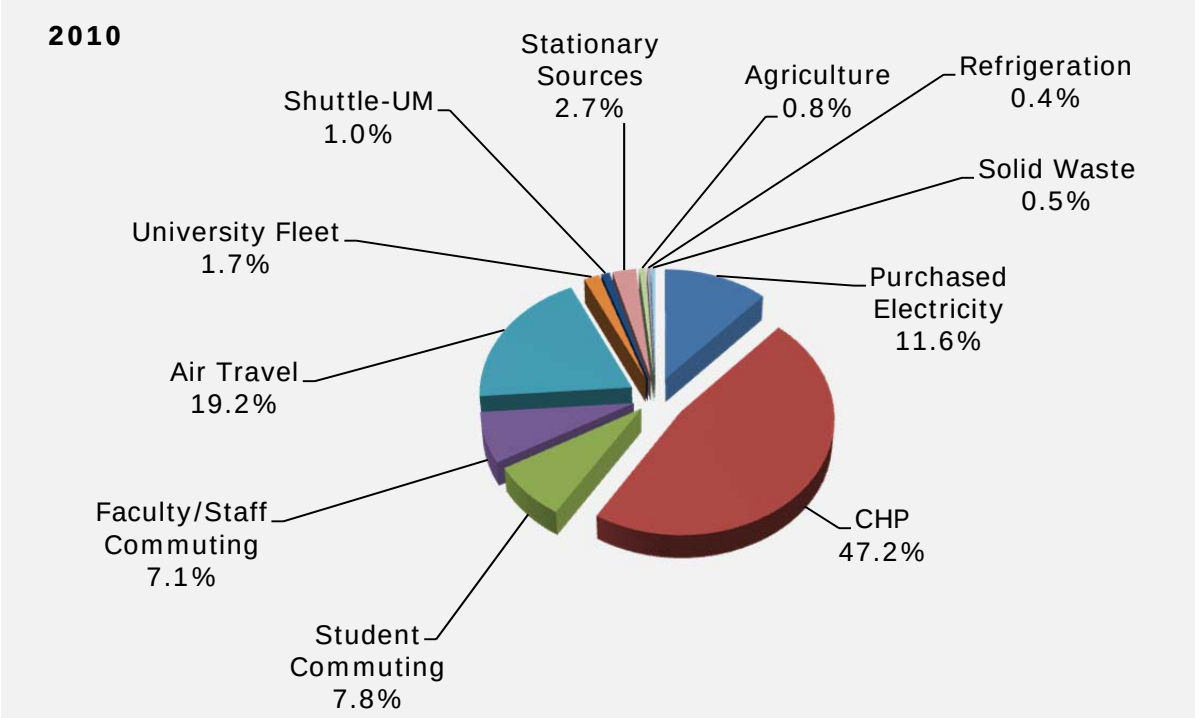


Table 3. Comparison of GHG emissions by source for FY 2005, CY 2009 and CY 2010.

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Directly Financed Air Travel	31,210	29,568	32,979	5.7%
Student Commuting**	26,437	21,582	19,758	-25.3%
Faculty/Staff Commuting**	19,852	18,181	17,847	-10.1%
Study Abroad Air Travel	7,240	12,209	15,439	113.2%
Other On-Campus Stationary	4,267	5,276	6,676	56.5%
University Fleet**	4,600	4,489	4,409	-4.2%
Shuttle-UM**	2,297	2,219	2,404	4.7%
Agriculture	1,932	2,047	1,959	1.4%
Solid Waste	8,251	1,686	1,623*	-80.3%
Refrigerants & Chemicals	8,438	2,553	899	-89.3%
Total Measured Emissions	321,544	283,480	292,792	-8.9%
Total with Emission Offsets	321,544	283,480	251,956	-21.6%

*Deductions from Renewable Energy Certificates are not included in the Purchased Electricity row and deductions from composting are not included in the Solid Waste row. Deductions are factored into the Total with Emission Offsets row at the bottom.
** For student commuting, faculty/staff commuting, University Fleet and Shuttle-UM data shown is for FY 2008, CY 2009 and CY 2010 because accurate data is not available from previous years. The 2 yr. trend for these categories is shown in black in place of a 5 yr. trend.

Purchased electricity is carried to UM buildings by the regional electric grid. Since there is no way to differentiate between electrons generated from a conventional power plant and those from renewable sources, renewable energy certificates (RECs) are necessary to track ownership of renewable electricity.

Photograph provided by the National Renewable Energy Laboratory Photographic Information Exchange, www.nrel.gov/data/pix

Power and Operations

Stationary Sources: Emissions decreased by 1.7%

Purchased Electricity: Emissions increased by 13.2%

Campus-Owned Stationary Sources

In 2010, 125,674 MT-CO_2e of emissions resulted from combustion of natural gas, fuel oil (#2), and propane in stationary sources. The majority of the natural gas was burned in the CHP plant on the College Park campus, with the remainder in other building specific equipment. Fuel oil was primarily burned in individual boilers and emergency generators, while propane was primarily used for heating and cooking. The CHP's use of natural gas emitted 118, 998 MT-CO_2e which is a decrease of 2,985 MT-CO_2e compared to 2009. The CHP produces and distributes steam and electricity to meet the needs of the campus for space heating, water heating, air conditioning, and electric power. According to FM, the CHP produces enough steam to heat most of the buildings on the College Park campus in winter, and enough electricity to meet approximately 90 percent of winter power demand and 50 percent of summer power demand. During the summer, steam from the CHP is used to power two chillers that are applied for air conditioning in the engineering quadrant and occasionally at the Comcast Center. Additionally, steam is used to dehumidify buildings on campus as part of the air conditioning process. In 2010, the CHP generated 56.7 percent of the electricity that was consumed by the campus and its satellite programs, and 100 percent of the steam used for heating. By using the waste heat from the gas turbines to create steam, the CHP operates much more efficiently than normal simple cycle gas turbines. This increased efficiency results in a GHG emission reduction of over 30 percent when compared to the emissions from producing electricity, steam and chilled water independently.

