RADFORD UNIVERSITY

Sustainability

# Radford University's 2016 Greenhouse Gas Inventory

## July 1, 2015 – June 30, 2016


### Summary

Radford University conducts an annual inventory of its greenhouse gas emissions. The process collects data about emissions sources related to university operations and calculates the association between these operations and greenhouse gas emissions. The inventory described here encompasses Fiscal Year 2016 (July 1, 2015 through June 30, 2016). During this time, Radford University's estimated net greenhouse gas emissions totaled **38,160 metric tons of carbon dioxide equivalent** ($MTCO_2e$).

This report summarizes the 2016 Greenhouse Gas Inventory (GGI), provides important information pertaining to certain measured criteria, and benchmarks Radford University's 2016 performance against university inventories conducted since 2010 (the baseline year for RU's greenhouse gas inventory).


### Introduction

In 2009, Radford University became a signatory of the American College & University President's Climate Commitment (ACUPCC). As such, the University pledges to pursue carbon neutrality and to provide students with the knowledge and skills they need to be successful in meeting the challenges of the 21st Century. (See Appendix B). The ACUPCC requires that signatories conduct a GGI during the first year of participation to establish a baseline emissions calculation; the participant then submits a GGI annually, as it enables the university to analyze emissions sources, track progress towards target goals, and ultimately reduce the campus's contribution to climate change. Radford University has conducted a GGI each year since 2010, with the exception of 2015.

### Methods

For the initial GGI in 2010, Radford University selected the Clean Air-Cool Planet Campus Carbon Calculator (CCC) as the tool for calculating and analyzing its emissions, as it is the preferred tool of the ACUPCC (the University of New Hampshire now manages the CCC). Designed specifically for campuses, the CCC is consistent with greenhouse gas protocol standards and is commonly used by universities. Radford University used the CCC for each GGI since 2010 and the most recently updated version (V.9.0) for the 2016 inventory. All data from previous inventories was transferred to and evaluated by this tool.

**Organizational Boundary**: The 2016 GGI included emissions data for all Radford University buildings under operational control of the university. If the university paid the utility bills for a building, it was included in the inventory.

**Data Collection**: The GGI process requested information and support from many individuals, departments, offices, and the Sustainability Steering Committee. The data included in the inventory is the most up-to-date and accurate information available and provides a comprehensive snapshot of the University's greenhouse gas emissions. Some assumptions and estimations were necessary due to limitations in the data. These assumptions and estimations are accepted industry standards and are outlined below.

- **Faculty, Staff, & Student Commuting**: The Sustainability Office oversaw a new commuter survey for the 2015 – 2016 fiscal year. A senior Geo-Spatial Science major, under direct supervision of the department chair, ran a GIS model using the home address data of each commuter parking pass holder. The model calculated the shortest driving distance between each address and the Radford University campus. The student then extrapolated the daily mileage for the entire year by estimating the number of commuting days per year for each classification of permit holder – students, faculty, and staff.
- **Directly Financed Air Travel**: Total air travel mileage was calculated using the 2016 Average Cost per Mile of commercial air travel ($0.15). This figure, calculated by *Airlines for America*, is adjusted annually and accounts for all domestic and international flights. Radford University Accounts Payable and the local travel agency, Christian Travel, provide the total cost of directly financed air travel. The total cost is divided by the average cost per mile to calculate the estimated total miles of directly financed air travel.
- **Study Abroad Air Travel**: The Director of International Education provided the air travel mileage, which includes both student and university employee air travel related to study abroad programs.
- **Solid Waste**: Radford University hauls all of its trash to the Cloyd's Mountain Landfill in Pulaski County, VA. The landfill weighs all trash per load delivered; this provides us a very accurate measurement of our landfilled trash. At the landfill, Ingenco Distributed Energy is operating a landfill gas capture and electricity production operation. This greatly reduces the greenhouse gas emissions of our organic landfilled trash and is reflected by the calculations in the CCC.
- **Paper**: Radford University Procurement and Contracts provided the data on purchased paper. The paper figure is limited to general purpose/copier paper purchases from different suppliers and does not include every type of paper utilized within a year by the University. General use and copier paper are delivered in reams, and single ream of paper weighs 4.75 pounds. This weight is used to estimate the total pounds of paper used.

