VANDERBILT UNIVERSITY INVENTORY OF GREENHOUSE GAS EMISSIONS 2013

Electricity purchased by VU was at a seven-year low in 2013

17%
Overall greenhouse gas emissions reduction since 2008

35%
Reduction in greenhouse gas emissions per $1000 research dollars, 2005-2013

27%
Reduction in greenhouse gas emissions per person on campus 2005-2013

VANTAGE laboratory earns
LEED GOLD CERTIFICATION

U.S. GREEN BUILDING COUNCIL LEED USGBC

GREEN COLLEGE HONOR ROLL
The Princeton Review
2013

1 of 21 colleges with a perfect score!

Vanderbilt University Medical Center

54%

REDUCTION IN GREENHOUSE GAS EMISSIONS PER AMBULATORY VISIT SINCE 2005

VANDERBILT RECYCLING VOLUME
DOUBLED
FROM 2011 TO 2013

BY
2015
VANDERBILT WILL BE
COAL FREE

SustainVU
VANDERBILT

VANDERBILT UNIVERSITY

Developed By

Andrea George, PhD, CHMM
Director, Sustainability and Environmental Management Office

Steven Gild, MS, CHMM
Environmental Management Systems Coordinator, Sustainability and Environmental Management Office

Produced collaboratively by the Sustainability and Environmental Management Office, Plant Operations, Campus Planning and Construction and Vanderbilt News and Communications.

The Sustainability and Environmental Management Office (SEMO) is a collaborative venture between Vanderbilt Environmental Health and Safety and Vanderbilt University's Plant Operations. SEMO's mission is to initiate, promote, coordinate, evaluate and encourage environmental management and sustainability initiatives that improve Vanderbilt's impact on the community and environment.

Plant Operations provides facilities support for all construction, renovation and routine maintenance of University Central space and facilities; housekeeping services for approximately 5.8 million square feet of academic, administrative, residential, and recreational space; grounds care for 330 acres that are a registered arboretum; turf care for athletic fields; and utilities for University Central and the Medical Center.

Campus Planning and Construction (CPC) aims to present a physical environment that meets the programmatic requirements of its customer base while visually expressing the quality to which Vanderbilt University aspires. Functions closely related to the delivery of new facilities are performed by the Facilities Information Services unit within CPC. This group addresses the inventory and management of Vanderbilt's construction document library, GIS mapping and documentation of all utilities and tracking of floor plans for the Space Inventory and Accounting processes.

Vanderbilt University's award-winning **Division of Public Affairs** which includes **Vanderbilt News & Communications** serves as the institution-wide hub for communications, marketing and public policy initiatives. Whether developing unique relationships with and communicating to Vanderbilt's vast array of external and internal constituencies, promoting government and community initiatives, creating a broader, deeper and more complete understanding of Vanderbilt, each and every activity of the division supports the University's academic missions of teaching, research, service and patient care.

Front page graphic created by Jennifer Wu.

Published October 22, 2014

VANDERBILT UNIVERSITY
MEDICAL CENTER

VANDERBILT
UNIVERSITY

SustainVU
VANDERBILT

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the following individuals for providing data to SEMO and sharing their insight on operations that produce greenhouse gas emissions:

VU Plant Operations

Roger Bess

James "Darren" Bevill

Larry Cox

Terry Haley

Debbie Kunik

Mitchell Lampley

David Manning

Mark Petty

Richard Warf

Robert West

Jeff Youngblood

Environmental Health and Safety

Melanie Byers

Ben Edwards

Susan Johnson

Marisa Scott

Kevin Warren

Robert Wheaton

VUMC Facilities and Construction

Mike Gable

Elizabeth Hiett

Tim Simpson

Mark Walker

Joel Wilson

VUMC Parking and Transportation Services

David Banks

Gary Streaty

Campus Planning and Construction

Hugh Brantley

Judson Newbern

Human Resources

Leah Cannon

Vanderbilt University Information Technology

Jeff Flint

Office of Traffic and Parking

Lance Hale

Finance

Jane Hershey

VU Police Department

Missy Morrison

VUMC Pharmacy Procurement

Michael O'Neal

Division of Animal Care

Jessie Pirtle

Vanderbilt University Real Estate

Benji Rust

The authors gratefully acknowledge the following individuals for assisting SEMO with reviewing this report:

James Clarke, *Professor of the Practice of Civil and Environmental Engineering and Professor of Earth and Environmental Sciences; Chair, Environmental Advisory Committee*; Eric Kopstain, *Vice Chancellor for Administration*; Judson Newbern, *Deputy Vice Chancellor for Facilities and Environmental Affairs;* Mark Petty, *Assistant Vice Chancellor for Plant Operations*; and Robert Wheaton, *Executive Director, Environmental Health and Safety*.

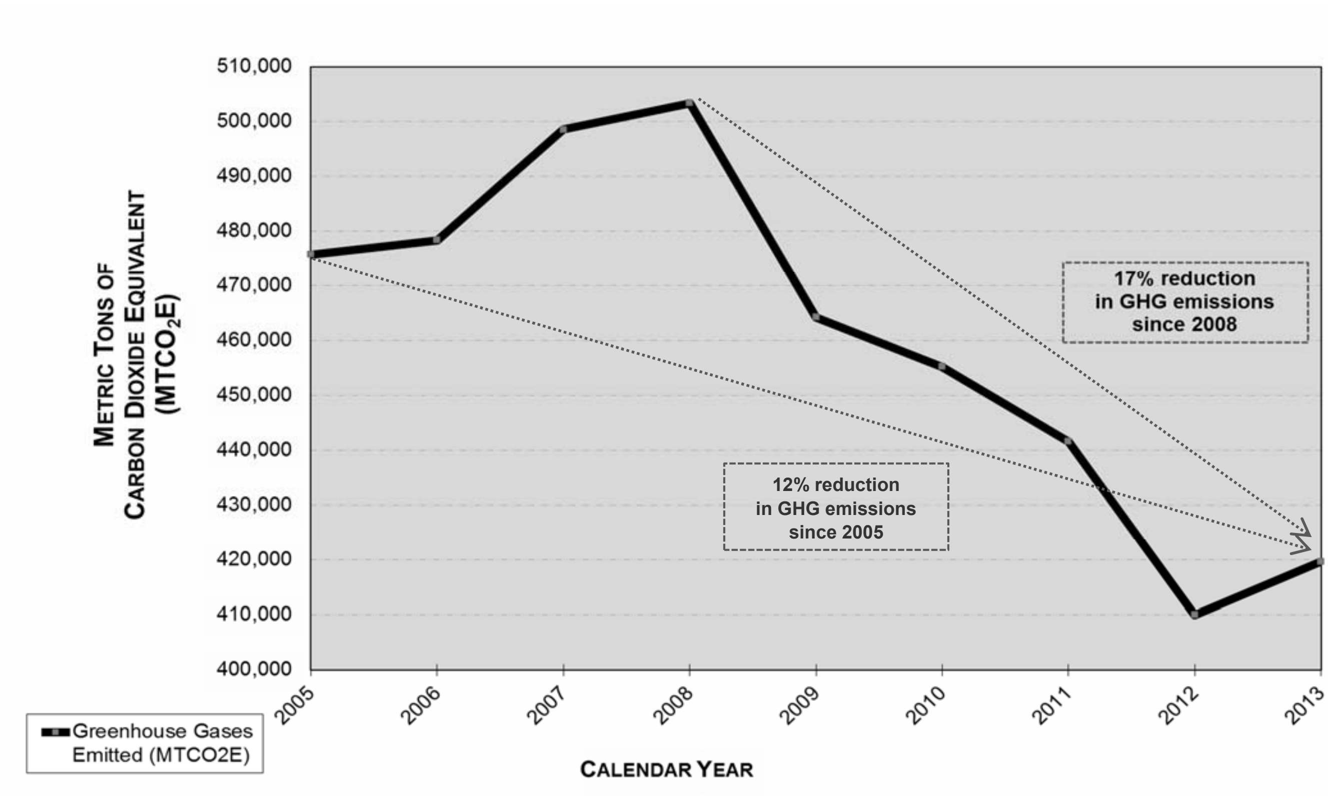
PAGE LEFT INTENTIONALLY BLANK

EXECUTIVE SUMMARY

This Greenhouse Gas (GHG) emissions inventory is intended to portray Vanderbilt's current carbon footprint as accurately as possible and to provide trending information to show progress in GHG emissions reductions from 2005-2013. This GHG inventory was developed by Vanderbilt's Sustainability and Environmental Management Office (SEMO).

This report, a supplement to previous reports for 2005 to 2012[1], establishes Vanderbilt's GHG emissions for calendar year 2013 so that the Vanderbilt community can better understand its own unique impact on the environment and determine the most effective improvement strategies to implement in the future. Trending data for 2005 through 2013 is provided in Appendix B and discussed below.

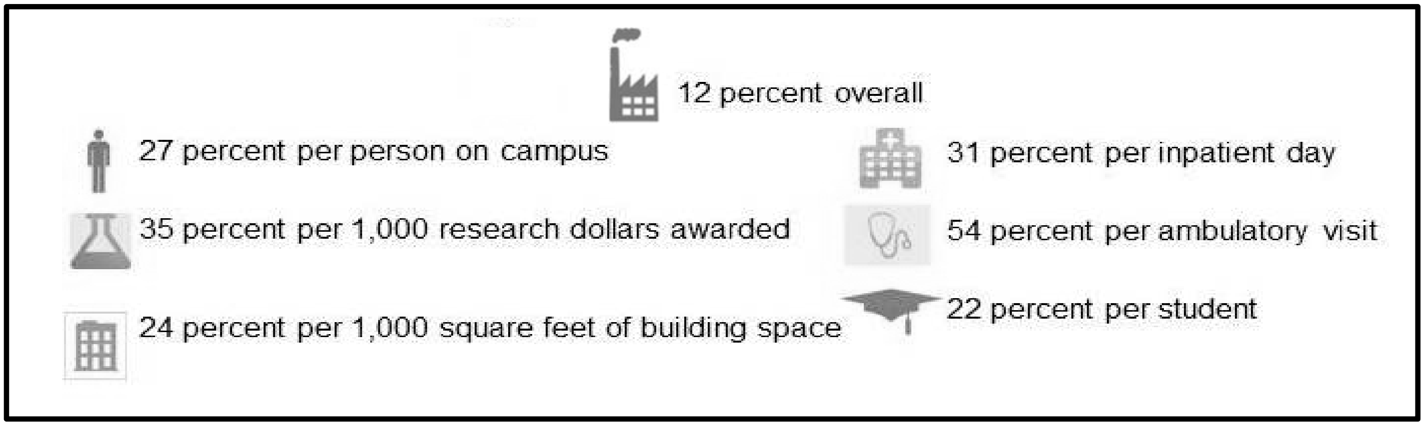
Findings



Total Vanderbilt GHG Emissions, Calendar Years 2005-2013.

[1] Vanderbilt University's Inventory of Greenhouse Gas Emissions 2005-2013 is available at www.vanderbilt.edu/sustainvu.

Between 2005 and 2013, Vanderbilt University's GHG emissions have decreased by:



- VU's total GHG emissions for calendar year 2013 were 419,692 Metric Tons of Carbon Dioxide Equivalent ($MTCO_2E$), down 12 percent from 2005 and 17 percent from the all-time high reached in 2008[2].
- Vanderbilt University's EPA-Required GHG emissions for calendar year 2013 were 155,065 $MTCO_2E$, as reported to the Environmental Protection Agency (EPA) on March 13, 2014.
- GHG emissions from Academic and Research Areas have decreased by 17 percent since 2008, and GHG emissions from Patient Care Areas have decreased by 16 percent since 2008[3].
- 92 percent of GHG emissions in 2013 came from purchased electricity, coal and natural gas use at the campus co-generation power plant and faculty and staff commuting[4].
- Overall GHG emissions did uptick slightly in 2013 (by 2%) due to a shift in increased on-campus fuel use and decreased purchased electricity in order to save money on utilities as well as better tracking of Vanderbilt-funded air travel for faculty, staff and students through a new travel management tool, Concur. However, this uptick should reverse as the power plant fuel conversion discussed below is completed in 2014.

---

[2] Additional information about the University's total GHG emissions for 2005-2013 can be found in Table B.1 in the appendices.
[3] Additional information about GHG emissions from Academic and Research Areas and Patient Care Areas can be found in Sections III and IV and Tables B.1, B.2 and B.3 in the appendices.
[4] Additional information about the sources of GHG emissions can be found in Figure C.1 in the appendices.

Did You Know?

In 2013, Vanderbilt University began the conversion of its co-generation power plant from being fueled with both coal and natural gas to being fueled entirely by natural gas. This improvement will continue to meet the power needs of the University and Medical Center, but in a more environmentally sustainable way. This project will increase operational efficiency while also reducing greenhouse gas emissions, air pollutant emissions and noise pollution, and eliminating associated fuel use and emissions from trucking coal to the power plant. Coal use at the power plant will be discontinued by the end of 2014, barring unforeseen construction delays[5].

2014 Photo of power plant prior to construction (*left*); artist rendition of power plant after conversion (*right*)

Future Plans

This inventory provides campus stakeholders with a consistent means of comparing annual GHG emissions and sufficiently detailed information to make informed decisions to determine reduction strategies. Annual emissions inventories will be conducted in the future to measure progress, which will continue to be made publicly available on the SustainVU website[6].

[5] More information regarding the VU Power Plant Conversion can be found at www.vanderbilt.edu/sustainvu/2013/04/vu-power-plant-to-convert-to-all-natural-gas/.

[6] www.vanderbilt.edu/sustainvu

I. BACKGROUND

Vanderbilt University

Vanderbilt University, founded in 1873, is a private research higher education institution offering undergraduate, graduate and professional degrees to over 12,700 full and part-time students[7]. Comprised of 10 schools and a world-class medical center, Vanderbilt University is consistently ranked as one of the country's top 20 universities with several programs ranking in the top 10. As the largest private employer in Middle Tennessee and the second largest private employer in the state, Vanderbilt University currently has more than 3,600 full-time faculty and a staff of over 20,000[8]. The core campus, located near downtown Nashville, Tennessee, spans approximately 330 acres and contains 230 buildings[9]. More than 200 tree species exist on Vanderbilt's grounds, leading to the school's recognition as an arboretum since 1988.

Photo provided by Robert Wheaton

Vanderbilt Featured in Sustainable Business Magazine

Vanderbilt's sustainability programs are discussed in the latest edition of ***Sustainable Business Magazine,*** the premiere platform for senior executives to share ways in which they are meeting 21st Century challenges. You can read about the new College Halls, waste and recycling programs, conversion of Vanderbilt's power plant to 100% natural gas, and much more.

Inventory Development

Vanderbilt emits Greenhouse Gases (GHG) through its daily operations, such as electricity and steam production at the on-campus co-generation power plant; electricity purchased from Nashville Electric Service (NES); University-owned vehicle fuel use; refrigerant releases; anesthetic gas use; faculty and staff commuting to work; air travel paid for by the University; and disposal of waste generated by Vanderbilt. VU has issued previous reports for the years 2005 to 2012[10]. Trending data summaries for 2005 to 2013 are provided in Appendix B.

The Environmental Protection Agency (EPA)-issued *Mandatory Greenhouse Gas Reporting Rule* [40 CFR Part 98][11] requires annual reporting of GHG emissions from large sources in the United States that emit more than 25,000 metric tons of carbon dioxide equivalent ($MTCO_2E$) per year. Vanderbilt is subject to this reporting rule because of the emissions produced from the current use of coal and natural gas at the on-campus, co-generation power plant for the production of steam and electricity for campus. Under the GHG reporting rule, the scope and emissions factors of stationary sources

[7] According to 2012-2013 enrollment data found in ReVU: Quick Facts about Vanderbilt. Accessed December 2013. Available www.vanderbilt.edu/facts.html.
[8] According to 2013 employment information found in ReVU: Quick Facts about Vanderbilt. Accessed December 2013. Available www.vanderbilt.edu/facts.html
[9] VU facilities data is available online at cpc-fis.vanderbilt.edu/pdf/facilitiesreportbook.pdf.
[10] Vanderbilt University's Inventory of Greenhouse Gas Emissions 2005-2009, 2010, 2011, and 2012 reports are available at www.vanderbilt.edu/sustainvu.
[11] www.epa.gov/ghgreporting/

vary from those utilized in Vanderbilt's initial baseline GHG inventory. In order to create a single, consistent methodology for calculating and reporting GHG emissions for the University, emissions for Vanderbilt, including those years prior to 2009, were calculated utilizing the EPA's scope and emissions factors for relevant stationary sources. For calendar year 2013, Vanderbilt University emissions from EPA-required sources amounted to 155,065 $MTCO_2E$, which was reported to the EPA on March 13, 2014. Emissions from all sources not covered by the GHG reporting rule were calculated using methodology from the Clean Air – Cool Planet Campus Carbon Calculator™ (Campus Carbon Calculator) or emissions factors developed for specific on-campus activities.

Greenhouse Gases: Impact and Importance

A carbon footprint is a standard that people and organizations use to quantify the impact they have on the environment, particularly as their behaviors relate to climate change concerns. GHGs, once released, trap heat in the atmosphere, acting like a gas blanket. As the concentrations of these gases increase, the earth's temperature could potentially climb higher than previous levels; and wind, storm and precipitation patterns could shift and become more extreme. These weather pattern shifts result in the migration of plant and animal species to new locales as well as increased frequency of catastrophic natural disasters[12].

Long-Term Warming Still Trending, Despite Mild Summers

According to a 2013 report released recently by the National Oceanic and Atmospheric Administration (NOAA) and its partners, cooler temperatures in the summer of 2013 across the central Arctic Ocean, Greenland, and northern Canada moderated the record sea ice loss and extensive melting that the surface of the Greenland ice sheet experienced in 2012. Yet there continued to be regional extremes, including record low snow cover in Eurasia and record high summer temperatures in Alaska.

"The Arctic caught a bit of a break in 2013 from the recent string of record-breaking warmth and ice melt of the last decade," said David M. Kennedy, NOAA's deputy undersecretary for operations. "But the relatively cool year in some parts of the Arctic does little to offset the long-term trend of the last 30 years: the Arctic is warming rapidly, becoming greener and experiencing a variety of changes, affecting people, the physical environment, and marine and land ecosystems."

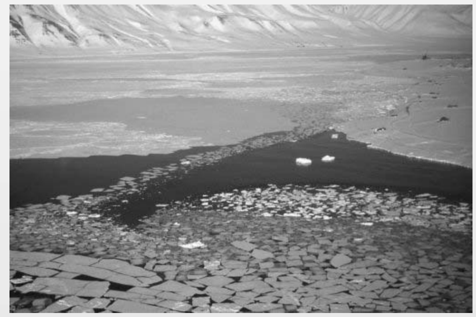
Kennedy joined other scientists to release the Arctic Report Card 2013, which has, since 2006, summarized changing conditions in the Arctic. One hundred forty-seven authors from 14 countries contributed to the peer-reviewed report.

The six GHGs emitted into the atmosphere that comprise the majority of the carbon footprint are: carbon dioxide (CO_2); methane (CH_4); nitrous oxide (N_2O); hydroflurocarbons (HFCs); perflurocarbons (PFCs); and sulfur hexafluoride (SF_6). Once the amount of emissions of each gas is determined, it is converted to a standard unit of measure, or carbon dioxide equivalent (CO_2E). The sum of all CO_2E emitted by that person or organization is the carbon footprint, usually reported in metric tons as $MTCO_2E$.