Non-CHP stationary sources of emissions totaled to 6,676 MT-CO_2e which is an increase of 1,400 MT-CO_2e compared to 2009. The greater reliance on non-CHP stationary sources this year can be explained by the addition of the IBBR and the Severn Building: together these two facilities accounted for 1,850 MT-CO_2e from use of natural gas and fuel oil. Without the addition of IBBR and Severn, emissions from non-CHP stationary sources would have decreased slightly.

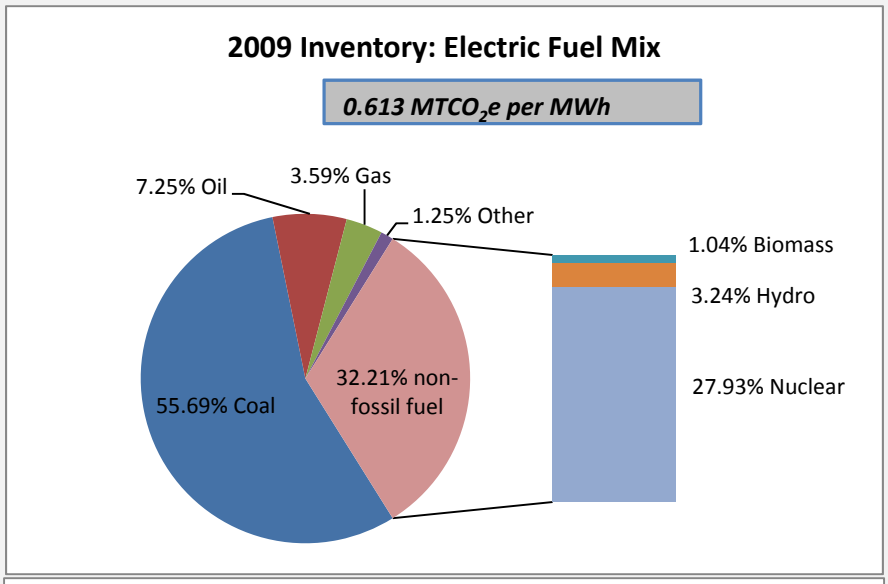
Purchased Electricity

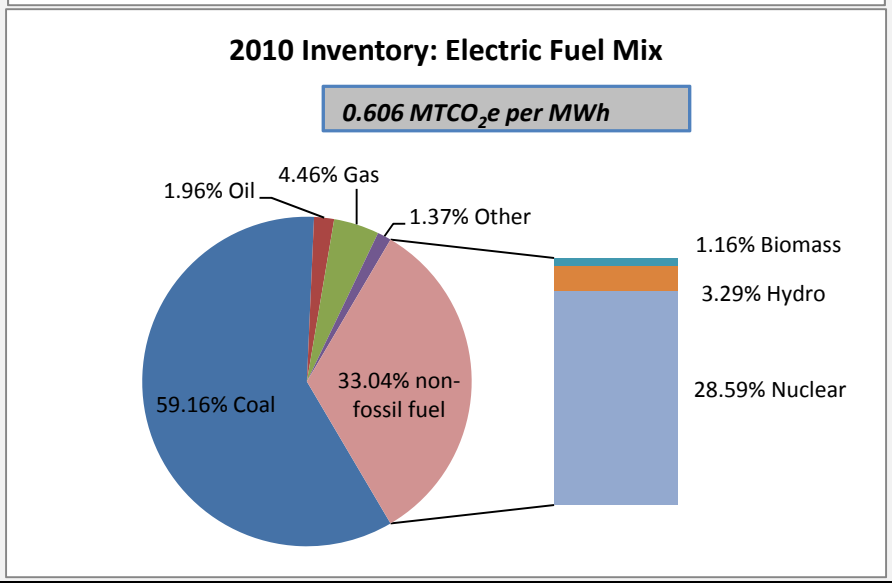
The burning of fossil fuels at regional power plants to generate electricity purchased by UMD in 2010 resulted in 69,800 MT-CO_2e which is 8,114 MT-CO_2e greater than 2009 emissions from purchased electricity. This 13.2 percent increase in purchased electricity emissions is due to an increase in electricity consumption resulting from the weather and additions to campus space. The summer of 2010 was exceptionally warm and resulted in greater air conditioning demand than in 2009 (this

explanation is supported by the higher number of cooling degree days: 1,423 in 2010 compared to 944 in 2009). IBBR and Severn also contributed significantly to the electric footprint, together comprising 5,454 $MTCO_2e$ or 7.8 percent of the emissions from purchased electricity and 67 percent of the purchased electricity emissions increase.

Box 2. GHG Emissions per MWh of Electricity Purchased from the Regional Power Grid

Over time there are changes to the fuel mix that is used by regional power plants to generate electricity. With the implementation of legislation, such as Maryland's Renewable Portfolio Standard (RPS), and the rising cost of some fossil fuels, energy utilities are slowly shifting toward a less carbon-intensive mix of fuels. In 2010 the Maryland RPS required a 5.525 percent renewable content for electricity. The graphs below show how the Maryland state average fuel mix for electricity has changed recently.