Radford University's Sustainability Manager worked with the university's Energy Manager to initiate the GGI process. Radford University's Energy Manager collected most of the data related to facilities and operations, Scopes 1 and 2, by reaching out to the appropriate manager or department contact from each category. The Sustainability Manager managed the collection of the Scope 3 data and demographic information.

During the data collection phase, the Sustainability Manager entered the raw data the CCC where appropriate and processed other data into units that are compatible with the tool. When the data collection was complete, the Sustainability Manager and other university employees began analyzing the results for any omissions or unusual discrepancies.

## Results

The CCC processes all data with emissions conversion factors that translate different emissions sources to greenhouse gas equivalents. This tool calculates energy consumption, amounts of three greenhouse gases, level of emissions from each source and Scope, and total metric tons of carbon dioxide equivalent ($MTCO_2e$).

### Table 1. Overview of 2016 Greenhouse Gas Emissions

| MODULE | Summary | | | | | |
|---|---|---|---|---|---|---|
| WORKSHEET | Overview of Annual Emissions | | | | | |
| UNIVERSITY | Radford University | | | | | |
| | | | | | | |
| Select Year --> | 2016 | Energy Consumption | $CO_2$ | $CH_4$ | $N_2O$ | $eCO_2$ |
| | | MMBtu | kg | kg | kg | Metric Tonnes |
| Scope 1 | Co-gen Electricity | - | - | - | - | - |
| | Co-gen Steam | - | - | - | - | - |
| | Other On-Campus Stationary | 153,501.5 | 8,382,830.2 | 782.8 | 20.1 | 8,408.4 |
| | Direct Transportation | 4,998.6 | 359,883.4 | 63.4 | 21.8 | 368.0 |
| | Refrigerants & Chemicals | - | - | - | - | 74.1 |
| | Agriculture | - | - | - | 117.9 | 35.1 |
| Scope 2 | Purchased Electricity | 111,679.2 | 20,495,572.5 | 351.2 | 514.3 | 20,657.6 |
| | Purchased Steam / Chilled Water | - | - | - | - | - |
| Scope 3 | Faculty / Staff Commuting | 34,752.4 | 2,483,535.5 | 521.7 | 175.2 | 2,548.8 |
| | Student Commuting | 32,714.4 | 2,334,955.2 | 504.0 | 168.6 | 2,397.8 |
| | Directly Financed Air Travel | 4,709.2 | 918,435.2 | 9.1 | 10.5 | 921.8 |
| | Other Directly Financed Travel | 7,480.0 | 533,725.5 | 115.9 | 38.8 | 548.2 |
| | Study Abroad Air Travel | 419.0 | 81,713.2 | 0.8 | 0.9 | 82.0 |
| | Student Travel to/from Home (OPTIONAL) | - | - | - | - | - |
| | Solid Waste | - | - | (1,684.8) | - | (42.1) |
| | Wastewater | - | - | 77.0 | 103.0 | 32.6 |
| | Paper | - | - | - | - | 42.0 |
| | Scope 2 T&D Losses | 11,275.3 | 2,069,268.3 | 35.5 | 51.9 | 2,085.6 |
| Offsets | Additional | | | | | - |
| | Non-Additional | | | | | - |
| Totals | Scope 1 | 158,500.1 | 8,742,713.6 | 846.2 | 159.8 | 8,885.6 |
| | Scope 2 | 111,679.2 | 20,495,572.5 | 351.2 | 514.3 | 20,657.6 |
| | Scope 3 | 91,350.3 | 8,421,633.0 | (420.8) | 548.9 | 8,616.7 |
| | All Scopes | 361,529.6 | 37,659,919.2 | 776.6 | 1,223.1 | 38,160.0 |
| | All Offsets | | | | | - |
| | | | | | Net Emissions: | 38,160.0 |

## Discussion

### Emissions by Scope

Emissions sources are categorized based on their origin; these categories are referred to as Scopes 1, 2, and 3. Scope 1 emissions are direct sources from campus and include on-campus energy generation and steam production, on campus mobile fuel usage, refrigerants, and fertilizers. Scope 2 refers to direct, off-campus emissions sources that are directly linked to campus operations, including purchased electricity. Indirect emissions linked to university activities are categorized as Scope 3. These emissions include university financed travel, solid waste disposal, water treatment, and faculty, staff, and student commuting.