[12] *Explaining Extreme Events of 2012 from a Climate Perspective,* September 2013, www.ametsoc.org/2012extremeeventsclimate.pdf.

Climate Change Being Felt On All Continents

Climate change is impacting human and natural systems on all continents and oceans, according to a summary report released by the Intergovernmental Panel on Climate Change (IPCC). The report, titled *Climate Change 2014: Impacts, Adaptation, and Vulnerability*, notes there are increasing risks from the changing climate, but the report also concludes that there are opportunities to respond to such risks. However, these risks become more difficult to manage as climate change levels increase. The findings mark the culmination of four years' work by hundreds of experts who have volunteered their time and expertise to produce a comprehensive assessment of impacts, adaptation, and vulnerability.



The report builds on the four previous assessment reports produced by the IPCC since it was established in 1988. In another report released in September 2013, the IPCC determined that human influence on the climate system is clear, and concludes that it is "extremely likely" that human influence has been the dominant cause of the observed warming since the mid-20th century. See the IPCC news release and the October 23, 2013 *EERE Network News*.

Vanderbilt Power Production

Vanderbilt's on-campus power plant produces 23 percent of the electricity, all of the steam and 40 percent of the chilled water consumed by the Vanderbilt community. These utilities are produced by a co-generation combined heat and power (CHP) plant. This plant currently uses two fuels, coal and natural gas, to produce electricity, steam heat and chilled water. This type of power plant is highly efficient because of the flexibility of the fuel system, the variety of utilities produced and the proximity of the utility production to the utility user. Since a portion of electricity produced at power plants hundreds of miles away is actually lost during the transmission process through the electrical lines (line losses), VU can use much less coal or natural gas than Tennessee Valley Authority (TVA) would require to deliver the same amount of electricity to campus. The remaining 77 percent needed to power Vanderbilt's campus is purchased from TVA through NES. This mix of on-campus generation and purchased electricity also results in uniqueness within Vanderbilt's carbon footprint.

In Fall 2013, Vanderbilt University began the conversion of its co-generation power plant from being fueled by both coal and natural gas to being fueled entirely by natural gas. This improvement will continue to meet the power needs of the University and Medical Center, but in a more environmentally sustainable way. This conversion will increase operational efficiency while reducing greenhouse gas emissions, air pollutant emissions and noise pollution, and eliminating associated fuel use and emissions from trucking coal to the power plant[13].

Other Operations Resulting in Greenhouse Gas Emissions

Vanderbilt University also produces GHG emissions through fossil fuel use in university-owned fleet vehicles and faculty and staff commuting to work; refrigerant and anesthetic gas releases; air travel paid for by the university; and disposal of waste.

[13] More information regarding the VU Power Plant Conversion can be found at http://www.vanderbilt.edu/sustainvu/2013/04/vu-power-plant-to-convert-to-all-natural-gas/.

II. VANDERBILT UNIVERSITY ENVIRONMENTAL COMMITMENT

The Vanderbilt University Environmental Commitment Statement presented here is the cornerstone of our Environmental Management System (EMS), which includes the VU GHG emissions inventory. This Environmental Commitment Statement is a collaborative product of many stakeholders and campus representatives and is meant to succinctly and uniquely reflect Vanderbilt's culture and values.

Environmental Commitment Statement

Vanderbilt University is a local and global community leader committed to environmental stewardship, protecting natural resources, and enhancing quality of life while maintaining academic, medical, social, and economic productivity. Through proactive education, research, and outreach, we strive to:

- Develop and transfer knowledge, increase awareness, and promote lifelong learning about sustainability best practices for the benefit of stakeholders who comprise the Vanderbilt community (students, patients, faculty, staff, alumni, and visitors), as well as the broader Nashville, state, national, and global communities;

- Achieve the highest standards of sustainability through a process of environmental responsibility and accountability at every level of University activity; and

- Consistently implement, monitor, evaluate, and improve our process.

http://www.vanderbilt.edu/sustainvu/who-we-are/environmental-commitment-statement/

III. ACADEMIC AND RESEARCH AREA GREENHOUSE GAS EMISSIONS

Results Summary

Academic and Research Areas (ARAs) at VU encompass typical university activities such as teaching, research, administration, student activities, student housing, dining and athletic facilities. Table 3.1 illustrates annual GHG emissions from ARAs for calendar years 2005 through 2013. Figure 3.1 shows that GHG emissions from ARAs have dropped by 17 percent since the all-time high in 2008.

Calendar Year	GHG Emissions from EPA-Required Sources[14] ($MTCO_2E$)	Other Scope 1 Emissions[15] ($MTCO_2E$)	Scope 2 Emissions ($MTCO_2E$)	Scope 3 Emissions ($MTCO_2E$)	Total GHGs Emitted from ARAs ($MTCO_2E$)	Percent Decrease in GHGs Emitted from Previous Year
Academic & Research Areas						
2005	99,554	2,446	145,173	49,291	**296,465**	-
2006	95,045	2,848	145,382	52,550	**295,825**	0.22%
2007	107,815	2,838	142,045	55,905	**308,604**	-4.32%
2008	108,255	2,598	149,266	53,222	**313,341**	-1.53%
2009	116,192	2,455	117,359	52,336	**288,343**	7.98%
2010	103,781	3,091	119,507	58,127	**284,506**	1.3%
2011	98,201	2,379	118,077	53,573	**272,229**	4.3%
2012	95,898	2,381	100,894	52,496	**251,669**	7.6%
2013	100,792	2,437	98,507	58,207	**259,943**	-3.2%

Table 3.1. GHG Emissions from Academic and Research Areas by Type, Calendar Years 2005-2013.

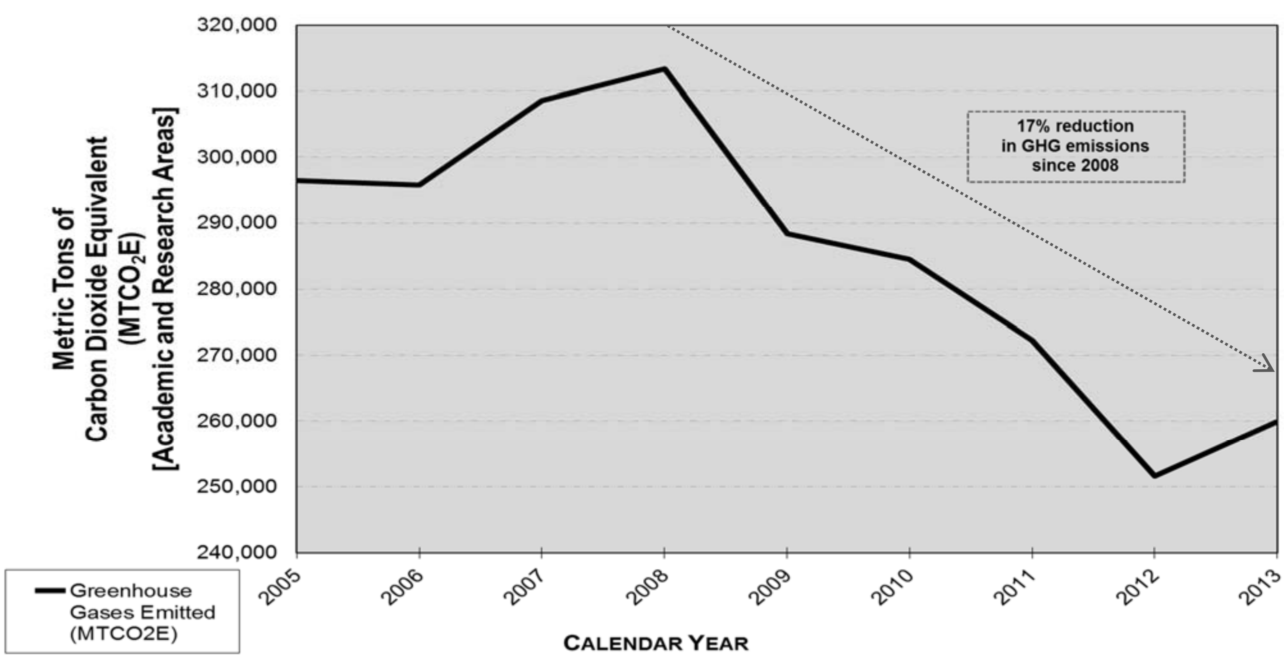


Figure 3.1. GHG Emissions from Academic and Research Areas, Calendar Years 2005-2013.

[14] EPA-required sources includes coal-fired boilers, natural gas-fired boilers and natural gas-fired turbines.
[15] Other Scope 1 Emissions includes anesthetic gas use, emergency generators, fleet vehicles and refrigerant releases.

As demonstrated in Figure 3.2 below, major contributors to the emissions from ARAs include purchased electricity (38 percent), coal use at the power plant (22 percent), faculty and staff commuting (18 percent) and natural gas use at the power plant (15 percent).

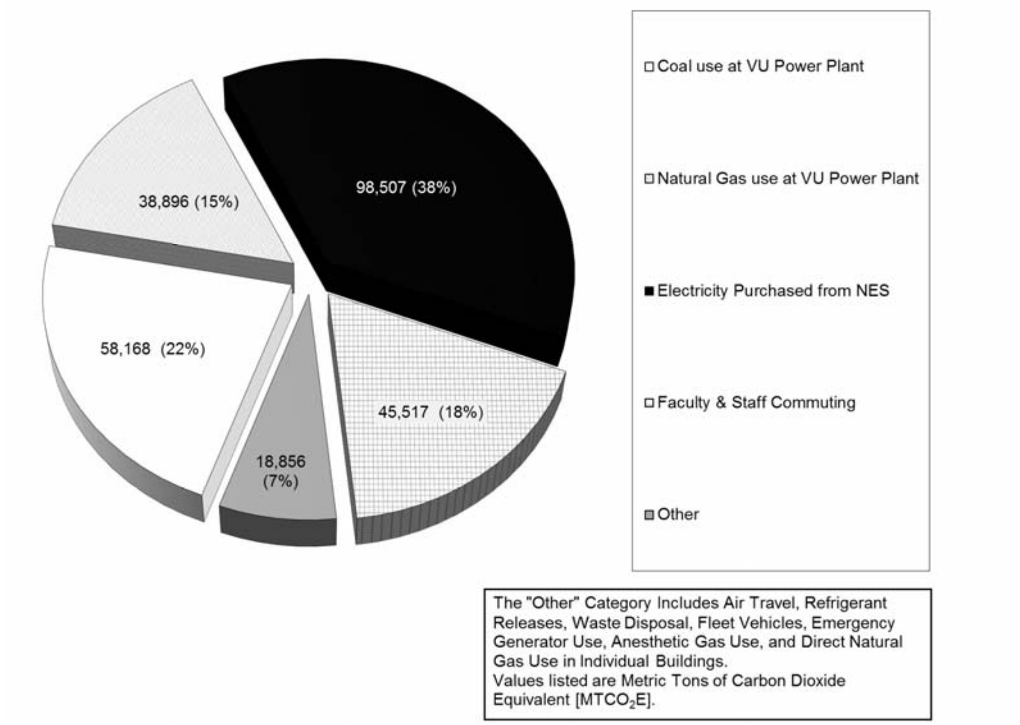


Figure 3.2. GHG Emissions Sources from Academic and Research Areas, Calendar Year 2013.

Scope 1: EPA-Required Emissions Sources

Individual building monthly steam and electricity usage for calendar year 2013 revealed that approximately 65 percent of the steam and electricity consumed by Vanderbilt was consumed by ARA buildings. Therefore, 65 percent of the GHG emissions associated with the power plant were attributed to ARAs. In 2013, GHG emissions from EPA-required emissions sources for ARAs amounted to 100,792 $MTCO_2E$ as shown in Table 3.2.

Calendar Year	Coal Use: Power Plant ($MTCO_2E$)	Natural Gas Use: Power Plant ($MTCO_2E$)	Natural Gas Use: Boilers in Individual Buildings ($MTCO_2E$)	Total VU GHG Emissions from EPA-Required Sources[16] ($MTCO_2E$)	GHG Emissions from EPA-Required Sources in ARAs (65 percent of previous column) ($MTCO_2E$)
2005	96,478	51,695	4,988	153,161	99,554
2006	99,582	38,485	8,155	146,222	95,045
2007	111,344	48,258	6,268	165,869	107,815
2008	102,172	51,358	13,017	166,547	108,255
2009	105,956	64,096	8,705	178,758	116,192
2010	92,090	62,835	4,738	159,663	103,781
2011	87,022	58,405	5,651	151,078	98,201
2012	85,968	56,798	4,770	147,536	95,898
2013	89,490	59,840	5,736	155,065	100,792

Table 3.2 Academic and Research Areas GHG Emissions from EPA-Required Stationary Sources, Calendar Years 2005-2013.

[16] Emission factors taken from the EPA's *Mandatory Reporting of Greenhouse Gases; Final Rule* [40 CFR Part 98, Subpart C].

Coal and Natural Gas Use at the Power Plant

The burning of coal and natural gas at the on-campus power plant releases carbon dioxide, nitrous oxide and methane. The inventory results illustrate that approximately 65 percent of the overall 89,490 $MTCO_2E$, or 58,168 $MTCO_2E$, are produced from coal use at the power plant for ARAs. This equates to 22 percent of the overall 2013 ARAs emissions. Additionally, 65 percent of the 59,840 $MTCO_2E$ resulting from natural gas use, or 38,896 $MTCO_2E$, equates to 15 percent of the overall ARAs emissions, as shown in Table C.1 of the appendices.

Power Plant Moves to Natural Gas in 2014

Two massive natural gas boilers were installed at the Vanderbilt power plant in July 2014 as part of the university's ongoing effort to convert the co-generation facility completely to natural gas fuel.

The new boilers will provide steam to more than 5.8 million square feet of building space at the university and medical center. This steam is used to heat buildings and water, in several campus processes such as the sterilization of equipment, and to make chilled water for air conditioning.

For more information, see the associated VU News story.

Natural Gas Use in Individual Buildings

Several buildings on campus use natural gas directly from Vanderbilt's natural gas supplier. The consumption of natural gas within individual buildings in ARAs accounts for 3,728 $MTCO_2E$ of 2013 emissions, as shown in Table C.1 of the appendices.

Scope 1: Other Direct Emission Sources

Vanderbilt's direct GHG emissions sources that are not required to be reported to the EPA are shown in Table 3.3 below. See Tables C.2, C.3, C.4 and C.5 in the appendices for more details.

Calendar Year	Diesel-powered Emergency Generators ($MTCO_2E$)	Refrigerant Releases ($MTCO_2E$)	VU Fleet Vehicles ($MTCO_2E$)	Anesthetic Gas Use ($MTCO_2E$)	GHG Emissions from Other Direct Emission Sources ($MTCO_2E$)
2005	550	286	1,609	1	2,446
2006	541	338	1,968	1	2,848
2007	830	137	1,870	1	2,838
2008	282	143	2,159	14	2,598
2009	394	35	2,013	14	2,455
2010	119	1,019	1,935	19	3,091
2011	110	41	2,210	18	2,379
2012	116	120	2,128	18	2,381
2013	116	76	2,154	91	2,437

Table 3.3. Academic and Research Areas Scope 1 Emissions from Other Sources, Calendar Years 2005-2013.

Scope 2: Purchased Electricity Emissions

98,507 $MTCO_2E$, or 38 percent of 2013 GHG emissions for ARAs are attributed to electricity purchased, as shown in Table 3.4 below. This is the result of the amount of electricity purchased from Nashville Electric Service (NES) and the mix of electricity generation methods employed by Tennessee Valley Authority (TVA). Electricity purchased by Vanderbilt is at its lowest level since 2007. See Tables C.8 and C.9 in the appendices for more details.

Calendar Year	Kilowatt-Hours Purchased (KwH)	Total VU Emissions ($MTCO_2E$)	Emissions Associated with Academic & Research Areas (65 percent of previous column) ($MTCO_2E$)
2005	294,070,522	223,343	145,173
2006	294,494,256	223,664	145,382
2007	287,734,887	218,531	142,045
2008	307,162,163	229,640	149,266
2009	305,308,699	180,553	117,359
2010	303,543,739	183,857	119,507
2011	313,049,916	181,657	118,077
2012	311,313,519	155,221	100,894
2013	299,441,016	151,549	98,507

Table 3.4 GHG Emissions from Purchased Electricity for Academic and Research Areas, Calendar Years 2005-2013.

As U.S. Shifts from Coal, So Does Vanderbilt

Inside of the coal-fired boiler that was decommissioned in August 2014

One of Vanderbilt's three coal-fired boilers was turned off forever on August 20, 2014. The remaining coal boilers will be shut down permanently before 2014 comes to a close, assuming no significant construction delays.

Just as Vanderbilt is shifting to natural gas, a similar shift is occurring on a national level. Under President Obama's Climate Action Plan, EPA is taking steps to address carbon pollution from the power and transportation sectors, and to improve energy efficiency in homes, businesses and factories. Under EPA's proposed Clean Power Plan, carbon emissions from the power sector would decrease by 30 percent below 2005 levels and electricity bills would shrink by 8 percent by 2030. [EPA Press Release, 9/30/14]

Scope 3: Indirect Emission Sources

Vanderbilt's indirect emissions include fuel use by commuters (faculty, staff and student commuters), fuel use from air travel, and waste disposal. Indirect emissions for ARAs for calendar years 2005 through 2013 are displayed below in Table 3.5. Recorded air passenger-miles increased significantly this year due to Vanderbilt's new centralized travel management portal Concur. All airline travel for Vanderbilt faculty, staff, and students is now captured by Concur, causing this increase in reported Scope 3 emissions for 2013. For more details, see Tables C.10, C.11, C.12, C.13 and C.14 in the appendices.

Calendar Year	Waste Disposal Emissions ($MTCO_2E$)	Air Travel Emissions[17] ($MTCO_2E$)	Commuter Travel Emissions ($MTCO_2E$)	Total Scope 3 GHG Emissions in Academic & Research Areas ($MTCO_2E$)
2005	1,022	5,259	43,010	49,291
2006	1,116	5,259	46,175	52,550
2007	1,150	5,259	49,496	55,905
2008	1,360	5,386	46,476	53,222
2009	1,205	6,944	44,186	52,335
2010	1,761	9,719	46,646	58,127
2011	1,651	8,993	42,929	53,573
2012	555	7,272	44,668	52,496
2013	613	12,077	45,517	58,207

Table 3.5. Academic and Research Areas Scope 3 GHG Emissions Sources, Calendar Years 2005-2013.

Study Finds "Addressing Climate Change Makes Economic Sense", Cities Should Take the Lead

Investments to help fight climate change can spur economic growth, rather than slow it as widely feared. However, a new international report by the Global Commission on the Economy and Climate says time is running short for a trillion-dollar shift to transform cities and energy use. The authors of the report, former heads of government, business leaders, and economists, state that the next 15 years are critical for a bigger shift to clean energies from fossil fuels to combat global warming and cut health bills from pollution.

"It is possible to tackle climate change and it is possible to have economic growth at the same time," says Felipe Calderon, a former Mexican president and head of the Global Commission on the Economy and Climate. "Many governments and businesses wrongly fear that measures to slow climate change will undermine jobs and growth."

You can view the report generated by the Global Commission on the Economy and Climate via this link: newclimateeconomy.report

[17] Air travel for 2005 and 2006 is not readily available. 2007 data has been used for those two calendar years.