Transportation

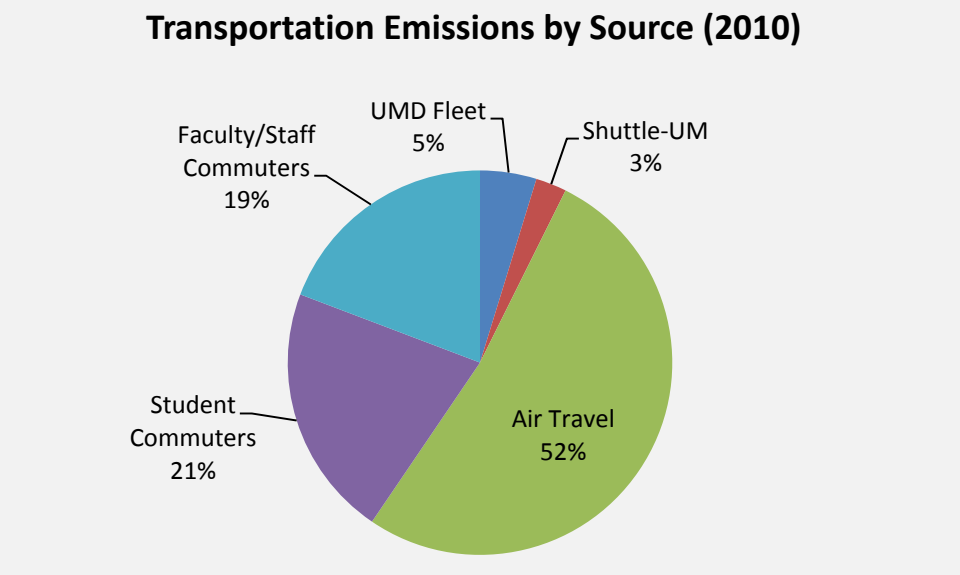
Commuting: Emissions decreased by 6.0%

Air Travel: Emissions increased by 15.9%

Campus-owned Vehicles: Emissions increased by 1.6%

Campus transportation emissions were calculated from Shuttle-UM, the University fleet, student commuting, faculty/staff commuting to the College Park campus and the IBBR campus in Rockville, and air travel. In 2010 campus transportation emissions increased by 5.20 percent compared to 2009. Of the 4,588 MTCO2e increase in transportation emissions between 2009 and 2010, commuting to IBBR represented 247 MTCO2e or 0.27 percent of the total emissions from transportation in 2010. Most of the increase can be attributed to a rise in emissions from air travel. Figure 6 shows each mode's contribution to overall transportation emissions.

Figure 6. Detailed breakdown of emissions from transportation, CY 2010.



Air Travel

GHG emissions from air travel increased by 15.9 percent compared to 2009. Emissions were calculated for flights taken by UMD faculty and staff for business reasons, flights taken by athletic teams, and flights for some student programs including Study Abroad. The inventory did not include travel paid by individuals, for which they were reimbursed by the University of Maryland College Park Foundation and/or non-University organizations. In 2010, air travel paid for by UMD for business trips, athletic teams, and student programs other than Study Abroad resulted in 32,979 MT-CO_2e, an emissions

increase of 11.5 percent over 2009 (see Figure 7). In 2010, the athletics program flew 3,468,614 passenger-miles—an increase of 32 percent over 2009—and purchased 616 more tickets than in the previous year. Faculty and staff on business, and students in programs other than Study Abroad flew 39,010,218 passenger-miles—an increase of 10 percent over 2009—and purchased 683 more tickets than in the previous year. Air travel for Study Abroad programs resulted in 15,439 MT-CO_2e which is 3230 MTCO_2e or 26 percent more than in 2009. The number of students who studied abroad increased from 1759 in 2009 to 2145 in 2010; these students flew 19,886,712 miles, an increase of 26 percent over 2009. One way to gauge the carbon intensity of UMD's air travel is to measure the average number of miles flown per passenger trip. For UMD business and athletics, the carbon intensity of travel has remained almost constant over the past three years (see Figure 8). For Study Abroad, the average number of air miles flown per student increased by 331 between 2009 and 2010 and 1773 between 2008 and 2010.

Figure 7. Measured air travel emissions in FY 2008, CY 2009 and CY 2010.

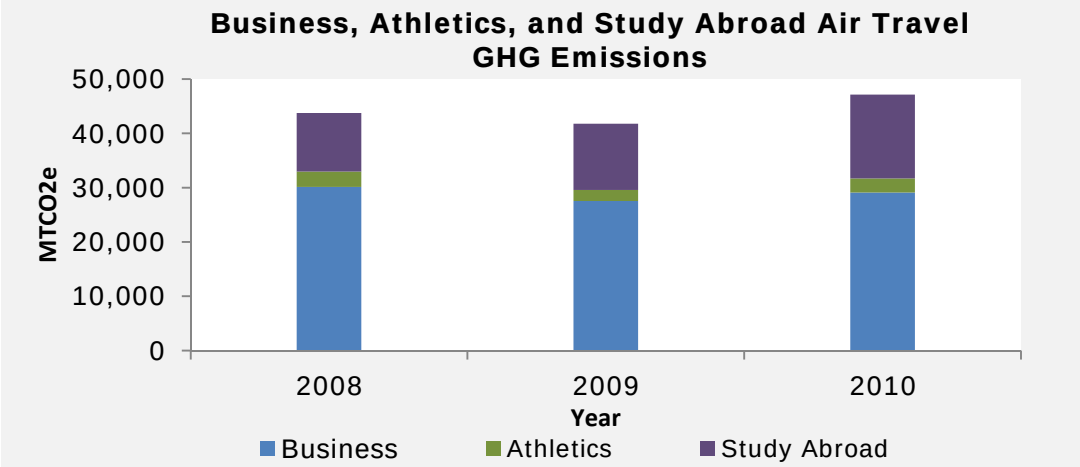
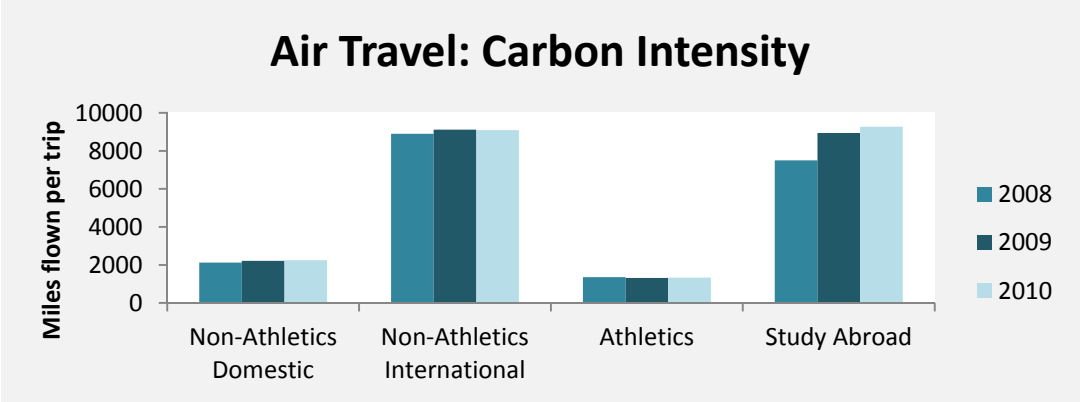


Figure 8. Average passenger miles flown per type of trip in FY 2008, CY 2009 and CY 2010.