Approximately 54% (20,657.6 $MTCO_2e$) of Radford University's total emissions are Scope 2 emissions. Scope 2 accounts for purchased electricity and is the largest source of the University's emissions. Scope 1 (8,885.6 $MTCO_2e$) emissions sources account for 23% of total emissions, produced primarily by burning Fuel Oil and Natural Gas on-campus, along with on-campus vehicles. The remaining emissions are considered Scope 3, and account for 22% (8,616.7 $MTCO_2e$) of total emissions. The primary sources of Scope 3 emissions are faculty, staff, and student commuting, and directly financed university air and vehicle travel.

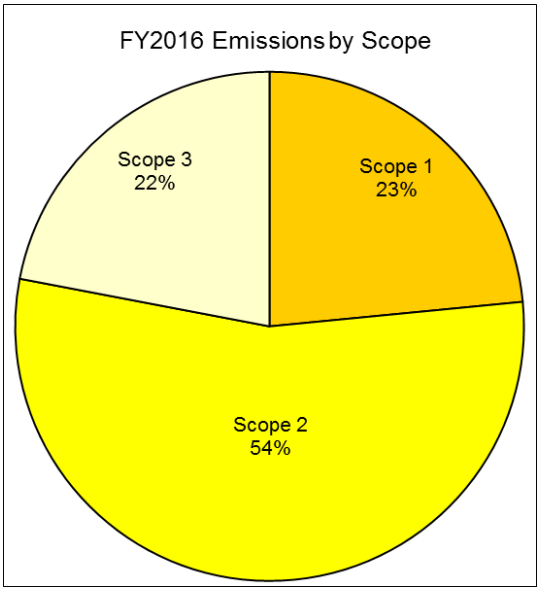



*Figure 1. FY2016 Emissions by Scope*

**2016 Results: Top 5 Sources of Emissions**

1. **Purchased Electricity and T&D Losses – 60% of Total Emissions**: Purchased electricity, a Scope 2 emission source, continues to be the university's largest emissions source (54%). During FY2016, Radford University purchased 32,755,200 kilowatt hours of electricity from Radford City. The approximate fuel mixture for producing electricity in the university's eGrid Subregion, RFC West, is used to calculate these emissions.

   Electricity Transmission and Distribution Losses, or T&D Losses, account for the electricity that is lost between the power station and the final user. The U.S. Energy Information Administration (EIA) estimates that T&D losses average about 5% of the electricity that is transmitted and distributed annually in the United States.[1] T&D Losses will increase or decrease based on the amount of electricity that the University purchases and/or the sources from which it is produced, and is currently 6% of total emissions.

   Purchased Electricity and T&D Losses produced 22,743.2 $MTCO_2e$ in FY2016.

2. **On-Campus Stationary – 22% of Total Emissions**: This emissions source is a Scope 1 emission and represents fuel sources consumed on the Radford University campus. In FY2016, the university used 84,739 gallons of distillate fuel oil, 439 gallons of propane, and 141,817 MMBtu of natural gas. During this time period, fuel oil was the primary fuel source used to generate steam for heating on-campus buildings. Propane and natural gas are heat sources for several on-campus and off-campus university-owned or operated buildings.

   On-campus Stationary produced 8,408.4 $MTCO_2e$ in FY2016.

3. **Faculty, Staff, and Student Commuting – 13% of Total Emissions**: In FY2016 Faculty, Staff, & Students logged an estimated 13,210,064 miles in their personal vehicles during their regular daily commute to campus. This is a Scope 3 emission source.

   Faculty, Staff, and Student commuting produced 4,946.6 $MTCO_2e$ in FY2016.

4. **Directly Financed Air Travel – 2% of Total Emissions:** Faculty and Staff accumulated approximately 1.9 million miles of air travel directly related to university business during FY2016. This is down slightly from last year and has been decreasing since 2013.

   Directly Financed Air Travel produced 921.8 $MTCO_2e$ in FY2016.

1. Frequently Asked Questions. How much electricity is lost in transmission and distribution in the United States. U.S. Energy Information Administration: Independent Statistics & Analysis. https://www.eia.gov/tools/faqs/faq.php?id=105&t=3. Feb 16, 2017.