IV. PATIENT CARE AREA GREENHOUSE GAS EMISSIONS

Results Summary

Patient Care Areas (PCAs) at Vanderbilt encompass hospital buildings and clinical buildings located on Vanderbilt's core 330 acres. Table 4.1 illustrates annual GHG emissions from PCAs for calendar years 2005 through 2013 and demonstrates that GHG emissions from PCAs have increased by less than one percent in the last year. Figure 4.1 shows that GHG emissions from PCAs have been reduced over 16 percent since an all-time high in 2008.

Calendar Year	GHG Emissions from EPA-Required Sources[18] ($MTCO_2E$)	Other Scope 1 Emissions[19] ($MTCO_2E$)	Scope 2 Emissions ($MTCO_2E$)	Scope 3 Emissions ($MTCO_2E$)	Total GHGs Emitted from Patient Care Areas ($MTCO_2E$)	Percent Decrease in GHGs Emitted from Previous Year
Patient Care Areas						
2005	53,606	5,864	78,170	41,620	**179,260**	**-**
2006	51,178	5,873	78,283	47,215	**182,548**	**-1.8%**
2007	58,054	5,632	76,486	49,786	**189,958**	**-4.1%**
2008	58,291	6,817	80,374	44,503	**189,985**	**-0.01%**
2009	62,565	5,716	63,193	44,420	**175,896**	**7.4%**
2010	55,882	5,026	64,350	45,497	**170,754**	**2.9%**
2011	52,877	5,416	63,580	47,516	**169,389**	**0.8%**
2012	51,638	7,878	54,327	44,494	**158,337**	**6.5%**
2013	54,273	6,384	53,042	46,050	**159,749**	**-0.9%**

Table 4.1. GHG Emissions from Patient Care Areas by Type, Calendar Years 2005-2013.

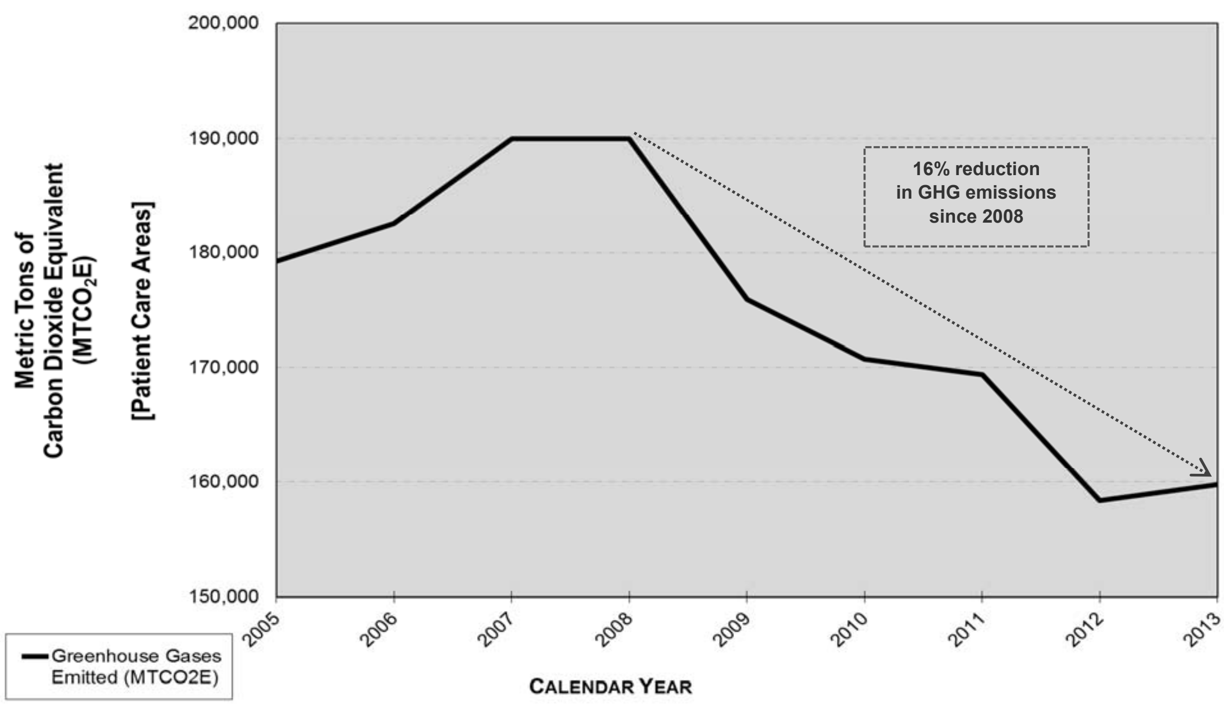


Figure 4.1. GHG Emissions from Patient Care Areas, Calendar Years 2005-2013.

---

[18] EPA-required sources includes coal-fired boilers, natural gas-fired boilers, and natural gas-fired turbines.
[19] Other Scope 1 Emissions sources include anesthetic gas use, emergency generators, fleet vehicles, and refrigerant releases.

For the calendar year 2013, major contributors to the emissions from PCAs are shown in Figure 4.2.

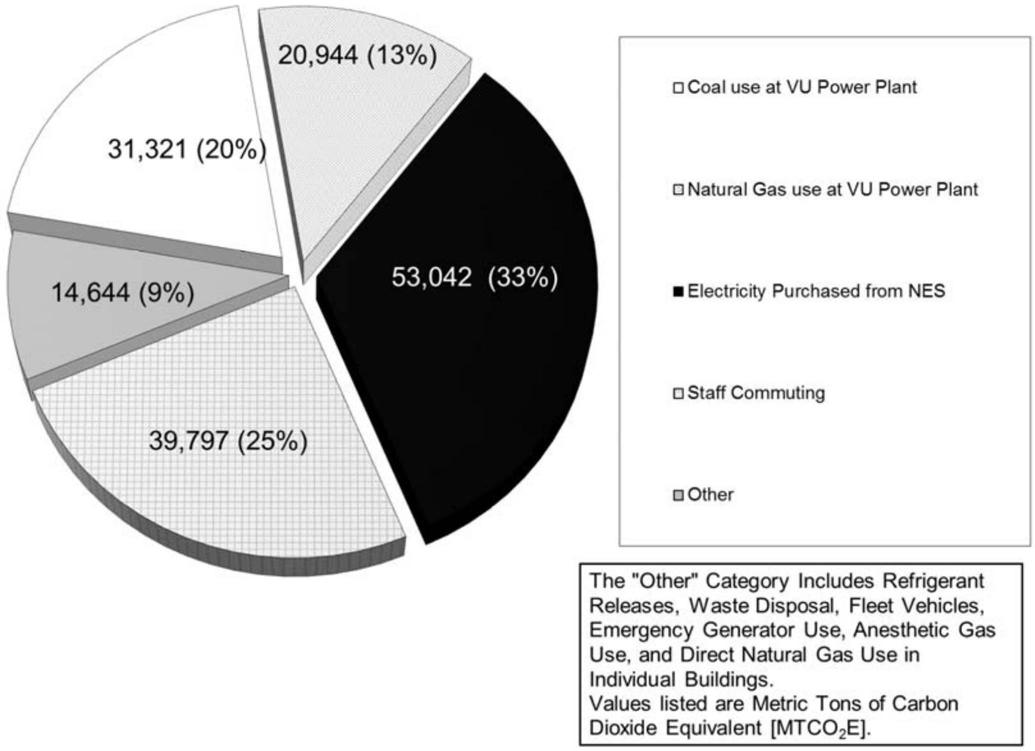


Figure 4.2. GHG Emissions Sources from Patient Care Areas, Calendar Year 2013.

Vanderbilt University PCAs were designated according to the criteria outlined in the Methodology section of the report. For PCA populations for 2013, please reference Table B.4 in the appendices.

Scope 1: EPA-Required Emission Sources

Individual building monthly steam and electricity usage for calendar years 2005 through 2013 revealed that approximately 35 percent of the steam and electricity consumed by Vanderbilt was consumed in Patient Care buildings. Therefore, 35 percent of the GHG emissions associated with the power plant were attributed to PCAs. In 2013, GHG emissions from EPA-required sources for PCAs amounted to 54,273 MTCO$_2$E, as shown in Table 4.2 below.

Calendar Year	Coal Use: Power Plant (MTCO$_2$E)	Natural Gas Use: Power Plant (MTCO$_2$E)	Natural Gas Use: Boilers in Individual Buildings (MTCO$_2$E)	Total VU GHG Emissions from EPA-Required Stationary Sources[20] (MTCO$_2$E)	GHG Emissions from EPA-Required Stationary Sources for Patient Care Areas (35 percent of previous column) (MTCO$_2$E)
2005	96,478	51,695	4,988	153,161	53,606
2006	99,582	38,485	8,155	146,222	51,178
2007	111,344	48,258	6,268	165,869	58,054
2008	102,172	51,358	13,017	166,547	58,291
2009	105,956	64,096	8,705	178,758	62,565
2010	92,090	62,835	4,738	159,663	55,882
2011	87,022	58,405	5,651	151,078	52,877
2012	85,968	56,798	4,770	147,536	51,638
2013	89,490	59,840	5,736	155,065	54,273

Table 4.2. Patient Care Areas GHG Emissions from EPA-Required Sources, Calendar Years 2005-2013.

[20] Emission factors taken from the EPA's *Mandatory Reporting of Greenhouse Gases; Final Rule* [40 CFR Part 98, Subpart C].

Coal and Natural Gas Use at the Power Plant

The on-campus, co-generation power plant currently burns coal and natural gas to produce electricity, steam and chilled water for distribution to buildings located on the 330-acre Vanderbilt campus, including Patient Care buildings. The burning of coal and natural gas releases carbon dioxide, nitrous oxide and methane. The inventory results illustrate that approximately 35 percent of the overall 89,490 $MTCO_2E$, or 31,321 $MTCO_2E$, are produced from coal use at the power plant for PCAs. This equates to 20 percent of the overall 2013 PCA emissions. Additionally, 35 percent of the 59,840 $MTCO_2E$ resulting from natural gas use, or 20,944 $MTCO_2E$, equates to 14 percent of the overall PCA emissions, as shown in Table C.1 of the appendices.

Natural Gas Use in Individual Buildings

Several Patient Care buildings use natural gas directly from Vanderbilt's natural gas supplier. The consumption of natural gas within individual Patient Care buildings accounts for 2,008 $MTCO_2E$ of 2013 emissions, as shown in Table C.1 in the appendices.

Vanderbilt's Power Plant – an Essential Part of Our Campus

Because Vanderbilt University Medical Center is a major regional Level 1 Trauma Medical Center and Children's Hospital, as well as housing for important experiments and research samples, it is essential to be powered by reliable, uninterruptable energy supply 24 hours a day, 7 days a week, 365 days per year, especially in the event of a widespread emergency or loss of power in the Nashville community. Because of the emergency needs required by our Medical Center, Vanderbilt will continue to have an on-campus power plant for many years to come.

Scope 1: Other Direct Emission Sources

Vanderbilt's direct emissions sources that are not required to be reported to the EPA are shown in Table 4.3, below. Emissions from emergency generators, fleet vehicles and anesthetic gas decreased during the 2013 calendar year. See Tables C.2, C.3, C.6 and C.7 in the appendices for more details.

Calendar Year	Diesel-powered Emergency Generators ($MTCO_2E$)	Refrigerant Releases ($MTCO_2E$)	Fleet Vehicles (Life Flight) ($MTCO_2E$)	Anesthetic Gas Use[21] ($MTCO_2E$)	GHG Emissions from Other Direct Emission Sources ($MTCO_2E$)
2005	296	189	2,206	3,174	**5,864**
2006	291	397	2,012	3,174	**5,873**
2007	447	131	1,880	3,174	**5,632**
2008	152	0	1,877	4,789	**6,817**
2009	212	0	1,608	3,896	**5,716**
2010	438	609	1,531	2,449	**5,026**
2011	315	98	1,643	3,360	**5,416**
2012	389	434	1,834	5,221	**7,878**
2013	281	745	1,655	3,703	**6,384**

Table 4.3. Patient Care Areas Scope 1 Emissions from Other Direct Sources, Calendar Years 2005-2013.

[21] Anesthetic gas for 2005 and 2006 is not readily available. 2007 data has been used for those two calendar years.

Scope 2: Purchased Electricity Emissions

53,042 $MTCO_2E$, or 34 percent of 2013 GHG emissions for PCAs, are attributed to electricity purchased, as shown in Table 4.4 below. This is the result of the amount of electricity purchased from NES and the mix of electricity generation methods employed by TVA. Electricity purchased by Vanderbilt is at its lowest level since 2007. See Tables C.8 and C.9 in the appendices for more details.

Calendar Year	Kilowatt-Hours Purchased (KwH)	Total VU Emissions ($MTCO_2E$)	Emissions Associated with PCA (35 percent of previous column) ($MTCO_2E$)
2005	294,070,522	223,343	78,170
2006	294,494,256	223,664	78,283
2007	287,734,887	218,531	76,486
2008	307,162,163	229,640	80,374
2009	305,308,699	180,553	63,193
2010	303,543,739	183,857	64,350
2011	313,049,916	181,657	63,580
2012	311,313,519	155,221	54,327
2013	299,441,016	151,549	53,042

Table 4.4 GHG Emissions from Purchased Electricity for Patient Care Areas, Calendar Years 2005-2013.

Scope 3: Indirect Emissions Sources

Vanderbilt's indirect emissions include commuter fuel use by staff members in Patient Care buildings, work-related air travel, and off-site waste disposal. Indirect emissions for PCAs for calendar years 2005 through 2013 are displayed below in Table 4.5 and Figure 4.3. Commuter travel emissions decreased by almost 10% in 2013. For the first time, airline travel paid for by Vanderbilt could be captured for PCA Staff through the new VU Travel Portal, Concur. For more details, see Tables C.16, C.17, C.18 and C.19 in the appendices.

VUMC Sustainability Committee

Made up of nurses, doctors, procurement staff, housekeeping staff and SEMO, VUMC initiated a sustainability committee in 2012 to address sustainability initiatives within the Medical Center. One of the first initiatives supported by the VUMC sustainability committee was the installation of occupancy sensors in operating rooms by VUMC Facilities and Construction to automatically power down the lighting and ventilation when the operating rooms are unoccupied.

Calendar Year	Waste Disposal Emissions ($MTCO_2E$)	Commuter Travel Emissions ($MTCO_2E$)	Air Travel Emissions* ($MTCO_2E$)	Total Scope 3 GHG Emissions for PCA ($MTCO_2E$)
2005	1,585	40,035	NA	41,620
2006	2,177	45,037	NA	47,215
2007	1,706	48,079	NA	49,786
2008	1,614	42,889	NA	44,503
2009	1,653	42,767	NA	44,420
2010	1,861	43,636	NA	45,496
2011	1,991	45,525	NA	47,516
2012	1,367	43,127	NA	44,494
2013	1,515	39,797	4,738	46,050

Table 4.5. Patient Care Areas Scope 3 GHG Emissions Sources, Calendar Years 2005-2013.
* Air travel for PCA staff was not available (NA) prior to 2013.

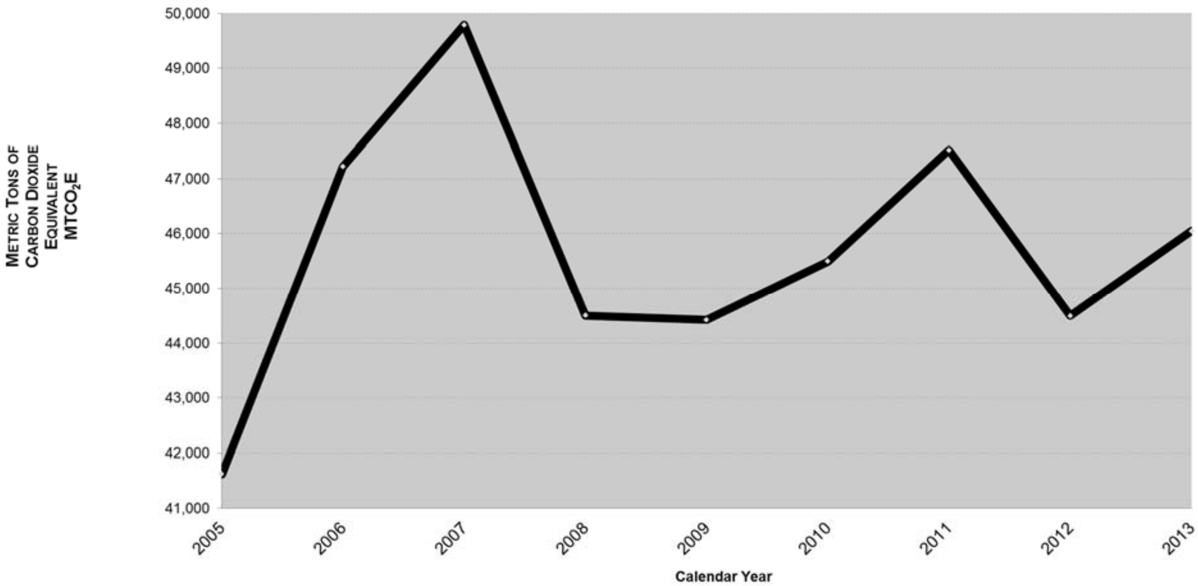
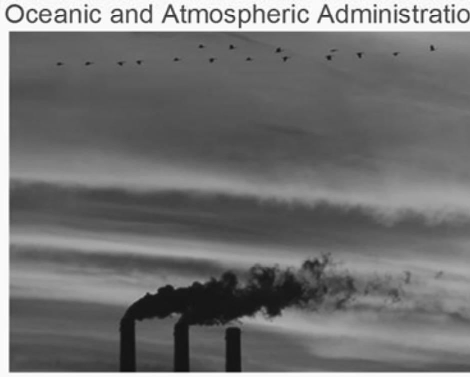


Figure 4.3. Patient Care Areas Scope 3 Emissions, Calendar Years 2005-2013.

Atmospheric Concentrations of Carbon Dioxide Reach Record-High Levels in 2013

Worldwide levels of the chief greenhouse gas that causes climate change, carbon dioxide, have hit a milestone, reaching an amount never before encountered by humans, according to federal scientists. Carbon dioxide was measured at 400 parts per million at the world's oldest CO_2 monitoring station, located in Hawaii. The last time the worldwide carbon level was that high was about 2 million years ago, said Pieter Tans of the National Oceanic and Atmospheric Administration (NOAA).



"It was much warmer than it is today," Tans said. "There were forests in Greenland. Sea level was higher, between 33 to 66 feet." Other scientists say it may have been 10 million years ago that Earth last encountered this much carbon dioxide in the atmosphere. The number 400 parts per million has been anticipated by climate scientists and environmental activists for years as a notable indicator.

Dr. Tans is head of NOAA's Greenhouse Gas Group, Earth System Research Laboratory. (http://www.esrl.noaa.gov/gmd)

V. INVENTORY SUMMARY

Vanderbilt University Emissions Summary

Vanderbilt University's greenhouse gas (GHG) emissions for calendar years 2005 to 2013 are presented in Table 5.1. Total annual GHG emissions for Vanderbilt University during the nine-year period reached a maximum of 503,327 Metric Tons of Carbon Dioxide Equivalent ($MTCO_2E$) in calendar year 2008. GHG emissions for 2013 show an 12 percent decrease in emissions since 2005 and a 17 percent from the all-time high in 2008, as shown in Figure 5.1.