Student Commuting

While many students who live off-campus still rely on privately-owned vehicles to commute to school, there appears to be a shift taking place toward alternative modes of transportation (see Figure 9). Based on commuter permit purchases in 2010, it is estimated that 31.6 percent of the full-time student population (27 percent of the total student population) commutes to school in an automobile (survey data suggests that 28.6 percent commute alone and 3 percent rely on carpools). Estimated emissions from automobile commuting by students in 2010 are 19,758 $MTCO_2e$ which is an 8.4 percent reduction compared to last year. The reduction is due to a 1,175 drop in the number of students who chose to purchase commuter permits and improved data about student carpooling habits (see Box 3). Emissions decreased despite the addition of 307 FTE students to campus and a 1.2 mile increase in the average commute distance. The longer average commute distance is probably due to fewer students who live near campus choosing to purchase commuter permits.

Figure 9. Student commuter permit purchases as a percentage of total student population.

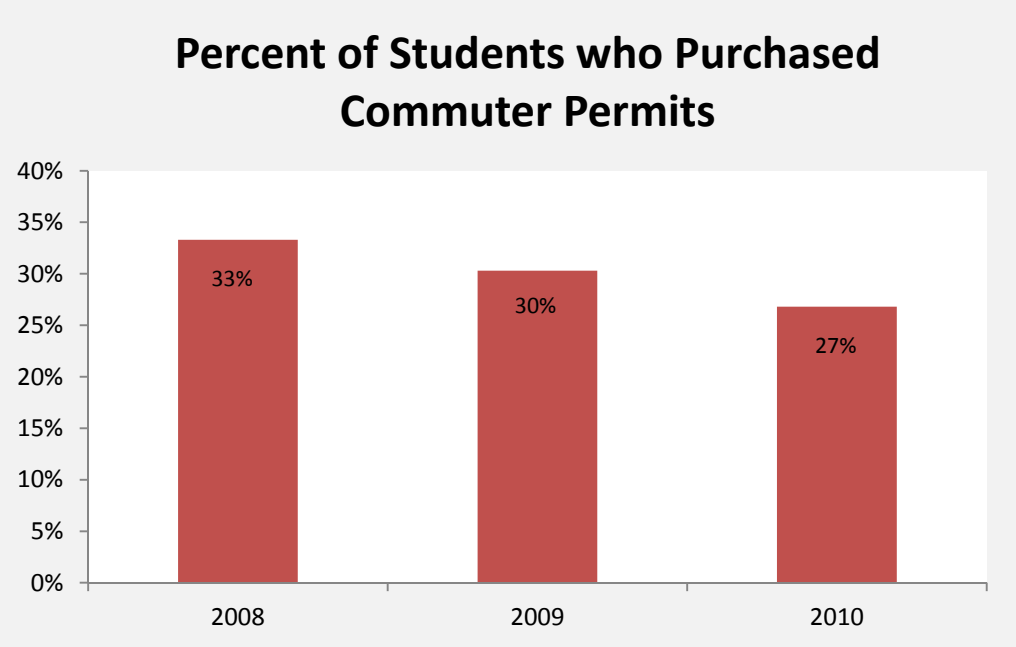


Table 4 illustrates changes in Shuttle-UM ridership, the number of commuter parking permits purchased by students, and the estimated number of beds on and near campus. There appears to be a strong relationship between the number of students who choose to purchase commuter permits and change in estimated numbers of student beds on/near campus. Increasing ridership of Shuttle-UM also appears to correlate loosely with decreasing student permit purchases and/or increasing numbers of student beds.

Table 4. Shuttle-UM ridership, student commuter parking permits and student beds on- and near- campus.

	FY 2006	FY 2007	FY 2008	CY 2009	CY 2010
Shuttle-UM ridership	1,660,447	2,030,816	2,340,828	2,627,029*	2,695,005*
Student commuter parking permits**	13,544	12,123	11,196	11,265	10,090
Estimated change in student beds	1,107	936	336	-99*	1514

*Data is for fiscal year, not calendar year.
** Data for FY 2006 and FY 2007 is inflated due to issues with the parking permit database.

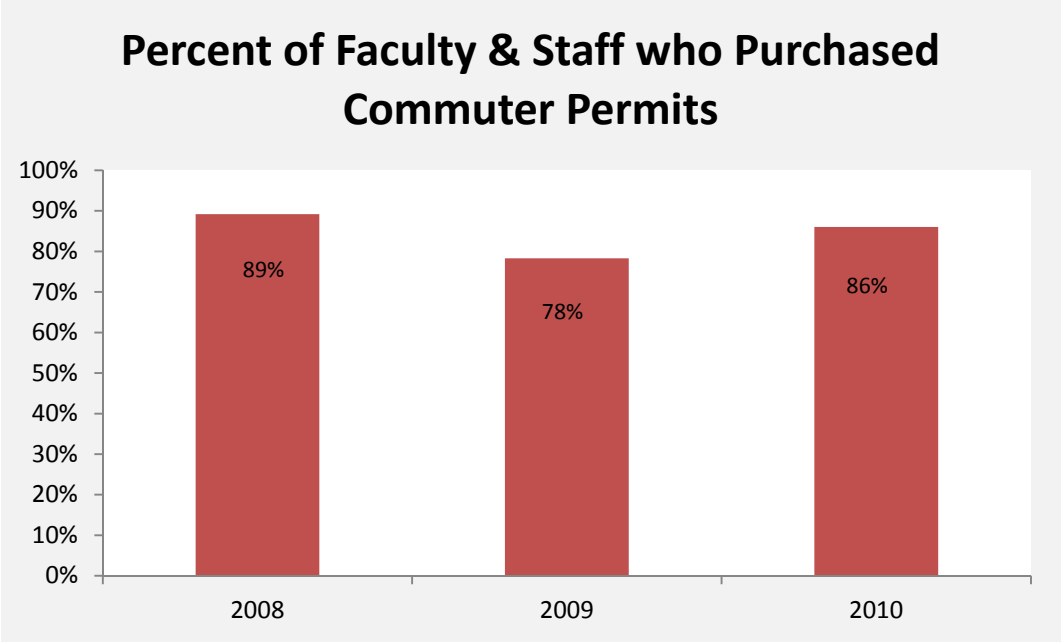
Cumulative progress to date toward the Climate Action Plan target of a 4,190 commuter permit reduction by 2015 (over 2008 levels) is a result of reductions in numbers of permits purchased by students (an overall reduction of 1106 since 2008). Much of this progress has been cancelled out by growth in commuter permit purchases by faculty and staff.