5. **Other Directly Financed Travel – 2% of Total Emissions**: Non-air travel that is directly related to and financed by the University produces these emissions. Travel in rental vehicles from Enterprise Holdings and in personal vehicles are the two primary sources, at 780,839 miles and 722,368 miles, respectively.

   Other Directly Financed Travel produced 548.2 $MTCO_2e$ in FY2016.

**Figure 2: FY2016 Emissions by Source**

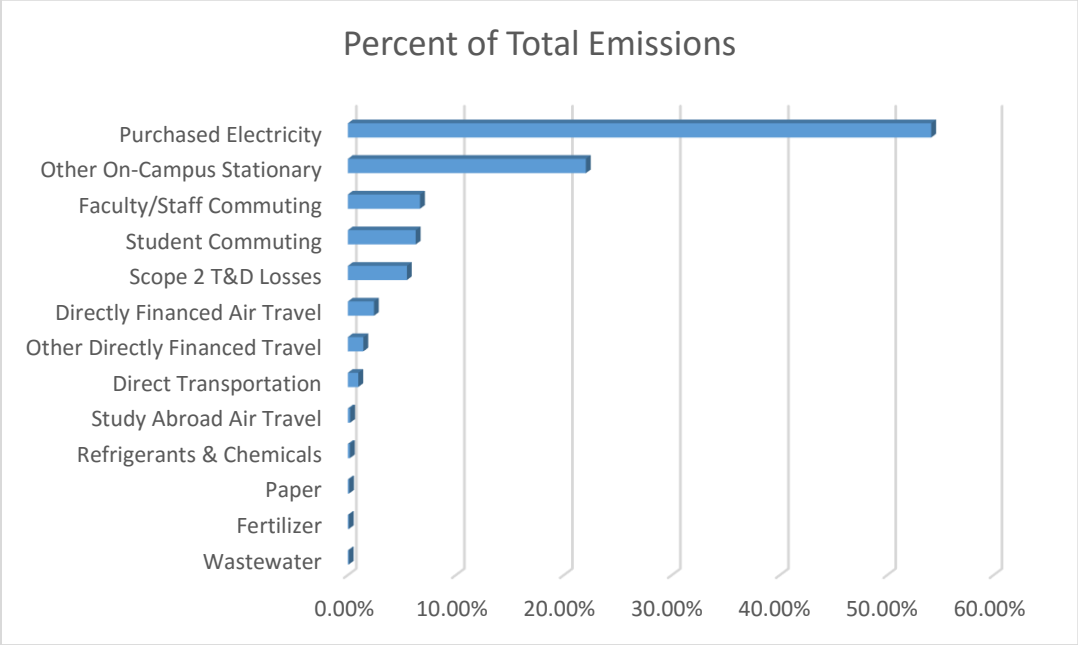



**Table 2: FY2016 Percent of Total Emissions by Source**

| Emissions Source | % of Total Emissions |
|---|---|
| Purchased Electricity | 54.13% |
| Other On-Campus Stationary | 22.03% |
| Faculty/Staff Commuting | 6.68% |
| Student Commuting | 6.28% |
| Scope 2 T&D Losses | 5.47% |
| Directly Financed Air Travel | 2.42% |
| Other Directly Financed Travel | 1.44% |
| Direct Transportation | 0.96% |
| Study Abroad Air Travel | 0.21% |
| Refrigerants & Chemicals | 0.19% |
| Paper | 0.11% |

| | |
|---|---|
| Fertilizer | 0.09% |
| Wastewater | 0.09% |

**Normalization & Trends**

For Radford University's 2016 GGI, the CCC also processed data entered from the University's inventories conducted since 2010. Due to personnel constraints, the University did not conduct a GGI in 2015 and completed an abbreviated version in 2014. As such, there is some estimated and extrapolated data for these two years based on data trends. In addition, there has not been a commuter survey since 2009. Therefore, this report uses the 2016 data for all years.