Calendar Year	Academic & Research Areas ($MTCO_2E$)	Patient Care Areas ($MTCO_2E$)	Total GHGs Emitted by VU ($MTCO_2E$)	Percent Decrease in GHGs From Previous Year
2005	296,465	179,260	**475,725**	**-**
2006	295,825	182,548	**478,374**	**-0.6%**
2007	308,604	189,958	**498,562**	**-4.2%**
2008	313,341	189,985	**503,327**	**-1.0%**
2009	288,343	175,896	**464,240**	**7.8%**
2010	284,506	170,755	**455,261**	**1.9%**
2011	272,229	169,389	**441,618**	**3.0%**
2012	251,669	158,337	**410,006**	**7.2%**
2013	259,943	159,749	**419,692**	**-2.4%**

Table 5.1. Total Vanderbilt GHG Emissions, Calendar Years 2005-2013.

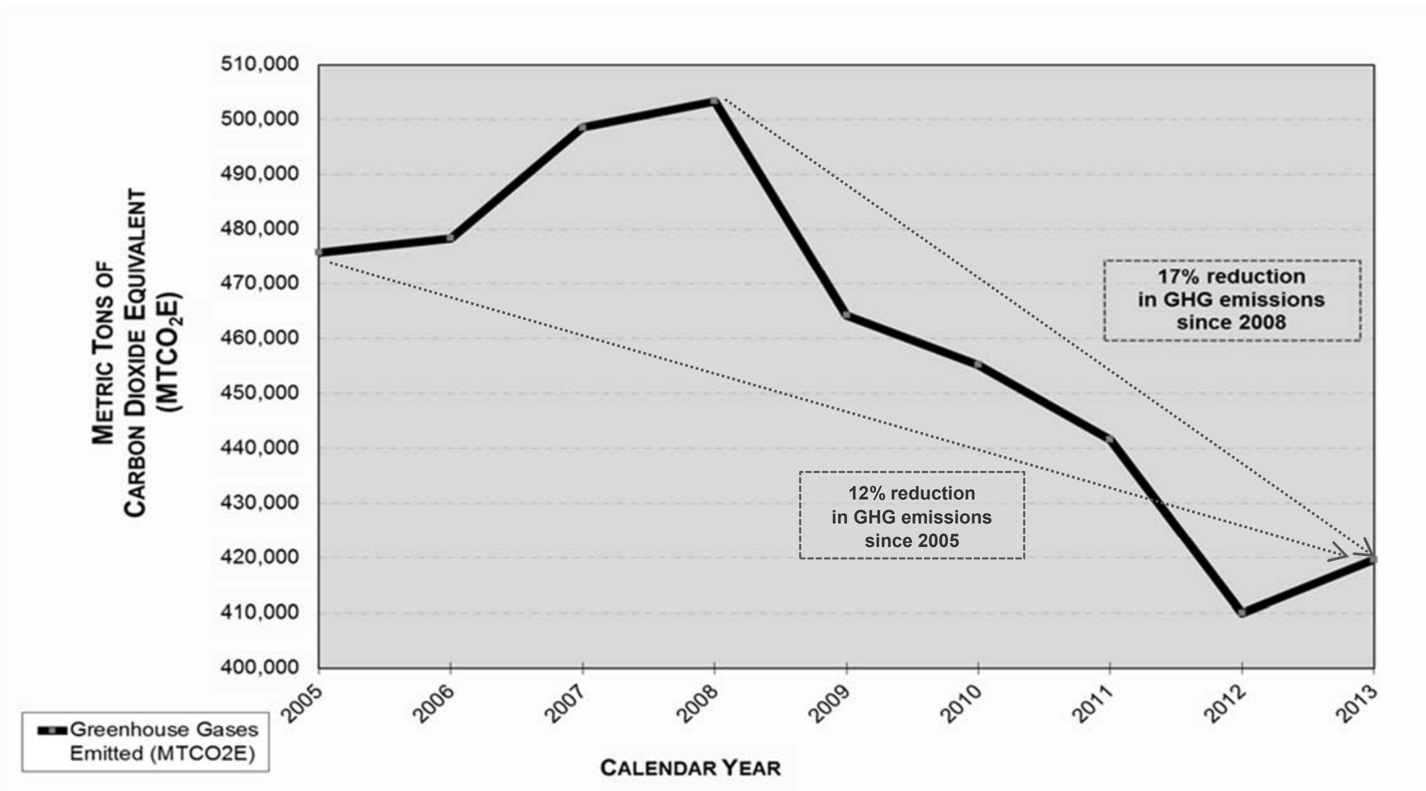


Figure 5.1. Total Vanderbilt GHG Emissions, Calendar Years 2005-2013.

As demonstrated in Figure 5.2, major contributors to Vanderbilt GHGs include purchased electricity (36 percent), coal use at the power plant (21 percent), faculty and staff commuting (20 percent) and natural gas use at the power plant (14 percent).

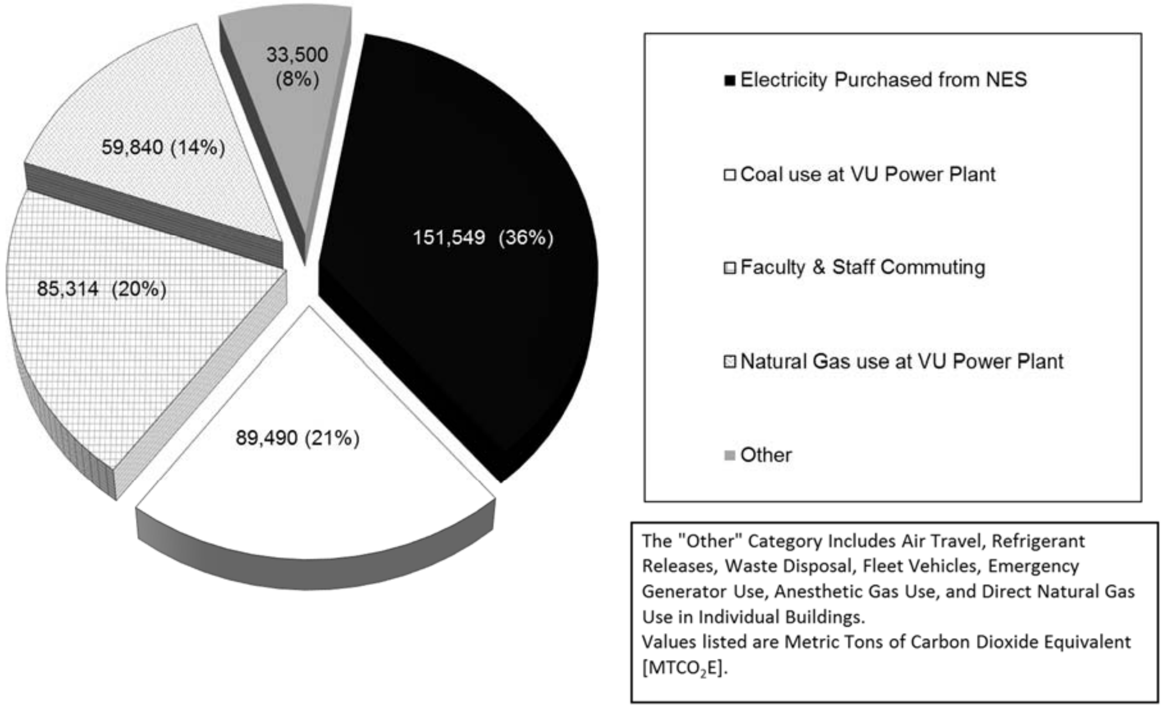


Figure 5.2. GHG Emissions Sources, Calendar Year 2013.

For calendar year 2013, Vanderbilt University emissions from Environmental Protection Agency (EPA)-required sources amounted to 155,065 $MTCO_2E$. In calendar year 2013, purchased electricity, coal and natural gas use at the on-campus co-generation power plant and commuter travel were the most substantial sources of GHG emissions, accounting for 92 percent of annual GHG emissions from Vanderbilt University as indicated in Figure 5.2. These major sources present the most significant opportunities for improvements in Vanderbilt University's carbon footprint. Thus, Vanderbilt initiated a significant infrastructure improvement project in 2013 to convert VU's on-campus power plant to all-natural gas.

Overall GHG emissions typically increase as college campuses grow, even if buildings are being used more efficiently or the campus community is working to conserve resources. It is important to account for this growth when evaluating GHG emissions data by analyzing the emissions data in relation to pertinent institutional metrics, such as campus population, student enrollment, gross square feet of building space, research dollars awarded or patient visits. Growth has a very positive impact on Vanderbilt and Middle Tennessee; so normalization of GHG emissions based on these metrics can allow for periodic comparisons and evaluation for improvements in efficiency and conservation while also accounting for the growth of the university.

Analysis and Interpretation of 2005-2013 Trending Results

Between 2005 and 2013, Vanderbilt University's GHG emissions have decreased by:

12 percent overall

27 percent per person on campus

31 percent per inpatient day

35 percent per 1,000 research dollars awarded

54 percent per ambulatory visit

24 percent per 1,000 square feet of building space

22 percent per student

Overall GHG emissions are down 17 percent from the all-time high reached in 2008, even though square footage has increased by 6.5 percent, or by almost one million square feet, since 2008. Between 2005 and 2013, Vanderbilt University's GHG emissions have decreased by 24 percent on a per gross 1,000 square foot basis, by 27 percent on a per person basis, by 22 percent per student and by 35 percent per 1,000 research dollars awarded to VU. Considering that Vanderbilt on-campus buildings have increased by 2.5 million square feet since 2005, total population has increased by over 5,000 people since 2005, and research dollars awarded has increased by $161 million since 2005, it is clear that VU Plant Operations, Campus Planning and Construction and VUMC Facilities and Construction are significantly improving the energy efficiency of Vanderbilt's buildings in the midst of continued growth. Please see Figures 5.3 through 5.8 below for more details.

VANTAGE Laboratory Achieves LEED GOLD Certification

The VANderbilt Technologies for Advanced GEnomics (VANTAGE) laboratory, located in the basement of Medical Center North, achieved LEED (Leadership in Energy and Environmental Design) Gold Certification from the U.S. Green Building Council in 2013, making it the14th certified project and the first laboratory renovation to achieve LEED certification at Vanderbilt. VANTAGE is a genomics core laboratory occupying over 15,800 square feet. It is home to the Flow Cytometry Core, Genome Sciences Resource, DNA Resources Core and BioVU, Vanderbilt's massive DNA database. Laboratory spaces are complex and difficult to renovate to LEED's green standards, so achieving the Gold level of certification is a significant accomplishment for VUMC's Space and Facilities Planning department.

Highlights from the renovation include a 20% reduction in lighting energy usage with more than 75% of lighting controls connected to occupancy sensors, a 38% reduction in water usage achieved through plumbing fixture upgrades, and 100% of eligible, newly purchased equipment is ENERGY STAR rated. During the renovation of the laboratory, 73% of construction waste was diverted from the landfill and recycled, 11% of the total building materials now contain recycled content, and 32% of the total building materials used were manufactured regionally. Also, most workstations now have individual controls for thermal and lighting comfort allowing lab staff to adjust to their preferred settings in their own workspace.

Emissions per Gross Square Foot

Calculating GHG emissions per gross square foot (GSF) of space provides a normalized method of interpreting emissions in light of Vanderbilt's size and building energy efficiency. Heating and cooling building space, which requires large amounts of energy, results in significant GHG emissions. A single calculation was made based on all Vanderbilt University facilities, totaling over 15 million square feet. For more details on Figure 5.3, please refer to Table B.3 in the appendices.

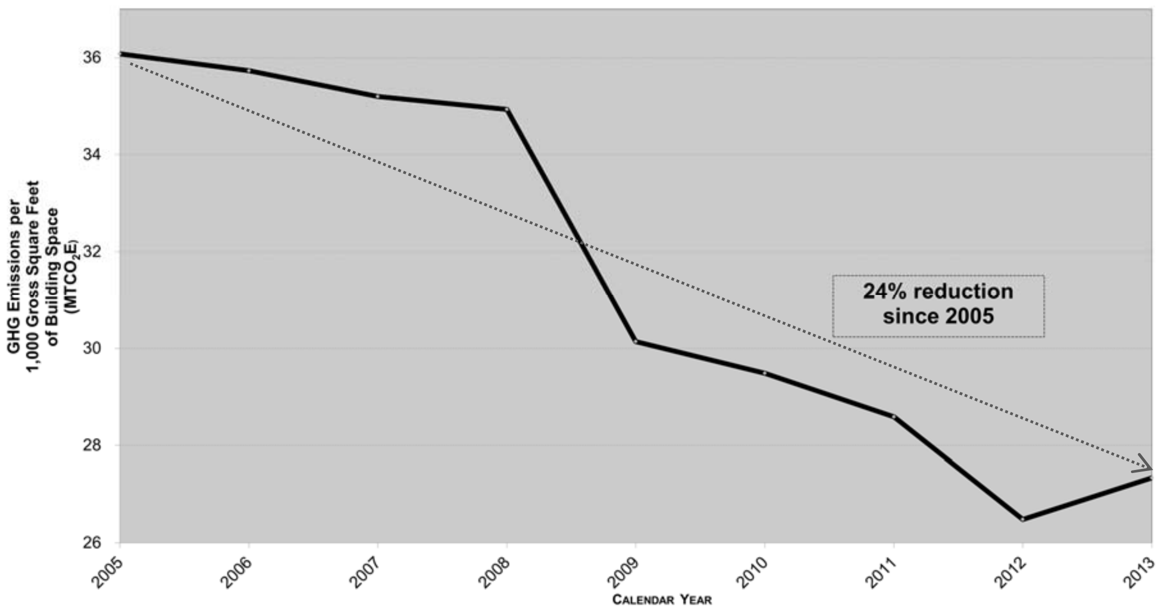


Figure 5.3. Total Vanderbilt GHG Emissions per 1,000 GSF, Calendar Years 2005-2013.

Emissions per Person

The size of the student population and faculty/staff population also directly influence the amount of GHGs emitted from Vanderbilt. More individuals on campus result in more building occupants using electricity and heating/cooling, increased amounts of waste generation and more commuters. For additional information on Figure 5.4 and 5.5, please reference Tables B.1 and B.3 in the appendices.

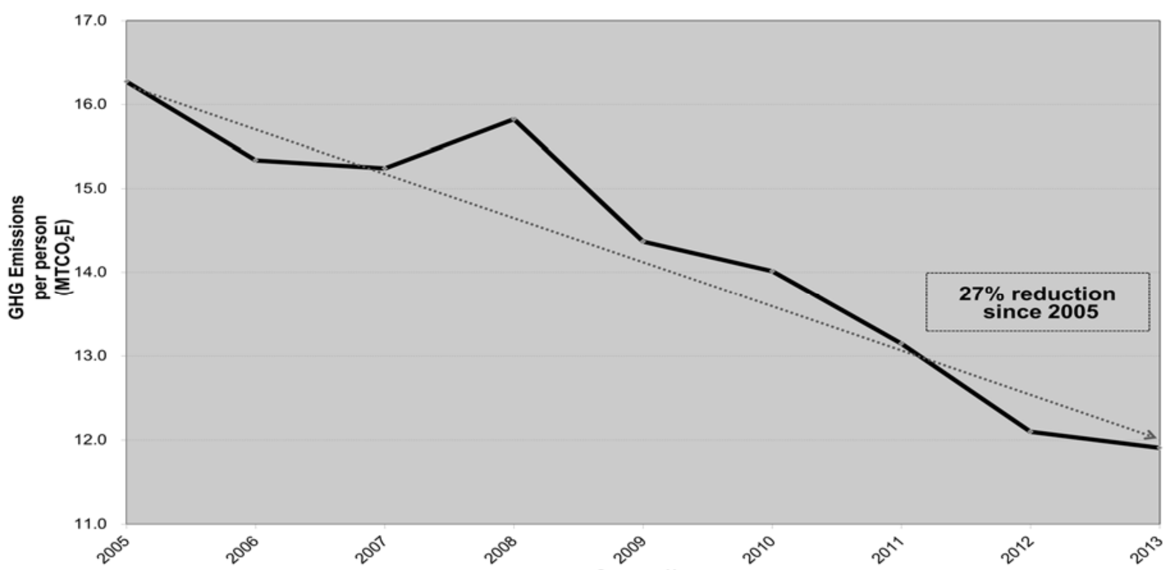


Figure 5.4. Total Vanderbilt GHG Emissions per Person, Calendar Years 2005-2013.

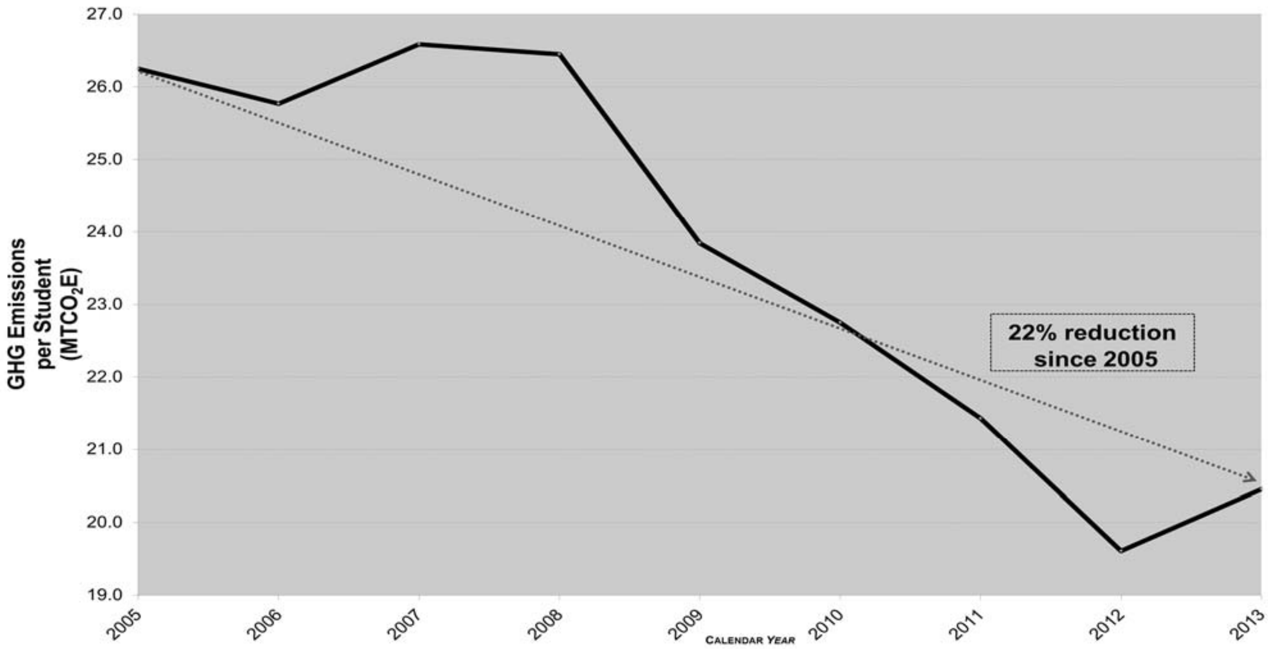


Figure 5.5. Vanderbilt Academic and Research Area GHG Emissions per Student, Calendar Years 2005-2013.

Emissions per Research Dollars Awarded

Conducting research and operating laboratory facilities require large amounts of energy. The typical laboratory uses four to five times more energy than an equivalent-sized office or classroom[22]. Universities receiving substantial amounts of research dollars (like Vanderbilt) use those dollars to operate laboratories and advanced technology to make scientific discoveries that benefit humankind. These activities can increase GHG emissions on a per-person basis and a per-square-foot basis because of energy-intensive research activities. For more details on Figure 5.6, please reference Table B.1 in the appendices.