Faculty/Staff Commuting

The primary mode of transportation for faculty and staff commuting to and from campus continues to be alone by privately-owned vehicles. A small percentage of the population commutes by carpool (3 percent of faculty and 4 percent of staff according to DOTS 2010 Commuting Survey). Estimated emissions from automobile commuting by faculty and staff in 2010 are 17,847 MT-CO_2e. This is a reduction of 1.8 percent compared to 2009. University employees of the IBBR added 247 MTCO_2e in 2010; without IBBR, emissions from faculty and staff commuting would have been 17,600 MTCO_2e, a 3.2 percent decrease compared to 2009.

The Climate Action Plan calls for a commuter parking permit reduction of 4,190 by 2015 (over 2008 levels): as of 2010, a reduction of 566 permits has been achieved due to reduced student reliance on privately-owned vehicles. Faculty and staff commuter permit purchases actually increased by 678 between 2009 and 2010, despite the fact that the total number of faculty and staff on campus decreased by 23 FTE (see Figure 10). The increase in permit purchases did not result in increased emissions because average one-way commute distance for both faculty and staff decreased slightly. These findings indicate that despite a slight reduction in GHG emissions, a greater number of faculty and staff are relying on single-occupancy vehicles this year than they were last year, but on average employees are not driving as far during their daily commutes.

Figure 10. Faculty and staff commuter permit purchases as a percentage of total faculty and staff population.



Box 3. Improving GHG Emission Calculations for Commuting

With input from the Center for Integrative Environmental Research and the Office of Sustainability, DOTS conducted a commuter survey in the fall of 2010 with plans to survey regularly every two years going forward.

- Results from the 2010 survey indicate a higher percentage of carpooling by students and a lower percentage of carpooling by faculty and staff than was assumed in previous inventories: 2010 survey results show 3 percent of students, 3 percent of faculty and 4 percent staff carpool (previous estimates were 0 percent, 6 percent, and 6 percent respectively).
- Using survey data, the Office of Sustainability is working on methodology to estimate GHG emissions from commuting by alternative modes of transportation, including regional transit buses, Metro-rail, and MARC Train.
- In 2010, 1 percent of students, 4 percent of faculty, and 3 percent of staff reported that they commute regularly by bus, and 4 percent of students, 1 percent of faculty, and 2 percent of staff reported that they commute regularly by rail.

University Fleet

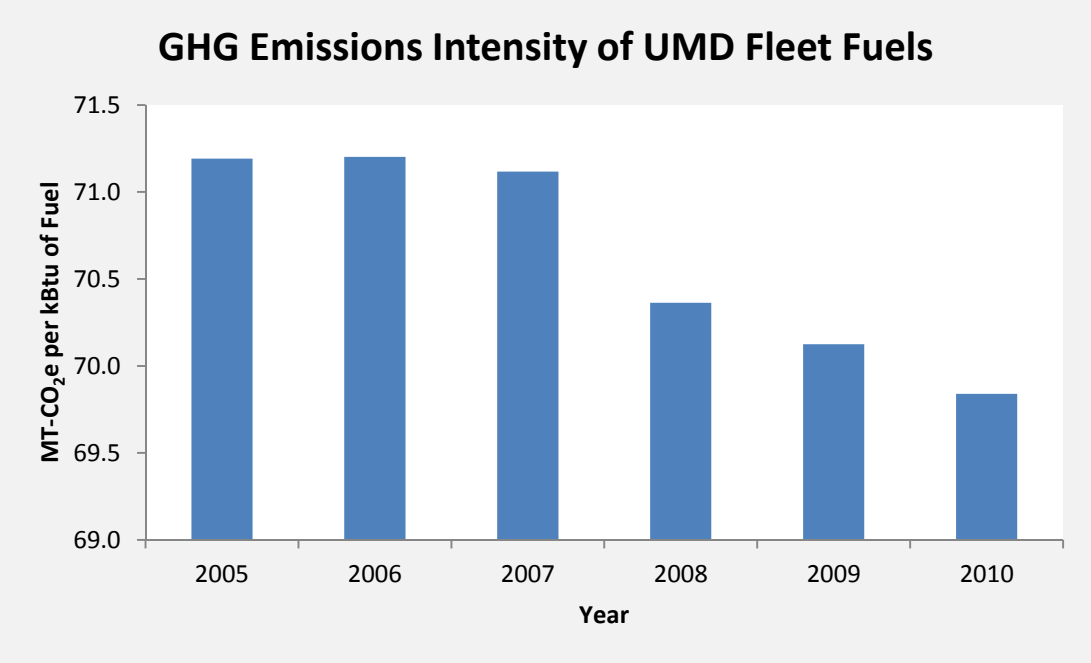
UMD owns and maintains a fleet of vehicles. The fleet includes department-owned vehicles, motor-pool vehicles, fire and rescue vehicles, and agricultural equipment. Most of the vehicles in the fleet run primarily on gasoline or diesel. In 2010, the UMD Fleet emitted 4,409 $MTCO_2e$. This 1.8 percent reduction in emissions since 2009 is explained by reduced reliance on gasoline and increasing reliance

on alternative fuels, including ethanol (E85) and biodiesel (B5). Figure 11 shows how the average GHG emissions per unit of fuel consumed have decreased between FY 2005 and CY 2010 demonstrating that UMD is shifting toward fuels that result in less carbon pollution.