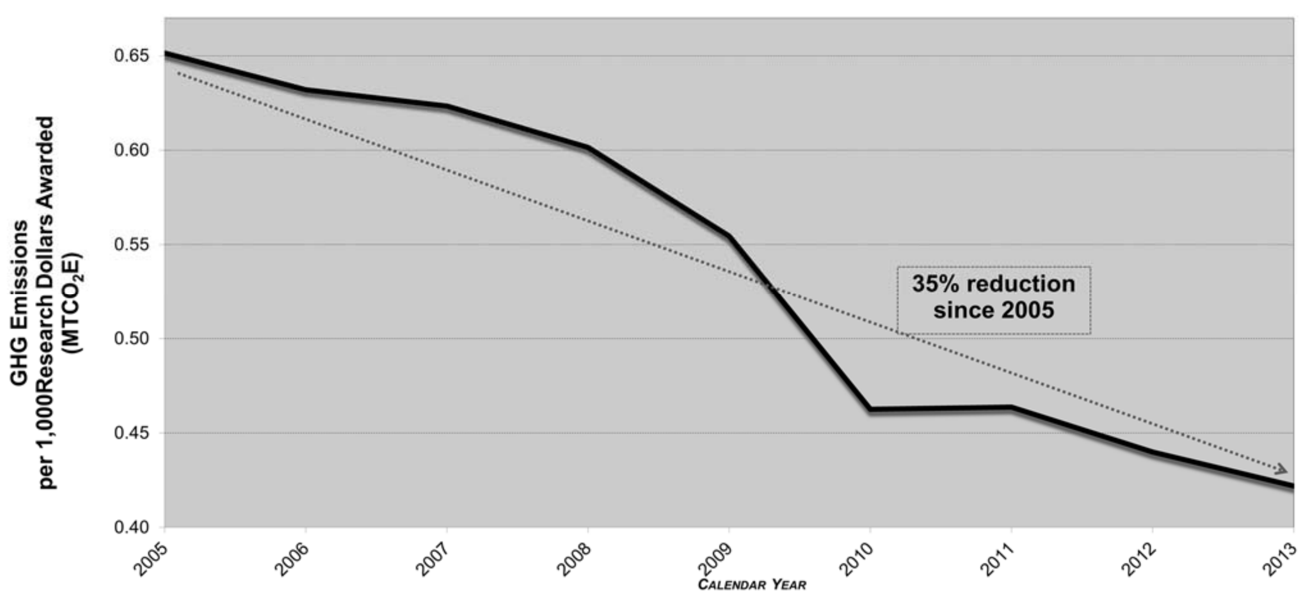


Figure 5.6. Vanderbilt ARA GHG Emissions Per 1,000 Research Dollars Awarded, Calendar Years 2005-2013.

[22] Avimm, D. (2007). This Man Wants to Green Your Lab. *Science*, v.318, 39-41.

Emissions per Inpatient Day and Ambulatory Visit

Patient care facilities, such as the Vanderbilt University Medical Center, that provide health care 24 hours per day, 7 days per week, 365 days per year, can substantially contribute to GHG emissions. Few universities have on-campus patient care activities that match the size and extent of operations of Vanderbilt University Medical Center. Thus, calculating GHG emissions per inpatient day and ambulatory (clinic) visit as presented in Figures 5.7 and 5.8, provides a means of interpreting emissions while considering the quality and magnitude of our medical operations on campus. For more details, please reference Table B.2 in the appendices.

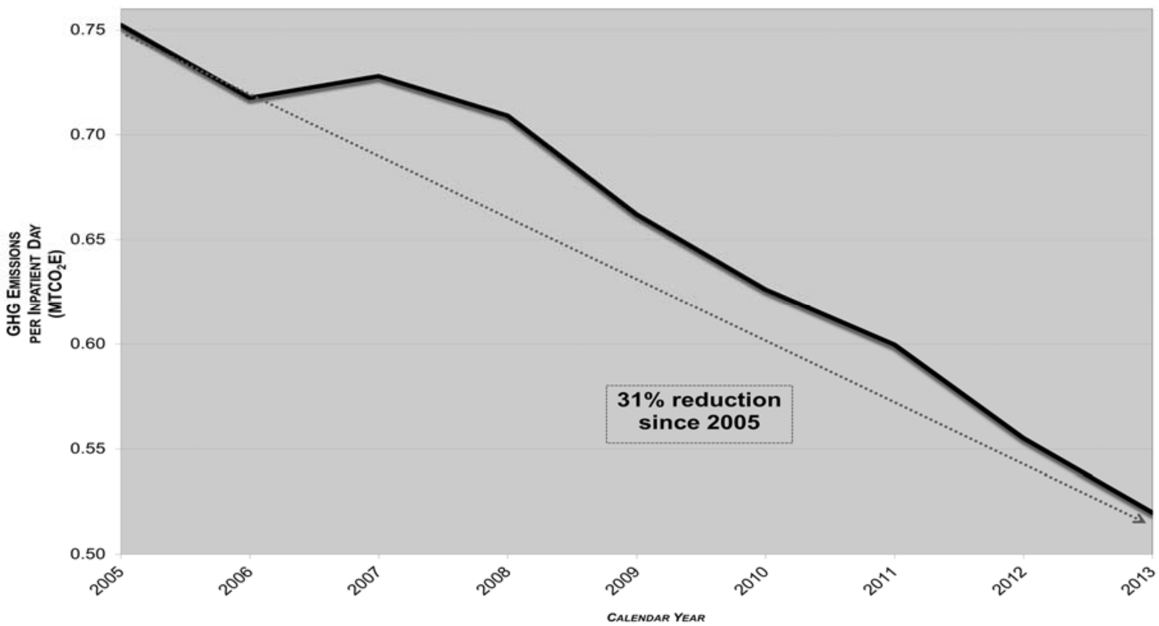


Figure 5.7. Vanderbilt Patient Care GHG Emissions per Inpatient Day, Calendar Years 2005-2013.

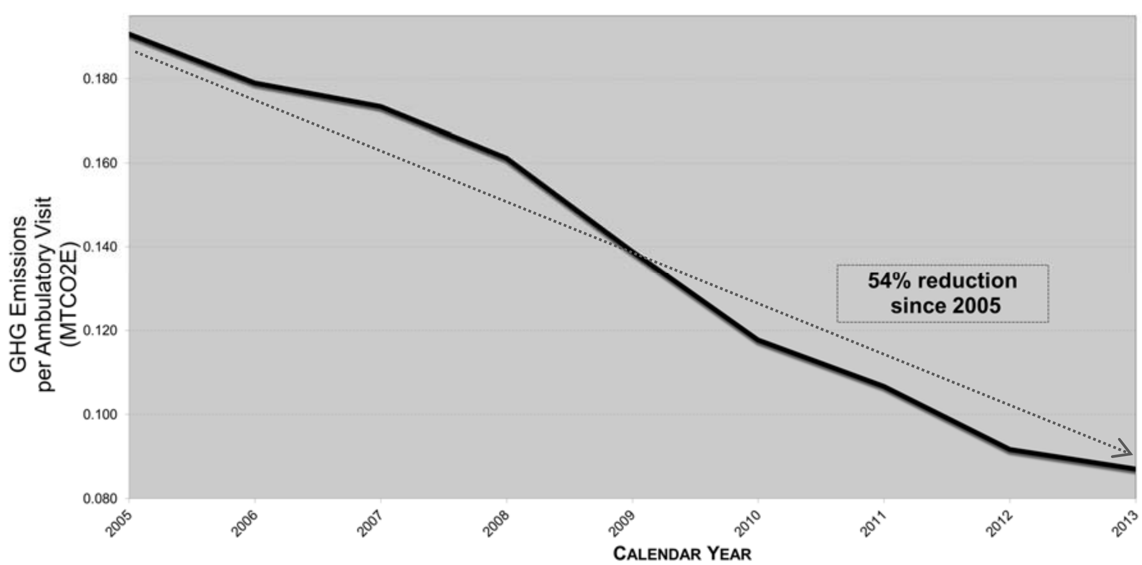


Figure 5.8. Vanderbilt Patient Care GHG Emissions per Ambulatory Visit, Calendar Years 2005-2013.

This nine-year analysis illustrates that Vanderbilt University's GHG emissions are trending in the right direction, both overall and when normalized by all important institutional metrics. Despite 2013 being named one of the hottest years on record, GHG emissions continued to decrease for many of these metrics. Overall GHG emissions did uptick slightly (by 2%) in 2013 due to a shift in increased on-campus fuel use and decreased purchased electricity in order to save money coupled with better tracking of Vanderbilt-funded airline travel for faculty, staff and students. However, emissions will continue to decrease as the power plant conversion is completed in 2014.

Interpreting Vanderbilt's Results Compared to Other Universities

There are over 2,800 colleges and universities offering Bachelor's and advanced degrees in the United States[23]. Only a small portion of these universities have completed GHG inventory reports and made them publicly available. Thus, Vanderbilt has acted proactively by taking this step forward. Additionally, most university GHG inventory reports do not include research and/or patient care activity, making Vanderbilt's report more comprehensive than most.

While reports exist for a small number of Vanderbilt's peer institutions, drawing comparisons between universities is difficult. Each school has its own defining characteristics and mix of variables even within the shared, primary emissions' attributes. Thus, often the most useful standard to which Vanderbilt can accurately compare its GHG emissions from year to year is its own previous emissions inventory, utilizing consistent interpretations as presented in this report.

The authors recognize the tendency to place VU's results in context with those of other universities. At Vanderbilt, several factors should be considered when comparing VU's GHG emissions to others:

- 89 percent of Vanderbilt undergraduate students live in on-campus residence houses, which are supplied with centralized utilities such as chilled water, heat, electricity and air conditioning. Colleges and universities with larger commuter populations and/or off-campus housing would have potentially smaller Scope 1 emissions and larger Scope 3 emissions.
- Vanderbilt was awarded $616 million[24] in 2013 (a $44 million increase from 2012) to conduct scientific and medical research, with a majority of the research occurring in laboratories. Vanderbilt University has over 800 research laboratories which are large consumers of energy through the operation of lab equipment such as fume hoods, biosafety cabinets, computers, and autoclaves (four to five times that of the same size office or classroom[25]).
- The Vanderbilt University Medical Center provides regional health care 24 hours per day, 7 days per week, 365 days per year. Very few universities have on-campus patient care that matches the size and extent of operations of Vanderbilt Medical Center. Moreover, universities that *do* have an associated medical center often exclude their medical centers from their GHG inventory. Due to Vanderbilt's small physical footprint and connected medical center and campus buildings, an omission of patient care buildings was not seen as appropriate.

[23] Information obtained from the Department of Education's National Center for Education Statistics IPEDS Data Center at http://nces.ed.gov/ipeds/datacenter/Default.aspx on October 1, 2014. Search included public and private 4-year schools awarding Bachelor's and Advanced degrees. Search excluded 2-year schools awarding Certificate and Associate's degrees. Including the latter, there are over 7,100.
[24] According to data found in ReVU: Quick Facts about Vanderbilt. Accessed December 2013. Available at www.vanderbilt.edu/facts.html.
[25] Avimm, D. (2007). This Man Wants to Green Your Lab. *Science*, v.318, 39-41.

As discussed above, the most common methods for reporting GHG emissions is to analyze GHG emissions based on institutional metrics (GSF, full-time student enrollment, total campus population, research awards, inpatient days and ambulatory visits). Because efforts to draw comparisons are inevitable, we attempted to determine how Vanderbilt's calendar year 2013 GHG emissions compared from the limited number of colleges and universities having such data available, as listed in Table 5.2; these universities were selected based upon one or more of the following measures:

- The university completed and published a GHG inventory;
- Similar climate and/or geographic location;
- Similar operational size;
- Similar campus population size;
- Similar activities (i.e., research and patient care);
- Inclusion of Scope 1, Scope 2 and Scope 3 emissions sources; and/or
- Comprehensiveness of emissions inventory.

Additional information on the peer institutions listed below is provided in Table B.13 in the appendices.

University	Total Emissions ($MTCO_2E$)	Emissions per 1,000 Square Feet	Emissions per Student	Emissions per $1,000 Research Awarded
University of Michigan[26]	709,982	21.98	16.35	0.53
Duke University – Campus Only[27]	243,026	18.93	16.28	0.22
Washington University – St. Louis[28]	296,000	74.59	20.97	0.54
Emory University[29]	305,007	33.89	21.00	0.60
University of Pennsylvania[30]	288,945	21.92	11.75	0.35
Vanderbilt University – Academic & Research Areas Only[31]	259,943	28.50	20.50	0.42

Table 5.2. Comparison of Vanderbilt University GHG Emissions with Other Universities.

As previously mentioned, conducting research and operating laboratory facilities require large amounts of energy and therefore increase GHG emissions on a per-person basis and a per-square-foot basis. When compared to other major research institutions, Vanderbilt's GHG emissions compare quite well, with the 2nd lowest overall emissions and one of the lowest emissions per research dollar awarded. Figures 5.9 and 5.10 illustrate Vanderbilt's GHG emissions and GHG emissions per $1,000 in research awarded in relation to several other research entities.

---

[26] GHG emissions, GSF, and student, faculty, and staff populations for FY 2013 retrieved from 2013 Annual Sustainability Report, http://sustainability.umich.edu/report/2013/#ourcommitment_two.php, GSF, and student, faculty and staff populations for FY 2013 retrieved from 2013 U-M Facts and Figures, http://digital.turn-page.com/i/197688.
[27] GHG emissions, GSF, and student, faculty, and staff populations for 2013 as reported to ACUPCC, http://rs.acupcc.org/progress/383/. 2013 research dollars retrieved from https://finance.duke.edu/resources/docs/financial_reports.pdf.
[28]. 2013 Data retrieved from http://wustl.edu/about/annualreport/_assets/pdf/WUSTL_Annual_Report_2013.pdf
[29] Emissions data for 2012 from http://sustainability.emory.edu/html/dashboard/other-ghg-sources.html. University student population and 2012 research dollars from 2013 Academic Profile,http://www.emory.edu/home/about/factsfigures/index.html.
[30] GHG emissions, GSF, and student populations for 2013 from ACUPCC's website at http://rs.acupcc.org/ghg/1516/ and http://www.upenn.edu/about/facts.php.
[31] GHG emissions for CY 2013 from ARAs only.

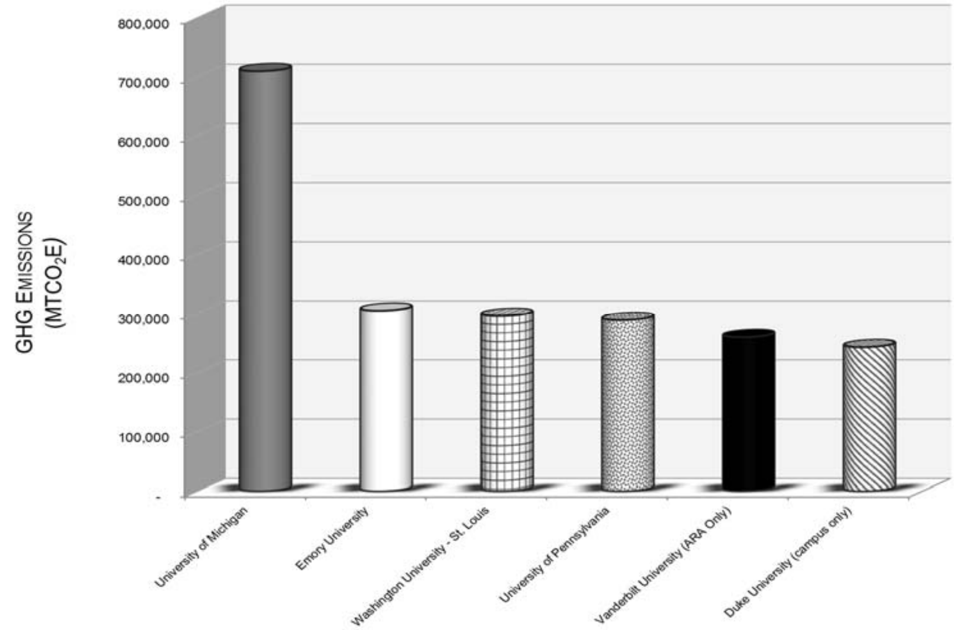


Figure 5.9. Comparison of Vanderbilt University GHG Emissions with Other Universities.

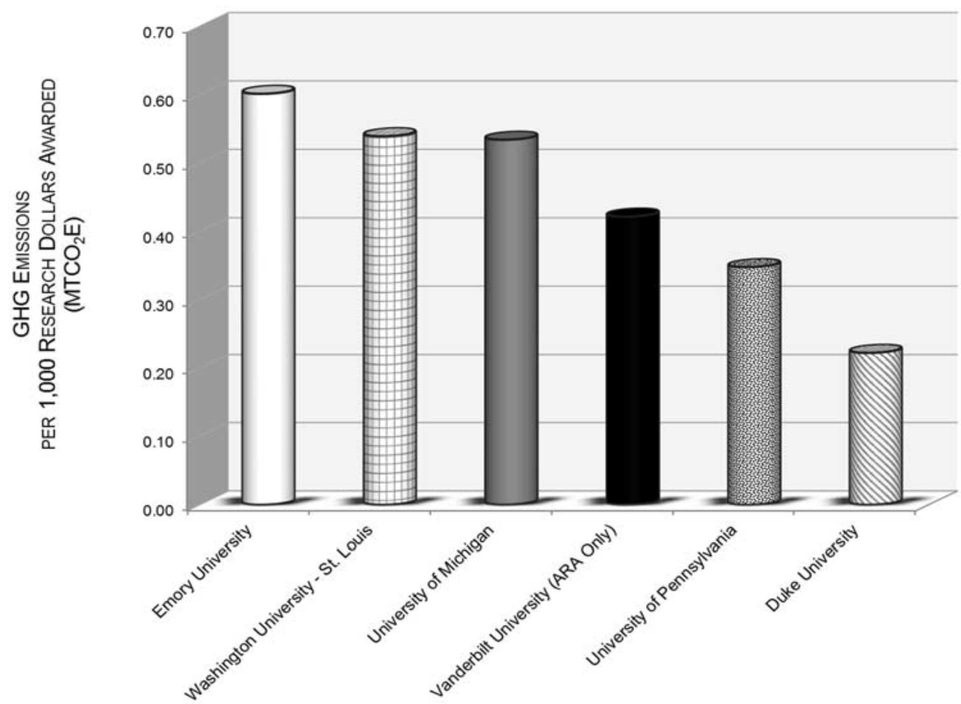


Figure 5.10. Comparison of Vanderbilt University GHG Emissions with Other Universities, by Research Dollars Awarded.

Vanderbilt University recognizes its comparisons to peers; however, GHG inventory reports have been completed and made publicly available for only a small number of universities. Moreover, many GHG inventory reports do not include research and/or patient care activity, making Vanderbilt's report more inclusive than most that have been published. Direct evaluations between universities are challenging, as each school possesses unique qualities and features and as there is currently no standardized methodology for calculating university carbon footprints. Therefore, our own emissions presented in this report provide the only applicable standard to which Vanderbilt can accurately assess its GHG emissions in years past and the years to come.

This inventory, as well as previous ones, provides historical data and trending information that has enabled campus stakeholders to have sufficiently detailed information to make informed decisions to determine reduction strategies and compare future improvements in GHG emissions on campus. As the positive downward trend of GHG emissions indicates, VU is substantially investing in improving its carbon footprint. To monitor this positive progress, subsequent annual calculations of emissions will be conducted in the future and will be made publicly available.

Suggestions on how the University community can continue to reduce its energy consumption can be found at Vanderbilt's ThinkOne website[1]. Specific energy conservation information for patient care areas, research areas, offices and classrooms and residence halls can be found at ThinkOne and are a significant, no-cost first step in reducing Vanderbilt's carbon footprint. The most cost-effective and environmentally-friendly way to reduce our use of nonrenewable energy sources is to first reduce our demand for energy. The kilowatt not needed is the most environmentally-friendly kilowatt of all. It will take the entire Vanderbilt community working together to reduce Vanderbilt's reliance on nonrenewable energy sources.

The SustainVU website also has information on Vanderbilt's green building program, efforts to improve energy and water efficiency in existing buildings, commuter choice programs, waste and recycling initiatives and academic research related to GHG emissions, all of which contribute to reductions in institutional emissions. All information related to Vanderbilt's GHG emissions reports and future updates and commitment statement will be publicly available on this site.

Did You Know?

Vanderbilt doubled the amount of recycled materials from 3 million pounds in 2011 to 6 million pounds in 2013!

Waste-hauling trucks that service Vanderbilt run on clean-burning natural gas as of 2013.

[1] The ThinkOne website may be accessed at http://www.vanderbilt.edu/sustainvu/thinkone.

APPENDIX A: INVENTORY DEVELOPMENT METHODOLOGY

Boundary Definitions

Prior to conducting the first Vanderbilt GHG inventory, the operational, spatial and temporal boundaries of the inventory were firmly defined. Furthermore, a GHG calculation protocol was established prior to gathering the data for this GHG inventory.

Operational Boundary

Activities at Vanderbilt University that produce GHG emissions include those outlined by the EPA's *Mandatory GHG Reporting Rule* [40 CFR Part 98][2], as well as The American College & University Presidents Climate Commitment (ACUPCC) Implementation Guide (2009)[3]. The boundaries established by the ACUPCC Implementation Guide rely heavily on the methodology established by the World Resources Institute Greenhouse Gas Protocol[4]. As noted by the World Resources Institute (WRI), "identification of operational boundaries helps institutions to categorize their sources of emissions, providing accountability and the prevention of 'double counting'."

The EPA defines GHG emissions as required under the *Mandatory GHG Reporting Rule* as follows:

- EPA-Required Stationary Sources: Scope 1 – Direct Sources. These are emissions produced by stationary sources that are under direct control of the institution. Vanderbilt's EPA-required stationary sources include coal and natural gas consumption at the on-campus power plant and consumption of natural gas within individual buildings at Vanderbilt.

Throughout this report, the WRI definition of Scope 1 sources will be utilized to capture all other direct source emissions not included in the EPA-required stationary sources definition:

- Other Scope 1: Non-EPA Direct Sources. The remaining Scope 1 emissions that are not designated as stationary sources by the EPA are emissions produced by activities that are under direct control of the institution. Vanderbilt's other Scope 1 emissions include fuel consumption by University-owned vehicles, releases of refrigerants and anesthetic gases and fuel consumed by Vanderbilt-owned emergency generators.

The WRI Greenhouse Gas Protocol[5] categorizes GHGs into Scopes 2 and 3 as follows:

- Scope 2: Indirect Emissions from Electricity Purchases. These are emissions associated with the generation of electricity that is purchased by Vanderbilt. Scope 2 emissions physically occur at power-generation facilities owned by Vanderbilt's electricity supplier and not at the Vanderbilt campus itself. Vanderbilt purchases 77 percent of the electricity needed to supply campus operations.

---

[2] http://www.epa.gov/ghgreporting/
[3] www2.presidentsclimatecommitment.org/pdf/ACUPCC_IG_Final.pdf
[4] Ohndorf, M. & Gillenwater, M. (2003). "Measurement and Estimation Uncertainty of Greenhouse Gas Emissions." World Resources Institute. Available http://www.ghgprotocol.org/calculation-tools/all-tools.
[5] http://www.ghgprotocol.org/

- Scope 3: Indirect Emissions by Individuals at Vanderbilt. These are emissions that result from activities by individuals in the Vanderbilt community but are not under the direct control of the University. Scope 3 emissions include fuel use by commuters (faculty, staff and student commuters), fuel use from air travel and off-site waste disposal.

GHG emissions associated with the production and delivery of goods and services to Vanderbilt (i.e. “upstream” emissions) were not included in this inventory.

Spatial Boundary – Academic Research Areas, Patient Care Areas

Vanderbilt University is a diverse institution, providing regional health care while simultaneously pursuing robust academic endeavors. As such, this report provides a subtotal of GHG emissions associated with Academic Research Areas (ARAs), which are traditional academic university endeavors, and a separate subtotal for emissions associated with Patient Care activities. The contrast in the activities in these two areas is worth noting: Patient Care Areas (PCAs) provide medical care on a continuous basis, while activities in ARAs are associated with an academic calendar. ARAs include academic and administrative buildings, residence halls, athletics facilities, parking garages, common space/multi-purpose areas and laboratory research space, while PCAs include hospitals, clinics and patient and visitor parking garages.

The typical definition of Vanderbilt University’s “core campus” is the University property that is bounded by Blakemore Avenue to the south, West End Avenue to the northwest and 21st Avenue South to the east. The Peabody Campus at Vanderbilt is also part of the core 330 acres of Vanderbilt. The Peabody Campus is bounded by 21st Avenue South to the west, Edgehill Avenue to the north, 18th Avenue South to the east and Capers Avenue to the south. These two areas encompass the majority of the academic, residential, research and patient care buildings associated with Vanderbilt, and the buildings located within this core 330 acres are serviced by Vanderbilt’s on-campus power plant. The core VU campus contains over 230 buildings, encompassing over 15 million gross square feet of space.

Buildings that are classified as Patient Care buildings include Vanderbilt University Hospital, The Vanderbilt Clinic, Vanderbilt Children’s Hospital & Doctor’s Office Tower, Psychiatric Hospital at Vanderbilt, Vanderbilt-Ingram Cancer Center, Vanderbilt Eye Center, Free Electron Laser Building, Medical Center East (North Tower), Zerfoss Health Center, Oxford House, Dayani Center, Central Garage, East Garage, South Garage, Children’s Way Garage, Medical Arts Building, Medical Center East II (South Tower) and 40 percent of Medical Center North. All other buildings on the “core” 330 acre campus are considered ARAs.

Off-site buildings, such as medical clinics located elsewhere in Tennessee, were not included in this inventory. A few buildings located within the core 330 acres of the Vanderbilt campus (approximately 3 million gross square feet of space) are not under the direct operational control of the University and do not receive utility services from Vanderbilt;

therefore, these buildings were not included in this GHG inventory. Such buildings include the Veteran's Administration Hospital, Stallworth Rehabilitation Hospital, the 2525 Building located on West End Avenue, the Marriott Hotel & parking garage on West End Avenue and the Village at Vanderbilt Apartments and Townhomes.

Temporal Boundary

The purpose of this inventory is to establish a history of Vanderbilt's annual GHG emissions that can serve as a guide for future GHG-emitting reductions. Using the total GHG emissions from a single fiscal or calendar year as a focal point would not accurately represent a 'typical' year of activity at Vanderbilt University due to annual fluctuations in emissions caused by commissioning new buildings, changes in faculty/staff/student populations and seasonal/climatic variations from year to year - all of which have a direct bearing on Vanderbilt's GHG emissions for a particular year. In an effort to capture these "peaks & valleys" in activities at Vanderbilt, this nine-year inventory establishes the annual GHG emissions created by Vanderbilt during the 2005 through 2013 calendar years.

Greenhouse Gas Data Collection and Inventory Methodology

On-Campus Energy Production

Vanderbilt's sources of GHG emissions that are under direct control of the University include the consumption of coal and natural gas at the on-campus, co-generation power plant, natural gas-fired boilers and heaters located in various Vanderbilt buildings, and diesel fuel consumed in Vanderbilt's emergency generators. Annual consumption of coal and natural gas at the on-campus, co-generation power plant and natural gas by individual buildings was provided by Plant Operations and input into formulas provided by the EPA for calculation of annual GHG emissions. Annual consumption of diesel fuel by individual emergency generators was also provided by Plant Operations and input to the Clean Air – Cool Planet Campus Carbon Calculator™ to compute annual GHG emissions.

University-Owned Vehicles

Vanderbilt University owns over 320 vehicles. Some departments at Vanderbilt purchase their own fuel in bulk and track dispensing of that fuel (i.e., Plant Operations), while others purchase their fuel from local retail stations. Departments that track their fuel use provide their annual fuel usage, and that data is directly input into the Campus Carbon Calculator. Fuel dispensed to Vanderbilt shuttle buses and vans is recorded monthly by Vanderbilt University Medical Center (VUMC) Parking and Transportation Services and is included in this inventory.

Some University-owned vehicles at Vanderbilt purchase their fuel at local retail stations using a VU Procurement Card, and the volume of fuel purchased is *not* recorded by the vehicle manager. For this portion of University-owned vehicles, two assumptions were made in order to estimate the approximate annual fuel use for these vehicles: (1) a University-owned vehicle averages 4,500 miles a year (based on the vehicle-miles logged by the vehicle manager for VU Information Technology), and (2) a University-owned vehicle gets 24 miles per gallon which the default value provided in the Clean Air – Cool Planet Campus Carbon Calculator™. From this, the gallons of fuel consumed by these vehicles was calculated and input into the Campus Carbon Calculator.

Annual consumption of fuel by Vanderbilt's LifeFlight helicopters is reported by VUMC Facilities and Construction. GHG emissions associated with LifeFlight's use of Jet-A fuel were calculated using an emission factor from WRI's Greenhouse Gas Protocol[6].

Anesthetic Gases

Vanderbilt uses anesthetic gases in both PCAs and in animal care areas and research laboratories; however, different types are used for animals and humans. Purchase records for anesthetic gas were provided by VUMC's Department of Anesthesiology and Vanderbilt's Division of Animal Care. The Campus Carbon Calculator does not provide Global Warming Potentials (GWP) for all anesthetic gases, since most universities use little to no anesthetic gas. Vanderbilt's GHG emissions from anesthetic gas use were calculated based on GWPs provided by the EPA's *Mandatory GHG Reporting Rule*[7].

Refrigerants

Universities track releases of refrigerants to the atmosphere as required by the EPA. VU Plant Operations and VUMC Facilities and Construction records of refrigerant releases from chillers, air conditioning units, walk-in coolers and freezers, and various types of appliances. Pounds of refrigerants released were provided and directly input into the Campus Carbon Calculator. Pounds of refrigerants released from academic areas has dropped since 2010, when VU Plant Operations created a dedicated chilled water technician group to perform robust preventative maintenance on systems. This maintenance minimizes downtime and reduces the costs associated with refrigerant replacement and loss of chilled water for critical equipment.

Electricity Purchases

The University's co-generation power plant supplies Vanderbilt with 100 percent of the steam needed for heating buildings and 40 percent of the chilled water needed for cooling buildings. Excess heat from steam generation is used to create electricity, satisfying 23 percent of Vanderbilt's annual electricity demand. The remaining 77 percent of Vanderbilt's electricity demand is obtained through electricity purchased from TVA (through NES). In 2013, 43 percent of TVA's electricity came from coal-fired power plants; 36 percent came from nuclear power; 9 percent came from hydroelectric dams; 12 percent came from natural gas-fired power plants; and <1 percent came from other renewable sources[8]. Figure A.1 below presents TVA's sources of power generation.

---

[6] www.ghgprotocol.org

[7] Suppliers of anesthetic gases are required to report their sales/shipments under a separate portion of the EPA's *Mandatory Reporting of Greenhouse Gases; Final Rule* [40 CFR Part 98, Subpart C].

[8] Page 12 of TVA Annual Report filed with the Securities and Exchange Commission on November 18, 2013. Available at http://www.snl.com/Cache/c20876667.html

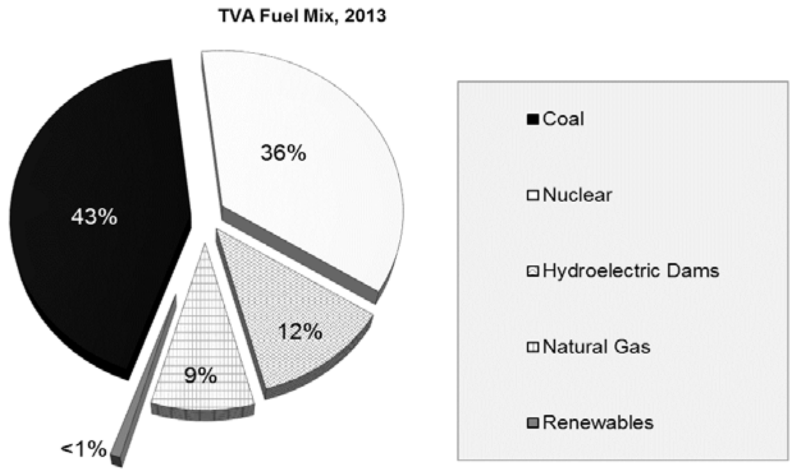


Figure A.1. TVA's Fuel Mix, Calendar Year 2013[9].

Vanderbilt University purchases electricity from NES, the local distributor of power generated by TVA. Monthly consumption of electricity by building was provided by VU Plant Operations. Aggregate annual consumption of electricity in PCA buildings and in ARA buildings were entered into the Campus Carbon Calculator. The specific methods of electricity generation used by TVA were input to the Campus Carbon Calculator.

Faculty, Staff, and Student Commuter Traffic

Commuter traffic reflects the fuel used by faculty, staff and students during their regular travels to and from Vanderbilt. Table A.1 below shows assumed travel patterns based on commuter data[10]:

Population	Percent commuting in a single-occupancy vehicle	Percent commuting in a car/vanpool	Percent commuting via bus or train	Other forms of commuting (walk/bike)	Days per year commuting to campus	Average commuter distance per day, via automobile (miles)
Faculty	86%	6%	7%	1%	150	48
Staff	86%	6%	7%	1%	250	48
Student	15%	5%	2%	78%	150	10

Table A.1. Assumptions for Faculty, Staff and Student Commuter Travel, Calendar Year 2013.

It was determined that faculty and staff in ARAs have an average commuting distance of 24 miles (one-way) and students who do not live on campus have an average commuting distance of 5 miles (one-way)[11].

Commuter distance, commuter patterns and faculty/staff/student populations were input to the Campus Carbon Calculator to determine Vanderbilt's commuting GHG emissions. The University employee population associated with PCAs was provided by Vanderbilt's Human Resources Department. Based on building assignment, separate commuter GHG emission amounts were calculated for ARAs and PCAs. All students and all faculty members (including School of Medicine faculty and School of Nursing faculty) were classified as commuters in the ARA category for the purpose of this report. Medical Center employees assigned to off-campus locations were not included in the commuter traffic calculations.

---

9 Page 12 of TVA Annual Report filed with the Securities and Exchange Commission on November 18, 2013. Available at http://www.snl.com/Cache/c20876667.html

10 Assumptions based on 2013 data provided by VUMC Parking and Transportation Services and VU Traffic and Parking.

11 Average commuting distance established by VUMC Parking and Transportation Services and VU Human Resources.

Air Travel

All University-sponsored travel is now recorded by Vanderbilt's travel management tool, Concur, for all faculty, staff and students on Vanderbilt-funded travel. Passenger-miles traveled in the 2013 calendar year were captured in Concur and input to the Campus Carbon Calculator. Air travel miles were proportioned based on the percent of the Vanderbilt population included in ARA and PCA calculations. Since all airline travel is now being tracked, Scope 3 GHG emissions that include air travel emissions increased significantly as a result of this new tracking system.

Waste Management

Data related to the amount of waste generated annually by Vanderbilt was provided by VU's waste vendor and by Vanderbilt Environmental Health and Safety (VEHS). Waste generated by Vanderbilt is disposed of in one of four ways: (1) waste is landfilled, with landfill gas being converted to electricity; (2) waste is landfilled, with landfill gas being combusted to the atmosphere; (3) waste is incinerated; or (4) waste is autoclaved and then landfilled. Each of these disposal methods has a separate impact on Vanderbilt's GHG emissions. Waste generated by Vanderbilt is disposed off-site by licensed waste management companies.

The volume of solid waste sent to the landfill from VUMC and from the University was reported separately by the disposal vendor, Waste Management. Solid waste removed from Vanderbilt is disposed of at a Waste Management landfill in Camden, Tennessee. According to Waste Management, 64 percent of landfill gas from this landfill is used to generate electricity, and the remaining 36 percent is "flared" to the atmosphere. Therefore, 64 percent of Vanderbilt's solid waste volume is multiplied by a greenhouse gas emissions factor that is different from the emissions factor developed for flared landfill gas. Based on this information, separate solid waste amounts were input to the Campus Carbon Calculator categories for landfill gas-to-electricity and landfill gas-to-flare. An input category for incinerated waste is provided in the Campus Carbon Calculator. Records for VU's incinerated waste are kept by VEHS.

Medical waste that is not autoclaved on-site is shipped to an external, vendor-operated autoclave facility. There is no input category for autoclaved waste in the Campus Carbon Calculator, nor is there a standard emissions number provided in WRI's Greenhouse Gas Protocol[12]. Using information from SteriCycle[13] and waste industry journals[14], an estimate as to how much natural gas is needed to autoclave one ton of medical waste was created. The GHG emissions associated with autoclaving Vanderbilt's medical waste at an off-site location was then calculated using the GHG emissions factor for natural gas use provided by the Campus Carbon Calculator.

---

[12] www.ghgprotocol.org
[13] SEMO communication with SteriCycle representatives John Nicklin, Greg Burkett, Marty Desper, and Dan Sullivan.
[14] Owen, K, Leese, L, Hodson, R, and Uhorchak R. 1997. Non-Incineration Medical Waste Treatment Technologies. Pan-American Health Organization. Chapter 5: "Control of Aerosol (Biological and Non-Biological) and Chemical Exposures and Safety Hazards In Medical Waste Treatment Facilities." Available http://www.bvsde.paho.org/bvsacd/cd48/cap5.pdf.

Uncertainties Associated with Greenhouse Gas Inventory Calculations

As noted by the WRI Greenhouse Gas Protocol[15], two types of uncertainties are associated with GHG inventories: scientific uncertainty and estimation uncertainty. Scientific uncertainty occurs when the science of an actual emission is not sufficiently understood. Estimation uncertainty occurs any time GHG emissions are quantified. Thus all emission estimates are associated with estimation uncertainty. Furthermore, the WRI notes that uncertainty exists when using a mathematical model such as a GHG calculator. Model uncertainty is due to the uncertainty associated with the mathematical equations (i.e. models) used to characterize the relationships between various parameters and emission processes. The WRI notes that analyzing and quantifying these uncertainties is likely beyond the scope of most institutions when compiling a GHG inventory.

In an effort to balance the inherent uncertainties in this inventory with the need for transparency and comprehensiveness, the GHG inventory results for academic and research areas and patient care areas are presented in Sections III and IV as generated from the EPA emissions calculator and the Clean Air-Cool Planet Campus Calculator. For purposes of 'readability,' many of the emission and conversion factors listed in tables in this report and its appendices have been rounded. However, calculations completed to determine emissions utilized full emission and conversion factors.

[15] Ohndorf, M. & Gillenwater, M. (2003). "Measurement and Estimation Uncertainty of Greenhouse Gas Emissions." World Resources Institute. Available http://www.ghgprotocol.org/calculation-tools/all-tools.