Shuttle UM

UMD operates one of the largest University transit services in the nation. A fleet of over 60 buses serve riders along 22 daytime commuter bus routes, five evening bus routes, three Park and Ride lots, and round the clock paratransit service. In 2010, Shuttle-UM emitted 2,404 $MTCO_2e$, an increase of 8.3 percent over 2009. The increase in emissions can be explained by the fact that Shuttle-UM service was augmented in 2010 with a greater number of buses on the road and expanded hours for many existing routes. Emissions from Shuttle-UM have increased each year since 2008 (when the Department of Transportation Services (DOTS) began tracking Shuttle-UM's fuel use). The upsurge in emissions is due to increasing service and use of Shuttle-UM in place of student commuting by personal vehicle. It is probable that without an increase in emissions in this category, there would not have been such a significant decrease in emissions from student commuting (see Table 4 above). Nonetheless, Shuttle-UM saw a greater increase in ridership between 2008 and 2009 yet had a decrease in emissions.

Figure 11. Average GHG emissions per unit of energy in fuels used to power campus-owned vehicles, personal vehicles used for business travel, and Shuttle-UM.



Other GHG Emission Sources

Refrigerants, Agriculture, and Solid Waste combined:
Emissions decreased by 28.7%

Refrigerants and Other Chemicals

In addition to energy ramifications of chiller (large air conditioning unit) use UMD facilities, there are ramifications when refrigerants from these units are inadvertently released into the atmosphere. These releases, often called fugitive emissions, occur as a result of equipment leaks or problems during maintenance operations. In 2010, fugitive emissions from refrigerant releases totaled to 899 MT-CO_2e, which is 1654 MT-CO_2e less than in 2009 representing a reduction of 65 percent. Refrigerants in newer equipment have much lower global warming potentials than those used in older equipment; as chillers are replaced and updated, refrigerant related emissions have been decreasing.

Agriculture and Landscaping

GHG emissions associated with agriculture and landscaping result from application of synthetic and organic nitrogen fertilizers to fields and grounds which releases nitrous oxides; decomposition of animal manure which releases methane; and enteric fermentation in the rumens of cows and sheep which also releases methane. For landscaping maintenance, fertilizer is applied to campus grounds, athletic fields, the golf course, and the grounds of IBBR facilities in Rockville. The College of Agriculture and Natural Resources' MAES farms utilize some fertilizers and keep animals. In 2010 the MAES farms were responsible for 209 dairy cows and 325 beef cows. UMD also operates an on-campus barn and small farm facility that is used by the Department of Animal and Avian Sciences, the Institute of Applied Agriculture, and the University of Maryland Equestrian Club. UMD has one of the few animal science departments in the nation with the presence of animals directly on campus at the Campus Farm, including seven cows, 25 sheep, 19 chickens, and eight horses. In 2010, agricultural and landscaping emissions were 1,959 MT-CO_2e which represents a reduction of 88 MT-$CO2_e$ compared to 2009, or 4.3 percent. The drop in emissions resulted from a reduction in the size of the MAES beef cow herd and a decrease in the average nitrogen intensity of the fertilizers selected for use.

Solid Waste Management

The University landfilled 205 short tons less waste in 2010 than in 2009 resulting in a GHG emissions decrease of 63 MT-CO_2e or 4.3 percent. The reduction would have been 23 short tons greater without the addition of IBBR. The total GHG emissions from landfilled waste in 2010 were 1,623 MT-CO_2e. The campus recycling rate for diverting waste from landfills has increased steadily since 2008 reaching

almost 63 percent in 2010; at the same time the total amount of waste generated has been slowly increasing since 2008.

CARBON SINKS AND BUFFERS

Renewable Energy Certificates (RECs)

A REC represents the property rights to the environmental, social, and other non-power qualities of 1000 kWh (1 MWh) renewable electricity generation[9]. RECs are valuable because they allow their owner to offset greenhouse gas emissions associated with an equivalent amount of purchased electricity that is delivered through the regional electric power grid. In 2010, UMD purchased 66,250 MWh of RECs: 66,000 MWh were funded by undergraduate students via the Student Sustainability Fee, and 250 MWh were funded as part of Knight Hall's construction in order to support the building's LEED Gold certification goal. The RECs offset GHG emissions from 62 percent of UMD's purchased electricity, or 42,301 MT-CO_2e in all. If UMD purchased a REC for every MWh of electricity that it purchased in 2010, the GHG emissions associated with 2010 electricity purchases would have been neutralized to zero. Without the 2010 REC purchase, UMD's total GHG emissions would have increased by 3.7 percent between 2009 and 2010.

Net Positive Energy Buildings

In 2010, UMD added its first net positive energy building: LEAFHouse, which was built by Maryland's 2007 Solar Decathlon Team. A net positive energy building produces more energy than it uses. The solar photovoltaic (PV) power system on the roof of LEAFHouse generates more than enough electricity to power the small building; the surplus electricity is fed back into the regional electric grid and is subtracted from UMD's total purchased electricity. Because LEAFHouse actually reduces the amount of non-renewable electric power that is needed, it allows for the avoidance of GHG emissions that otherwise would have occurred. LEAFHouse reduced UMD's GHG emissions in 2010 by 0.4 MT-CO_2e. While the GHG emission impact of LEAFHouse is insignificant, the educational value of having a model net positive energy home on campus is important. The next step will be to discover ways that the concept of net positive energy can scale to larger buildings in order to have more of an impact.

[9] All electrons are identical so once they enter transmission lines in the electric power grid it is impossible to distinguish between electrons that were generated by a renewable source and electrons that were generated by a fossil-fuel powered source. RECs are a way to accurately track GHG emissions that are avoided when electricity it generated by a clean, renewable technology instead of by a polluting, power plant. When a REC is sold, ownership of the avoided GHG emissions transfers from the electric generator to the purchaser.