APPENDIX B: 2005-2013 Trending Data and Calculations

Calendar Year	GHG Emissions from Academic & Research Areas ($MTCO_2E$)	Gross Square Feet (GSF) - Academic & Research Areas	GHG Emissions per 1,000 GSF	Number of Students	GHG Emissions Per Student	Millions of Research dollars Awarded[16]	GHG Emissions per $1,000 Research Awarded
2005	296,465	8,228,419	36.0	11,294	26.2	$455	0.65
2006	295,825	8,416,644	35.1	11,481	25.8	$468	0.63
2007	308,604	9,039,821	34.1	11,607	26.6	$495	0.62
2008	313,341	9,165,093	34.2	11,847	26.4	$521	0.60
2009	288,343	9,208,635	31.3	12,093	23.8	$520	0.55
2010	284,506	9,257,242	30.7	12,506	22.7	$615	0.46
2011	272,229	9,263,363	29.4	12,704	21.4	$587	0.46
2012	251,669	9,296,428	27.1	12,836	19.6	$572	0.44
2013	259,943	9,109,729	28.5	12,710	20.5	$616	0.42

Table B.1. GHG Normalization Metrics for Academic & Research Areas, Calendar Years 2005-2013.

Calendar Year	GHG Emissions from Patient Care Areas	GSF – Patient Care Areas	GHG Emissions per 1,000 GSF	Inpatient Days[17]	GHG Emissions per Inpatient Days	Ambulatory Visits[17]	GHG Emissions per Ambulatory Visits
2005	179,260	4,957,823	36.2	238,266	0.75	940,018	0.191
2006	182,548	4,972,220	36.7	254,396	0.72	1,019,715	0.179
2007	189,958	5,124,754	37.1	260,977	0.73	1,095,559	0.173
2008	189,985	5,243,043	36.2	267,947	0.71	1,178,841	0.161
2009	175,896	6,192,303	28.4	265,733	0.66	1,266,255	0.139
2010	170,754	6,183,728	27.6	272,731	0.63	1,450,196	0.118
2011	169,389	6,183,728	27.4	282,547	0.60	1,586,395	0.107
2012	158,337	6,183,728	25.6	285,270	0.56	1,725,901	0.092
2013	159,749	6,241,504	25.6	307,292	0.52	1,833,337	0.087

Table B.2. GHG Normalization Metrics for Patient Care Areas, Calendar Years 2005-2013.

Calendar Year	Total GHG Emissions	Total GSF	GHG Emissions per 1,000 GSF	Total VU Population	GHG Emissions per Person
2005	475,725	13,186,242	36.08	29,237	16.3
2006	478,374	13,388,864	35.73	31,189	15.3
2007	498,562	14,164,575	35.20	32,712	15.2
2008	503,327	14,408,136	34.93	31,805	15.8
2009	464,240	15,400,938	30.14	32,308	14.4
2010	455,261	15,440,970	29.48	32,487	14.0
2011	441,618	15,447,090	28.59	33,591	13.1
2012	410,006	15,480,155	26.49	33,890	12.1
2013	419,692	15,351,233	27.34	35,248	11.9

Table B.3. GHG Normalization Metrics for Vanderbilt University, Calendar Years 2005-2013.

[16] According to 2005-2013 research information found in ReVU: Quick Facts about Vanderbilt. Each year, the previous year's data is replaced with data from the most current year. Email SustainVU@vanderbilt.edu for more information.
[17] VU Financial Report 2013, http://financialreport.vanderbilt.edu/.

Calendar Year	Students[18]	Faculty[19]	Academic & Research Staff[20]	Academic & Research Population (students + faculty + staff)	Patient Care Staff[21]	Total On-Campus Population
2005	11,294	2,861	6,542	20,697	8,540	29,237
2006	11,481	3,004	7,097	21,582	9,607	31,189
2007	11,607	3,222	7,627	22,456	10,256	32,712
2008	11,847	3,358	7,073	22,278	9,527	31,805
2009	12,093	3,526	7,102	22,721	9,587	32,308
2010	12,506	3,733	6,667	22,906	9,581	32,487
2011	12,704	3,844	6,676	23,224	10,367	33,591
2012	12,836	3,990	6,733	23,559	10,331	33,890
2013	12,710	4,102	8,530	25,342	9,906	35,248

Table. B.4. Population Data Used for Normalization Metrics, Calendar Years 2005-2013.

Calendar Year	Academic GSF	Patient Care GSF	Total GSF
2005	8,228,419	4,957,823	13,186,242
2006	8,416,644	4,972,220	13,388,864
2007	9,039,821	5,124,754	14,164,575
2008	9,165,093	5,243,043	14,408,136
2009	9,208,635	6,192,303	15,400,938
2010	9,257,242	6,183,728	15,440,970
2011	9,263,363	6,183,728	15,447,090
2012	9,296,428	6,183,728	15,480,155
2013	9,109,729	6,241,504	15,351,233

Table B.5. GSF Data Used for Normalization Metrics, Calendar Years 2005-2013.

Calendar Year	Coal Use: Power Plant ($MTCO_2E$)	Natural Gas Use: Power Plant ($MTCO_2E$)	Natural Gas Use: Boilers in Individual Buildings ($MTCO_2E$)	Total VU GHG Emissions from EPA-Required Sources ($MTCO_2E$)
2005	96,478	51,695	4,988	153,161
2006	99,582	38,485	8,155	146,222
2007	111,344	48,258	6,268	165,869
2008	102,172	51,358	13,017	166,547
2009	105,956	64,096	8,705	178,758
2010	92,090	62,835	4,738	159,663
2011	87,022	58,405	5,651	151,078
2012	85,968	56,798	4,770	147,536
2013	89,490	59,840	5,736	155,065

Table B.6. Total VU GHG Emissions from EPA-Required Sources, Calendar Years 2005-2013.

[18] VU Financial Report 2013, http://financialreport.vanderbilt.edu/.
[19] VU Financial Report 2013, http://financialreport.vanderbilt.edu/.
[20] Calculated using data from VU Human Resources (employees by Building, Academic and Research Staff).
[21] Calculated using data from VU Human Resources (employees by Building, Medical Center Staff).

Calendar Year	Academic Research Areas (65 percent of total EPA-required sources emissions) ($MTCO_2E$)	Patient Care Areas (35 percent of total EPA-required sources emissions) ($MTCO_2E$)	Total VU GHG Emissions from EPA-Required Sources ($MTCO_2E$)
2005	99,554	53,606	153,161
2006	95,045	51,178	146,222
2007	107,815	58,054	165,869
2008	108,255	58,291	166,547
2009	116,192	62,565	178,758
2010	103,781	55,882	159,663
2011	98,201	52,877	151,078
2012	95,898	51,637	147,536
2013	100,792	54,273	155,065

Table B.7. Allocation of GHG Emissions from EPA-Required Sources to Academic and Research Areas and Patient Care Areas, Calendar Years 2005-2013.

Calendar Year	Fleet Vehicles ($MTCO_2E$)	Diesel-powered Emergency Generators ($MTCO_2E$)	Refrigerant Releases ($MTCO_2E$)	Anesthetic Gas Use[22] ($MTCO_2E$)	GHG Emissions from Other Direct Emission Sources ($MTCO_2E$)
2005	1,609	550	286	1	2,446
2006	1,968	541	338	1	2,848
2007	1,870	830	137	1	2,838
2008	2,159	282	143	14	2,598
2009	2,013	394	35	14	2,455
2010	1,935	119	1,019	19	3,091
2011	2,210	110	41	18	2,379
2012	2,128	116	120	18	2,381
2013	2,154	116	76	91	2,437

Table B.8. Academic and Research Areas Scope 1 Emissions from Other Sources, Calendar Years 2005-2013.

Calendar Year	Fleet Vehicles (Life Flight) ($MTCO_2E$)	Diesel-powered Emergency Generators ($MTCO_2E$)	Refrigerant Releases ($MTCO_2E$)	Anesthetic Gas Use[23] ($MTCO_2E$)	GHG Emissions from Other Direct Emission Sources ($MTCO_2E$)
2005	2,206	296	189	3,174	5,864
2006	2,012	291	397	3,174	5,873
2007	1,880	447	131	3,174	5,632
2008	1,877	152	0	4,789	6,817
2009	1,608	212	0	3,896	5,716
2010	1,531	438	609	2,449	5,026
2011	1,643	315	98	3,360	5,416
2012	1,834	389	434	5,221	7,878
2013	1,655	281	745	3,703	6,384

Table B.9. Patient Care Areas Scope 1 Emissions from Other Sources, Calendar Years 2005-2013.

[22] Anesthetic Gas for 2005 and 2006 is not readily available. 2007 data has been used for those two calendar years.
[23] Anesthetic Gas for 2005 and 2006 is not readily available. 2007 data has been used for those two calendar years.

Calendar Year	Kilowatt-Hours Purchased (KwH)	Total VU Emissions ($MTCO_2E$)	Emissions Associated with Academic & Research Areas (65 percent of total scope 2 emissions) ($MTCO_2E$)	Emissions Associated with Patient Care Areas (35 percent of total scope 2 emissions) ($MTCO_2E$)
2005	294,070,522	223,343	145,173	78,170
2006	294,494,256	223,664	145,382	78,283
2007	287,734,887	218,531	142,045	76,486
2008	307,162,163	229,640	149,266	80,374
2009	305,308,699	180,553	117,359	63,193
2010	303,543,739	183,857	119,507	64,350
2011	313,049,916	181,657	118,077	63,580
2012	311,313,519	155,221	100,894	54,327
2013	299,441,016	151,549	98,507	53,042

Table B.10. GHG Emissions from Purchased Electricity, Calendar Years 2005-2013[24].

Calendar Year	Waste Disposal Emissions ($MTCO_2E$)	Air Travel Emissions[25] ($MTCO_2E$)	Commuter Travel Emissions ($MTCO_2E$)	Total Scope 3 GHG Emissions: Academic & Research Areas ($MTCO_2E$)
2005	1,022	5,259	43,010	49,291
2006	1,116	5,259	46,175	52,550
2007	1,150	5,259	49,496	55,905
2008	1,360	5,386	46,476	53,222
2009	1,205	6,944	44,186	52,335
2010	1,761	9,719	46,646	58,127
2011	1,651	8,993	42,928	53,573
2012	555	7,272	44,668	52,496
2013	613	12,077	45,517	58,207

Table B.11. Scope 3 Emissions from Academic and Research Areas, Calendar Years 2005-2013.

Calendar Year	Waste Disposal Emissions ($MTCO_2E$)	Commuter Travel + Air Travel Emissions ($MTCO_2E$)	Total Scope 3 GHG Emissions: Patient Care Areas ($MTCO_2E$)
2005	1,585	40,035	41,620
2006	2,177	45,037	47,215
2007	1,706	48,079	49,786
2008	1,614	42,889	44,503
2009	1,653	42,767	44,420
2010	1,861	43,636	45,496
2011	1,991	45,525	47,516
2012	1,367	43,127	44,494
2013	1,515	44,535	46,050

Table B.12. Scope 3 Emissions from Patient Care Areas, Calendar Years 2005-2013.

[24] TVA's published fuel mix for electrical generation for 2005 through 2008 is as follows: coal (64 percent), nuclear (29 percent), and hydroelectric dams (7 percent). TVA's published fuel mix for 2009 electrical generation is as follows: coal (47 percent), nuclear (34 percent), hydroelectric dams (7 percent), natural gas (6 percent), and renewable (6 percent). TVA's published fuel mix for 2010 electrical generation is as follows: coal (51 percent), nuclear (36 percent), hydroelectric dams (9 percent), natural gas (4 percent), and renewable (<1 percent). TVA's published fuel mix for 2011 electrical generation is as follows: coal (52 percent), nuclear (34 percent), hydroelectric dams (9 percent), natural gas (5 percent), and renewable (<1 percent). TVA's published fuel mix for 2012 electrical generation is as follows: coal (41 percent), nuclear (38 percent), hydroelectric dams (9 percent), natural gas (12 percent), and renewables (<1 percent).

[25] Air travel for 2005 and 2006 is not readily available. 2007 data has been used for those two calendar years.

University	Total Emissions ($MTCO_2E$)	Emissions per 1,000 GSF	Emissions per Student	Emissions per Millions of Research Dollars Awarded
University of Michigan[26]	709,982	21.98	16.35	0.53
Duke University[27]	243,026	18.93	16.28	0.22
Washington University – St. Louis[28]	296,000	74.59	20.97	0.54
Emory University[29]	305,007	33.89	21.00	0.60
University of Pennsylvania[30]	288,945	21.92	11.75	0.35
Vanderbilt University – Academic & Research Areas Only[31]	259,943	28.50	20.50	0.42

Table B.13. GHG Emissions and Related Metrics Reported by other Universities.

[26] GHG emissions, GSF, and student, faculty, and staff populations for FY 2013 retrieved from 2013 Annual Sustainability Report, http://sustainability.umich.edu/report/2013/#ourcommitment_two.php, GSF, and student, faculty and staff populations for FY 2012 retrieved from 2012 U-M Facts and Figures, http://vpcomm.umich.edu/aboutum/home/factfigs.php.
GSF, and student, faculty and staff populations for FY 2013 retrieved from 2013 U-M Facts and Figures, http://digital.turn-page.com/i/197688.

[27] GHG emissions, GSF, and student, faculty, and staff populations for 2013 as reported to ACUPCC, http://rs.acupcc.org/progress/383/. 2013 research dollars retrieved from https://finance.duke.edu/resources/docs/financial_reports.pdf.
GHG emissions, GSF, and student, faculty, and staff populations for 2011 as reported to ACUPCC, http://rs.acupcc.org/ghg/2044/. 2011 research dollars retrieved from Financial Statements 2010/2011, https://finance.duke.edu/resources/docs/financial_reports.pdf.

[28] GHG emissions, GHG emissions per 1,000 GSF, and GHG emissions per person for FY 2009 retrieved from http://www.wustl.edu/initiatives/sustain/assets/GHGEmissions.pdf. 2013 Data retrieved from http://wustl.edu/about/annualreport/_assets/pdf/WUSTL_Annual_Report_2013.pdf

[29] Emissions data for 2012 from http://sustainability.emory.edu/html/dashboard/other-ghg-sources.html. University student population and 2012 research dollars from 2013 Academic Profile,http://www.emory.edu/home/about/factsfigures/index.html.

[30] GHG emissions, GSF, and student populations for 2013 from ACUPCC's website at http://rs.acupcc.org/ghg/1516/ and http://www.upenn.edu/about/facts.php.

[31] GHG emissions for CY 2013 from ARAs only.

APPENDIX C: 2013 Calendar Year Data and Calculations

Source	Academic & Research Areas ($MTCO_2E$)	Patient Care Areas ($MTCO_2E$)	Metric Tons of Carbon Dioxide Equivalent ($MTCO_2E$)
EPA-Required Sources			
Coal use at VU Power Plant	58,168	31,321	89,490
Natural Gas use at VU Power Plant	38,896	20,944	59,840
Natural Gas use in Individual Buildings	3,728	2,008	5,736
Subtotal of EPA-Required Emissions:	100,792	54,273	155,065
Other Scope 1 Emissions Sources			
Diesel-Powered Generators	116	281	397
Refrigerant Releases	76	745	821
Fleet Vehicles	2,154	1,655	3,810
Anesthetic Gas Use	91	3,703	3,793
Subtotal of Other Scope 1 Emissions:	2,437	6,384	8,821
Scope 2 GHG Emissions: Electricity Purchases			
Electricity Purchased from NES	98,507	53,042	151,549
Scope 3 GHG Emissions: Indirect Sources			
Faculty & Staff Commuting	45,519	39,797	85,314
Air Travel	12,077	4,738	16,814
Waste Disposal	613	1,515	2,128
Subtotal of Scope 3 Emissions:	58,207	46,050	104,257
Total emissions associated with each area per year:	**259,943**	**159,749**	**419,692**

Table C.1. Total Vanderbilt GHG Emissions, Calendar Year 2013.

Source	Volume Consumed (gallons)	Emissions Factor	$MTCO_2E$
Diesel fuel consumed by emergency generators – Academic Areas	11,439	1,000 gallons of diesel consumed = 10.14 $MTCO_2E$	116
Diesel fuel consumed by emergency generators – Patient Care Areas	27,734	1,000 gallons of diesel consumed = 10.14 $MTCO_2E$	281

Table C.2. GHG Emissions from Emergency Generators, Calendar Year 2013.

Source	Volume Released (kilograms)	Emission Factor	$MTCO_2E$
Refrigerant Releases - Academic Areas	59	1 kilogram of refrigerant = 1.3 $MTCO_2E$	76
Refrigerant Releases – Patient Care Areas	573	1 kilogram of refrigerant = 1.3 $MTCO_2E$	745

Table C.3. GHG Emissions from Refrigerant Releases, Calendar Year 2013[32].

Fleet Component	Volume Consumed (gallons)	Emission Factor	Emissions from Fleet Component ($MTCO_2E$)
Direct sale of gasoline to fleet vehicles through Plant Operations	96,037	1,000 gallons of gasoline consumed = 8.93 $MTCO_2E$	858
Gasoline purchases by VU PD and Vandy Vans	1,602	1,000 gallons of gasoline consumed = 8.93 $MTCO_2E$	14
Estimate of gasoline purchases by remaining fleet vehicles (221 vehicles) [33]	26,063	1,000 gallons of gasoline consumed = 8.93 $MTCO_2E$	233
Gasoline use by VUMC Shuttle Buses and Vans	101,742	1,000 gallons of gasoline consumed = 8.93 $MTCO_2E$	909
Diesel Fuel use by VUMC Shuttle Buses and Vans	12,062	1,000 gallons of diesel consumed = 10.14 $MTCO_2E$	122
Diesel Fuel use by Plant Operations	1,861	1,000 gallons of diesel consumed = 10.14 $MTCO_2E$	19
GHG Emissions from Academic & Research Fleet Vehicles:			2,154

Table C.4. Academic and Research Areas GHG Emissions from Vanderbilt Owned Vehicles, Calendar Year 2013

Anesthetic Gas	Department	Volume Used (kilograms)	Emission Factor	Emissions from Anesthetic Gas Use ($MTCO_2E$)
Nitrous Oxide	Animal Care	305	1 kilogram of Nitrous= 0.298 $MTCO_2E$	91

Table C.5. Academic and Research Areas GHG Emissions from Anesthetic Gas Use, Calendar Year 2013

Fleet Component	Volume Consumed (gallons)	Emission Factor	Emissions from Fleet Component ($MTCO_2E$)
Jet-A Fuel used by LifeFlight	172,988	1,000 gallons of Jet A Fuel consumed = 9.57 $MTCO_2E$	1,655

Table C.6. GHG Emissions from Patient Care Fleet Vehicles (LifeFlight), Calendar Year 2013.

[32] Emission Factor for R-134A is used as a default emission factor, as some refrigerants do not have a published emission factor/global warming potential (GWP).

[33] Estimate of gasoline purchases is based on VU IT fleet vehicle use of 4,500 miles per year at 24 miles per gallon.

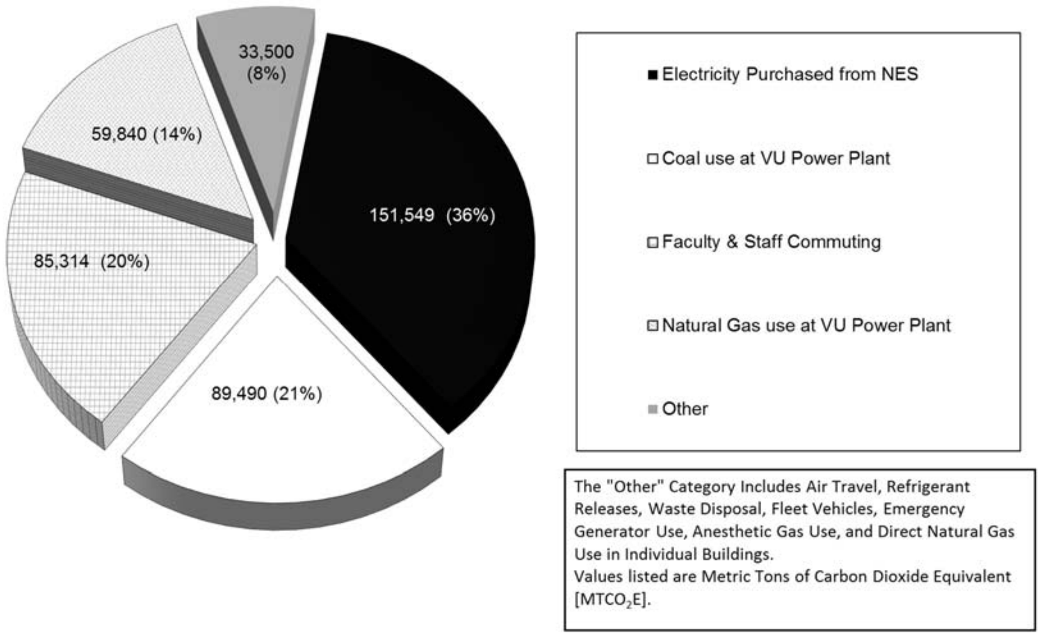


Figure C.1. Vanderbilt GHG Emissions Sources, Calendar Year 2013.

Anesthetic Gas	Volume Used (kilograms)	Emission Factor	Emissions from Anesthetic Gas Use ($MTCO_2E$)
Nitrous Oxide	8,727	1 kilogram of Nitrous Oxide = 0.298 $MTCO_2E$	2,601
Isoflurane	278	1 kilogram of Isoflurane = 0.350 $MTCO_2E$	97
Desflurane	453	1 kilogram of Desflurane = 0.989 $MTCO_2E$	448
Sevoflurane	1,612	1 kilogram of Sevoflurane = 0.345 $MTCO_2E$	556
Total for Anesthetic Gas Use/PCA			3,703

Table C.7. Patient Care Areas GHG Emissions from Anesthetic Gas Use, Calendar Year 2013[34].

Kilowatt-Hours Purchased (KwH)	Emission Factor per 1,000 KwH ($MTCO_2E$)	Total Emissions ($MTCO_2E$)	Emissions Associated with Academic & Research Areas (65 percent of total emissions) ($MTCO_2E$)	Emissions Associated with Patient Care Areas (35 percent of total emissions) ($MTCO_2E$)
299,441,016	0.506105	151,549	98,507	53,042

Table C.8. GHG Emissions from Electricity Purchases, Calendar Year 2013[35].

[34] Calculations and Values for Anesthetics taken from the EPA's *Mandatory Reporting of Greenhouse Gases; Final Rule* [40 CFR Part 98, Subpart C].
[35] Emission Factor based on TVA's published fuel mix for electrical generation: coal (43 percent), nuclear (36 percent), hydroelectric dams (9 percent), natural gas (12 percent), and renewables (<1 percent).

Year	Coal	Nuclear	Hydroelectric Dams	Natural Gas	Renewables
2005	64%	29%	7%	-	-
2006	64%	29%	7%	-	-
2007	64%	29%	7%	-	-
2008	64%	29%	7%	-	-
2009	47%	34%	7%	6%	6%
2010	51%	36%	9%	4%	<1%
2011	52%	34%	9%	5%	<1%
2012	41%	38%	9%	12%	<1%
2013	43%	36%	9%	12%	<1%

Table C.9. TVA's published fuel mix for electrical generation for Calendar Years 2005 through 2013.

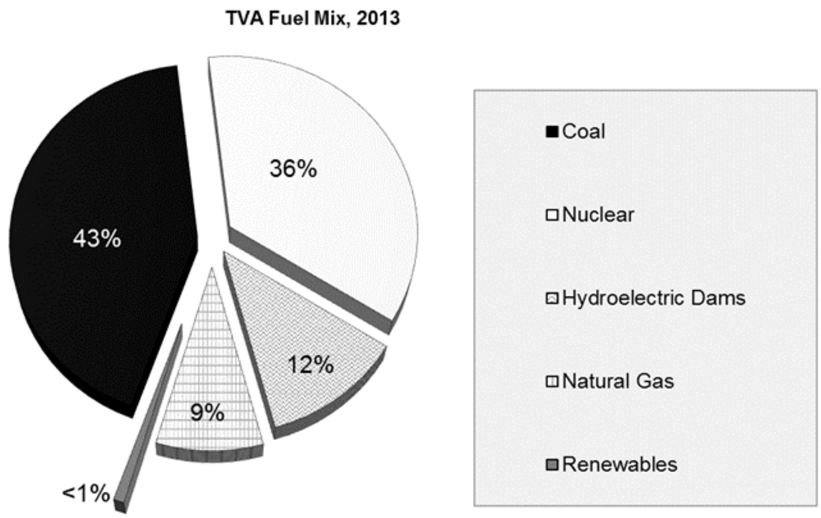


Figure C.2. TVA Fuel Mix, Calendar Year 2013.

	Percent commuting in a single-occupancy vehicle	Percent commuting in a carpool/vanpool	Percent commuting via bus or train	Other Forms of Commuting (walk/bike)	Days per year commuting to campus	Average Commute Distance (via automobile)[36]
Faculty	86%	6%	7%	1%	150	48
Staff	86%	6%	7%	1%	250	48
Student	15%	5%	2%	78%	150	10

Table C.10. Assumptions for Faculty, Staff, and Student Commuter Travel for Academic & Research Areas, Calendar Year 2013.

Faculty and Staff Commuter Miles for Academic & Research Areas	Gasoline Consumed (gallons)	Diesel Fuel Consumed (gallons)
123,022,809	5,029,922	56,667

Table C.11. Estimated Fuel Consumption for Academic and Research Areas by Commuters Based on Commuter Miles Traveled, Calendar Year 2013[37].

[36] Average Commute Distance established by VUMC Parking and Transportation Services and VU Human Resources.
[37] The fuel consumption estimate is based on a standard value provided by Clean Air - Cool Planet of 24 miles per gallon.

Gasoline Consumed (estimated gallons)	Emission Factor	GHG Emissions ($MTCO_2E$)
5,029,992	8.93 $MTCO_2E$ per 1,000 gallons of gasoline consumed	44,942
Diesel Fuel Consumed (estimated gallons)	**Emission Factor**	**GHG Emissions ($MTCO_2E$)**
56,667	10.14 $MTCO_2E$ per 1,000 gallons of diesel consumed	575
GHG Emissions Associated with Commuter Travel: Academic & Research Areas ($MTCO_2E$)		**45,517**

Table C.12. Academic and Research Areas GHG Emissions from Commuter Travel, Calendar Year 2013.

Air Passenger-Miles recorded for 2013 x 0.65 [38]	Emission Factor	(Passenger-miles/1000) * Emission Factor = $MTCO_2E$
15,683,922	0.77 $MTCO_2E$ per 1,000 passenger-miles travelled	12,077

Table C.13. Academic and Research Areas GHG Emissions from Air Travel, Calendar Year 2013.

Disposal Method	Solid Waste Disposal (Tons)	Emission Factor	Waste Disposed * Emission Factor = $MTCO_2E$
Waste landfilled with landfill gas recovery converted to electricity	1,708	1 Ton of waste = 0.1745 $MTCO_2E$	298.0
Waste landfilled with landfill gas combusted to the atmosphere	961	1 Ton of waste = 0.3055 $MTCO_2E$	293.5
Incinerated Waste	100	1 Ton of waste = 0.22 $MTCO_2E$	21.9
Total $MTCO_2E$ Emitted from Waste Disposal:			**613**

Table C.14. Academic and Research Areas GHG Emissions from Waste Disposal, Calendar Year 2013[39].

[38] Passenger-miles traveled provided by VU Finance Travel Specialist/Concur System.

[39] Solid waste removed from Vanderbilt is disposed of at a Waste Management landfill in Camden, Tennessee. According to Waste Management, 64 percent of landfill gas from this landfill is used to generate electricity, and the remaining 36 percent is "flared" to the atmosphere. Therefore, 64 percent of Vanderbilt's solid waste volume is multiplied by a greenhouse gas emissions factor that is different from the emissions factor developed for flared landfill gas.

Cohort	Population Size
Students[40]	12,710
Faculty Members[41]	4,102
University Central Staff[42]	4,202
Research & Administrative Staff in Medical Center[43]	4,328
Total Academic & Research Area Population	25,342
Total PCA Staff on campus [44]	9,906
Off-Site Patient Care Staff[45]	3,586

Table C.15. Population of Students, Faculty, and Staff, Calendar Year 2013.

Disposal Method	Solid Waste Disposal (Tons)	Emission Factor	Waste Disposed * Emission Factor = $MTCO_2E$
Waste landfilled with landfill gas recovery converted to electricity	4,119	1 Ton of waste = 0.1745 $MTCO_2E$	719
Waste landfilled with landfill gas combusted to the atmosphere	2,317	1 Ton of waste = 0.3055 $MTCO_2E$	707
Incinerated Waste	7	1 Ton of waste = 0.22 $MTCO_2E$	2
Medical Waste Autoclaved Off-Site	361	1 Ton of waste = 0.243 $MTCO_2E$	88
Total $MTCO_2E$ Emitted from Waste Disposal:			**1,515**

Table C.16. Patient Care Areas GHG Emissions from Waste Disposal, Calendar Year 2013[46].

	Percent commuting in a single-occupancy vehicle	Percent commuting in a carpool/vanpool	Percent commuting via bus or train	Other Forms of Commuting (walk/bike)	Days per year commuting to campus	Average Commute Distance (via automobile)[47]
Staff	86%	6%	7%	1%	250	48

Table C.17. Assumptions for Staff Commuter Travel for Patient Care Areas, Calendar Year 2013.

Staff Commuter Miles for Patient Care Areas	Gasoline Consumed (gallons)	Diesel Fuel Consumed (gallons)
107,529,630	4,408,170	42,624

Table C.18. Estimated Fuel Consumption for Patient Care Areas by Commuters Based on Commuter Miles Traveled, Calendar Year 2013[48].

---

[40]VU Financial Report 2013, http://financialreport.vanderbilt.edu/.

[41]VU Financial Report 2013, http://financialreport.vanderbilt.edu/. Faculty member population includes faculty from the School of Medicine and School of Nursing.

[42] From *Quick Facts about Vanderbilt University, 2013*. Retrieved December 2013. Available at http://www.vanderbilt.edu/facts.html.

[43] Calculated using data from VU Human Resources (employees by Building, Medical Center Staff). Research & Administrative Staff in the Medical Center includes on-campus medical center employees that do not have direct contact with patients.

[44] Calculated using data from VU Human Resources (employees by Building, Medical Center Staff).

[45] Determined using data from VU Human Resources (employees by Building). "Off-Site" employees include those that work at One Hundred Oaks, clinics in other counties, etc.

[46] Solid waste removed from Vanderbilt is disposed of at a Waste Management landfill in Camden, Tennessee. According to Waste Management, 64 percent of landfill gas from this landfill is used to generate electricity, and the remaining 36 percent is "flared" to the atmosphere. Therefore, 64 percent of Vanderbilt's solid waste volume is multiplied by a greenhouse gas emissions factor that is different from the emissions factor developed for flared landfill gas.

[47] Average Commute Distance established by VUMC Parking and Transportation Services and VU Human Resources.

[48] The fuel consumption estimate is based on a standard value provided by Clean Air - Cool Planet of 24 miles per gallon.

Gasoline Consumed (estimated gallons)	Emission Factor	GHG Emissions ($MTCO_2E$)
4,408,170	8.93 $MTCO_2E$ per 1,000 gallons of gasoline consumed	39,365
Diesel Fuel Consumed (estimated gallons)	**Emission Factor**	**GHG Emissions ($MTCO_2E$)**
42,624	10.14 $MTCO_2E$ per 1,000 gallons of diesel consumed	432
GHG Emissions Associated with Commuter Travel: Patient Care Areas ($MTCO_2E$)		**39,797**

Table C.19. Patient Care Areas GHG Emissions from Commuter Travel, Calendar Year 2013.

Air Passenger-Miles recorded for 2013 x 0.225 [49]	Emission Factor	(Passenger-miles/1000) * Emission Factor = $MTCO_2E$
6,152,923	0.77 $MTCO_2E$ per 1,000 passenger-miles travelled	4,738

Table C.20. Patient Care Areas GHG Emissions from Air Travel, Calendar Year 2013.

GHG Emissions from On-Campus Coal Combustion at the Co-Generation Power Plant					
Coal *(short tons or English tons)*	Kilograms to metric ton conversion	High Heat Value (mmbtu/short ton) (Default EPA value)	Emission Factor ($kgCO_2$/mmbtu) (Default EPA value)		CO_2 Emissions (Metric Tons)
52,979	0.001	17.25	97.17		88,802
Coal *(short tons or English tons)*	Kilograms to metric ton conversion	High Heat Value (mmbtu/short ton) (Default EPA value)	Emission Factor ($kgCO_2$/mmbtu) (Default EPA value)	CH_4 Emissions (Metric Tons)	CO_2e (Metric Tons of CH_4 * 25)
52,979	0.001	17.25	0.011	10.05	251
Coal *(short tons or English tons)*	Kilograms to metric ton conversion	High Heat Value (mmbtu/short ton) (Default EPA value)	Emission Factor ($kgCO_2$/mmbtu) (Default EPA value)	N_2O Emissions (Metric Tons)	CO_2e (Metric Tons of N_2O * 298)
52,979	0.001	17.25	0.0016	1.46	436
Total GHG Emissions from On-Campus Coal Combustion ($MTCO_2E$):					**89,490**
Partitioning of Emissions					
Academic & Research Area Emissions from On-Campus Coal Combustion (65 percent of total emissions) ($MTCO_2E$):					**58,168**
PCA Emissions from On-Campus Coal Combustion (35 percent of total emissions) ($MTCO_2E$):					**31,321**

Table C.21. Calculations for GHG Emissions from On-Campus Coal Combustion, Calendar Year 2013[50].

[49] Passenger-miles traveled provided by VU Finance Travel Specialist/Concur System.
[50] Greenhouse Gas Emissions Calculations and Values taken from the EPA's *Mandatory Reporting of Greenhouse Gases; Final Rule* [40 CFR Part 98, Subpart C]. EPA Formula for Calculating Greenhouse Gas Emissions from Coal Combustion: Coal (tons) * metric ton conversion * High Heat Value * Emission Factor = Tons of Emissions. Tons of Coal listed is the same amount reported in Vanderbilt's 2013 Annual Air Emissions Report.

GHG Emissions from Natural Gas Combustion at the Co-Generation Power Plant					
Natural Gas (Therms)	Emission Factor ($kgCO_2$/mmbtu) (Default EPA Value)	Convert Therms to MMBTU	Convert Kilograms to Metric Tons		CO_2 Emissions (Metric Tons)
11,266,097	53.06	0.1	0.001		59,777.91
Natural Gas (Therms)	Emission Factor ($kgCO_2$/mmbtu) (Default EPA Value)	Convert Therms to MMBTU	Convert Kilograms to Metric Tons	CH_4 Emissions (Metric Tons)	CO_2e (Metric Tons of CH_4 * 25)
11,266,097	0.001	0.1	0.001	1.11	28.16
Natural Gas (Therms)	Emission Factor ($kgCO_2$/mmbtu) (Default EPA Value)	Convert Therms to MMBTU	Convert Kilograms to Metric Tons	N_2O Emissions (Metric Tons)	CO_2e (Metric Tons of N_2O * 298)
11,266,097	0.0001	0.1	0.001	0.11	33.57
Total GHG Emissions from On-Campus Natural Gas Combustion ($MTCO_2E$):					**59,840**
Partitioning of Emissions					
Academic & Research Area Emissions from On-Campus Natural Gas Combustion (65 percent of total emissions) ($MTCO_2E$):					**38,896**
PCA Emissions from On-Campus Natural Gas Combustion (35 percent of total emissions) ($MTCO_2E$):					**20,944**

Table C.22. Calculations for GHG Emissions from On-Campus Natural Gas Combustion at the Co-Generation Power Plant, Calendar Year 2013[51].

GHG Emissions from Natural Gas Consumption in Individual Buildings					
Natural Gas (Therms)	Emission Factor ($kgCO_2$/mmbtu) (Default EPA Value)	Convert Therms to MMBTU	Convert Kilograms to Metric Tons		CO_2 Emissions (Metric Tons)
1,079,899	53.06	0.1	0.001		5,730
Natural Gas (Therms)	Emission Factor ($kgCO_2$/mmbtu) (Default EPA Value)	Convert Therms to MMBTU	Convert Kilograms to Metric Tons	CH_4 Emissions (Metric Tons)	CO_2e (Metric Tons of CH_4 * 25)
1,079,899	0.001	0.1	0.001	0.108	2.70
Natural Gas (Therms)	Emission Factor ($kgCO_2$/mmbtu) (Default EPA Value)	Convert Therms to MMBTU	Convert Kilograms to Metric Tons	N_2O Emissions (Metric Tons)	CO_2e (Metric Tons of N_2O * 298)
1,079,899	0.0001	0.1	0.001	0.0108	3.22
Total GHG Emissions from Natural Gas Consumption in Buildings ($MTCO_2E$):					**5,736**
Partitioning of Emissions					
Academic & Research Area Emissions from Natural Gas Consumption in Buildings (65 percent of total emissions) ($MTCO_2E$):					**3,728**
Patient Care Areas Emissions from Natural Gas Consumption in Buildings (35 percent of total emissions) ($MTCO_2E$):					**2,008**

Table C.23. Calculations for GHG Emissions from On-Campus Natural Gas Consumption in Individual Buildings, Calendar Year 2013[52].

[51] Greenhouse Gas Emissions Calculations and Values taken from the EPA's Mandatory Reporting of Greenhouse Gases; Final Rule [40 CFR Part 98, Subpart C]. EPA Formula for Calculating Greenhouse Gas Emissions from Natural Gas Combustion: Natural Gas (therms) * Emission Factor * MMBTU conversion * Metric Ton conversion = Tons of Emissions. Therms of natural gas listed are the same amount reported in Vanderbilt's Reporting of Greenhouse Gas Emissions to EPA. For the years 2005-2013, GHG calculations for natural gas consumption were based on cubic feet of natural gas * heat value, which is equivalent to therms.

[52] Greenhouse Gas Emissions Calculations and Values taken from the EPA's *Mandatory Reporting of Greenhouse Gases; Final Rule* [40 CFR Part 98, Subpart C]. EPA Formula for Calculating Greenhouse Gas Emissions from Natural Gas Combustion: Natural Gas (therms) * Emission Factor * MMBTU conversion * Metric Ton conversion = Tons of Emissions. Therms of Natural Gas listed is the same amount reported in Vanderbilt's Reporting of Greenhouse Gas Emissions to EPA. For the years 2005-2013, GHG calculations for natural gas consumption were based on cubic feet of natural gas * heat value, which is equivalent to therms.