Composting

UMD has been composting a portion of its organic waste since 2006. By composting food waste, animal bedding from the Campus Barn, and plant waste from landscaping, UMD is preventing the release of methane that would occur if this organic waste was sent to a landfill, and promoting storage of carbon in soils. When organic waste breaks down in a landfill, it produces methane, carbon dioxide, and trace amounts of other gases. When organic waste breaks down in a compost facility it produces carbon dioxide, water and nutrient-packed soil that can be used in place of fertilizers. Because actively composting organic waste results in soil carbon storage and avoidance of GHG emissions it makes sense to count composting as an offset to the institution's GHG emissions. In 2010, UMD composted 952 short tons of organic waste which resulted in a deduction of 366.3 MT-CO_2e from the emissions associated with landfilling solid waste.

RECOMMENDATIONS & NEXT STEPS

The following elements are under consideration for communicating, improving, and expanding annual UMD GHG emission estimates:

- As updates are made to standard conversion factors and improved data becomes available for previous reporting years, GHG emissions should be recalculated and republished by the Office of Sustainability in order to minimize the appearance of perceived changes in GHG emissions that did not actually occur. Careful thought and planning is needed for communicating GHG changes and Climate Action Plan Progress. An online data portal may facilitate straightforward communication about GHG emissions and alleviate confusion about discrepancies between subsequent versions of the annual UMD GHG Inventory.
- Collection of data about faculty and staff vehicles is underway for 2011 through the DOTS new vehicle registration program. This data will reveal average fuel efficiencies for faculty and staff vehicles and thus enable a more accurate estimate of emissions from faculty and staff commuting.
- The Office of Sustainability is collaborating with USM's Energy Manager to develop an approach for measuring the impact of new construction on campus carbon emissions.
- Incorporation of data about carbon sinks and buffers should be continued. As carbon offset strategies are considered, attention should be given to how best to communicate about offset impacts and practices in the GHG Inventory updates. The College of Agriculture & Natural Resources Research and Education Centers practice composting; data should be collected about composting at satellite programs for incorporation into the GHG inventory.

The following recommendations aim to connect the findings of the 2010 University GHG Inventory to the strategies and targets in the Climate Action Plan:

- UMD has surpassed the target date of 2012 for reaching a 15 percent reduction in GHG emissions over 2005 levels; without the contribution made by undergraduate students for offsetting a large portion of purchased electricity, UMD would not have reached this target early. Without a significant purchase of RECs or another type of carbon offset product in 2011, UMD will likely fall below this 15 percent milestone.
- The Climate Action Plan was approved by the Senate and President in 2009 and set a target to reduce emissions from 310,232 MT-CO_2e in 2008 to 273,312 MT-CO_2e in 2012 or by approximately 12 percent (15 percent compared to 2005 levels). Leaving out the impact of the 2010 REC purchase, emissions have been reduced to 292,289 MT-CO_2e in 2010 or 5.8 percent compared to 2008. This indicates that UMD was approximately half-way to meeting the Climate Action Plan's 2012 emission reduction target. By giving attention to neutralizing the impact of new construction, UMD can better prepare to achieve GHG emissions reduction targets on time and ahead of schedule.
- Increasing air travel is having a significant impact on campus GHG emissions. The Climate Action Plan specifies near-term priority strategies of exploring how video-conferencing facilities could be better promoted and used as substitutes for certain types of campus business travel, and how local sources of carbon offsets might be developed to address transportation-related emissions that UMD cannot otherwise reduce. Imminent progress on these two strategies is needed.

Next Steps:

The information in this report will be used by campus stakeholders to revisit and refine strategies outlined in the Climate Action Plan, to track progress and measure effectiveness of strategies, and to prioritize related programs and projects. The report will also be used to educate students, faculty, and staff about the campus environmental footprint and motivate participation in campus-wide sustainability efforts. The report will be submitted to the Presidents' Climate Commitment by January 2012 along with a progress report on strategies outlined in the CAP.

ACKNOWLEDGEMENTS

The Office of Sustainability (the Office) would like to thank Dr. Ann Wylie—former VP of Administrative Affairs and current Provost—and Frank Brewer—former Interim Vice President of Administrative Affairs—for their support. This is the first year that the Office has coordinated all of the data collection and authored the report fully in-house. The Office would also like to thank Ramy Serour of the Center for Integrative Environmental Research (CIER) for leaving detailed documentation of CIER's inventory protocol and for his continued support during this transitional year. The data in this report were provided by more than 30 campus data holders. The Office appreciates their contributions and on-going partnership in measuring and reporting UMD's carbon footprint.

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Frank Allnutt	*Director, Research & Education Centers, College of Agriculture & Natural Resources*
Karen Breen	*Director, Business Services*
Terry Brenner	*Assistant Director, Facilities Planning*
Vivey Chen	*Peer Mentor, Education Abroad*
Denise Clark	*Assistant Vice President, Research Administration*
Beulah Daniel	*Assistant Director of IT, Department of Transportation Services*
Tom Dobrosielski	*Research Assistant, Institutional Research, Planning & Assessment*
Catherine Donohoe	*Assistant Director of Education Abroad*
Robyn Dwyer	*Coordinator, Maryland Fire & Rescue Institute*
Sandra Dykes	*Assistant Director of Administrative Services, Building & Landscape Services*
Cheryl Givens	*Operations Manager, Research Administration*
Richard Gomez	*Business Manager, Wye Research & Education Center*
Valerie Goubeau	*Administrative Assistant, Department of Transportation Services*
Bill Guididas	*Coordinator, Building & Landscape Services*
Erika Heilig	*Coordinator, Financial Services*
Jim Johnson	*Director of Facilities, Institute for Bioscience and Biotechnology Research*
Joan Kowal	*Energy Manager, Financial Services*
George Long	*Course Superintendent, University of Maryland Golf Course*
Beverly Malone	*Assistant Director, Department of Transportation Services*
Jeremy Menna	*Assistant Director of Grounds, Inter-Collegiate Athletics*
Bill Monan	*Assistant Director, Building & Landscape Services*
Jimmy Pence	*HVAC Zone Supervisor, Facilities Management*
Karen Petroff	*Assistant Director, Arboretum & Horticultural Services*
Christian Presley	*IT/Telecommunications Specialist, Institute for Bioscience and Biotechnology Research*
Tim Robinson	*IT Coordinator, Department of Transportation Services*
Hilary Sazama	*Manager, Office of Extended Studies*
Dawn Schettino	*Business Operations Manager, Institute for Bioscience and Biotechnology Research*
Mark Sultenfuss	*Program Manager: Field Crops, Wye Research & Education Center*
Harry Teabout	*Director, Building & Landscape Services*
John Vucci	*Associate Director of HVAC Systems, Facilities Management*
Dave Wallace	*IT Programmer, Department of Transportation Services*
Allen Williams	*Manager LSS, Certifications & Accreditation, Maryland Fire & Rescue Institute*

Appendix A: Greenhouse Gas Emissions by Year and Source

Total University GHG Emissions ($MT\text{-}CO_2e$)	
2002	309,779
2003	319,831
2004	316,323
2005	321,544
2006	319,309
2007	312,474
2008	309,997
2009	283,480
2010	251,956

GHG Emissions from Power & Operations (reported in $MT\text{-}CO_2e$)					
	On-Campus CHP	Other Stationary Sources	Purchased Electricity	Renewable Energy Certificates	Totals
2002	43,811	3,610	153,712	0	201,132
2003	51,018	4,191	151,770	0	206,978
2004	120,325	5,055	78,976	0	204,355
2005	123,536	4,267	72,288	0	200,091
2006	128,855	4,152	66,614	0	199,620
2007	130,171	4,777	64,878	0	199,827
2008	127,134	5,040	70,930	0	203,104
2009	121,983	5,276	61,687	0	188,945
2010	118,998	6,676	69,801	-40,470	155,004

GHG Emissions from Transportation (reported in $MT\text{-}CO_2e$)						
	Business /Athletics Air Travel	Study Abroad Air Travel	Student Commuting	Faculty & Staff Commuting	UMD Bus & Vehicle Fleet	Totals
2002	24,757	4,803	40,121	18,905	5,392	93,979
2003	26,900	5,483	40,899	18,728	5,506	97,516
2004	29,620	6,250	38,839	17,027	5,690	97,425
2005	31,210	7,240	41,410	16,984	5,988	102,831
2006	33,093	8,278	39,540	17,399	6,167	104,477
2007	33,439	9,014	35,704	17,716	6,590	102,463
2008	31,693	10,770	26,437	19,852	6,897	95,649
2009	29,568	12,209	21,582	18,181	6,708	88,248
2010	32,979	15,439	19,758	17,847	6,813	92,836

GHG Emissions from Other Categories (reported in $MT\text{-}CO_2e$)					
	Agriculture & Landscaping	Solid Waste	Refrigerants & Chemicals	Compost	Other Totals
2002	1,856	5,617	7,195	0	14,668
2003	1,896	8,312	5,129	0	15,337
2004	1,937	9,411	3,194	0	14,542
2005	1,932	8,251	8,438	0	18,621
2006	2,201	7,285	5,725	0	15,211
2007	2,000	5,429	2,755	0	10,184
2008	2,150	4,877	4,217	0	11,244
2009	2,047	1,686	2,553	0	6,286
2010	1,959	1,623	899	-366	4,115

Appendix B: Commuting Changes and Assumptions

Previous versions of UMD's GHG Inventory relied on commuter permit data to estimate a percentage of the student population that drives alone (*S*), and a percentage of the faculty and staff population that drives alone (*E*). Survey data provided estimates of the percent of faculty and staff that carpool (*C*). These percentages were used to estimate miles driven as follows:

Student miles = S*(FTE Student Population)*160 days per year* 2 trips per day*average student commute distance

Faculty miles = [*E**(Total number of Faculty including grad assistants)+*C**(Total number of Faculty including grad assistants)/2]*215 days per year*2 trips per day*average faculty commute distance

Staff miles = [*E**(Total number of Staff)+*C**(Total number of Staff)/2]*215 days per year*2 trips per day*average staff commute distance

In this version and future versions of UMD's GHG Inventory a slightly different method has and will be used. Instead of using permit numbers to estimate percentage of the student population that drives alone, we segment the total number of student commuter permits into carpooler permits and non-carpooler permits (see Box 4). Student miles driven are estimated for each group of permits (using assumptions listed in Box 4) and miles for the two groups are added together. For faculty and staff it is not possible to use total number of permits to directly estimate GHG emissions because the DOTS does not disaggregate employee permits. Percentage of faculty and staff that purchase permits (E) is estimated by dividing the total number of employee permits into the total number of faculty and staff (not including graduate assistants). Carpooling deductions for faculty and staff are not be included because reductions from carpooling are assumed to be inherent in the number of permits purchased (see Box 4 for further explanation). Miles driven by faculty and staff are then be calculated as follows:

Faculty miles = E*(FTE Faculty not including grad assistants)*215 days per year*2 trips per day*avg. faculty commute distance

Staff miles = E*(FTE Staff)*215 days per year*2 trips per day*avg. staff commute distance

Box 4. Assumptions: Driving reductions due to Carpooling and Part-time status

We assume that:

- Part-time students do not buy commuter parking permits and instead rely on free evening parking, bundle-packs, and metered parking.

- Part-time faculty and staff do buy commuter parking permits. Reductions from faculty and staff who work part-time are accounted for by converting faculty and staff permits to FTE equivalents.

- Faculty and staff who carpool share a permit. There is no need to account for a reduction in emissions due to faculty and staff carpooling since each permit represents one car that drives to and from campus on each work day.

- Students who carpool do not share permits. Each permit holder who carpools accounts for half the miles of a permit holder who does not carpool. In order to account for the reduction in emissions due to student carpooling we multiply the percentage of the total student population that carpools by the FTE student population to get a number of carpooler permits. We then subtract the carpooler permits from the total number of student commuter permits to get a non-carpooler permit number. The non-carpooler permit number (X) and the carpooler permit number (Y) are used estimate miles driven as follows:

  Student Miles = [X+(Y/2)] * 160 days per year * 2 trips per day * avg. student commute distance