1. Total emissions ($MTCO_2e$) have increased since 2010, but are stabilizing.

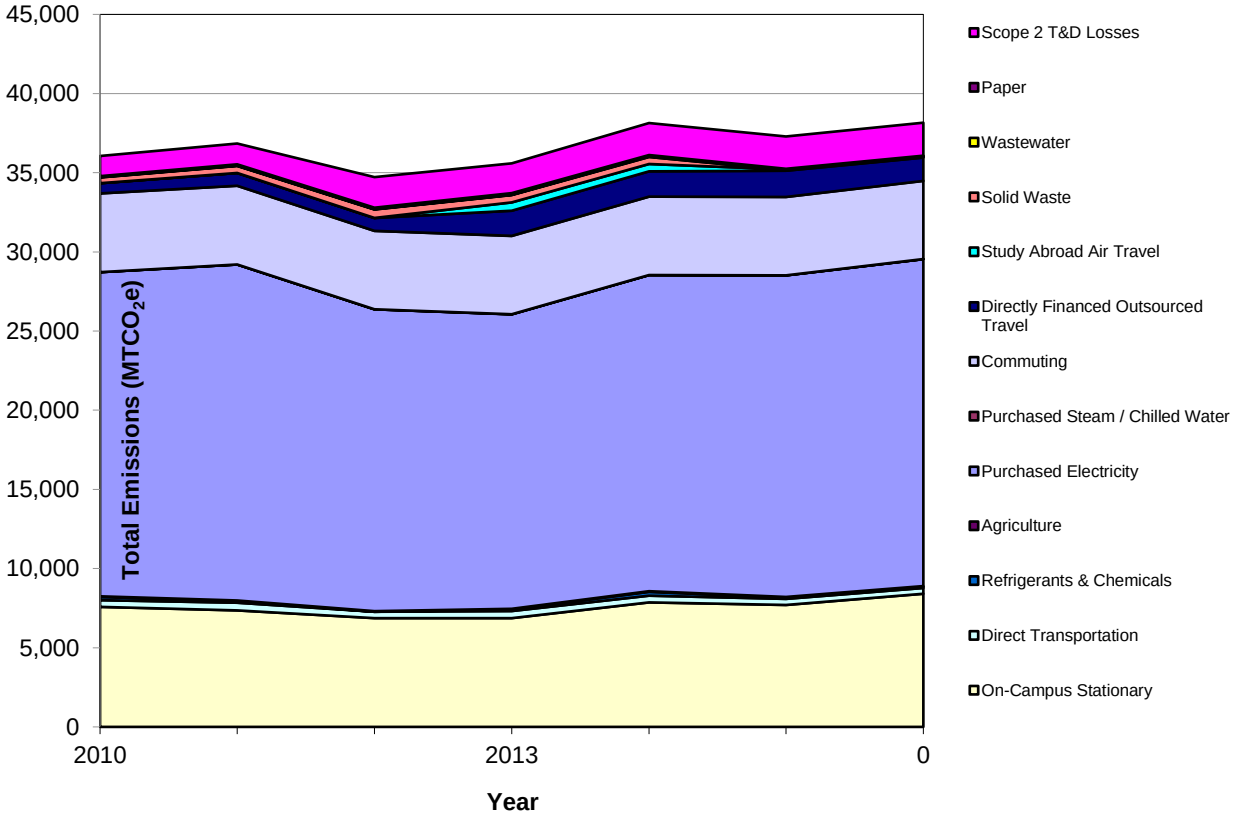



*Figure 3: Radford University emissions by source from FY2010 through FY 2016.*

Total emissions during FY2016 are much less than the 2010 Greenhouse Gas Inventory "Business As Usual" projection for total emissions ($MTCO_2e$).

- Total emissions increased from 37,749.6 $MTCO_2e$ in 2010 to 38,160 $MTCO_2e$ in 2016; a total increase of 410.4 $MTCO_2e$ or approximately 1%.
- The "Business as Usual" projection for 2016 was over 50,000 $MTCO_2e$, an increase of approximately 12,250 $MTCO_2e$, or approximately 32%.

- The 2010 GGI "Building Space" square footage projection for 2016 was approximately 2.8 million square feet. This was an accurate projection.
- The "Full Time Student Enrollment" in 2016 was 9,052. In the 2010 GGI, "Full Time Student Enrollment" projections for 2016 approached 11,000.

2. Emissions per square foot have decreased.

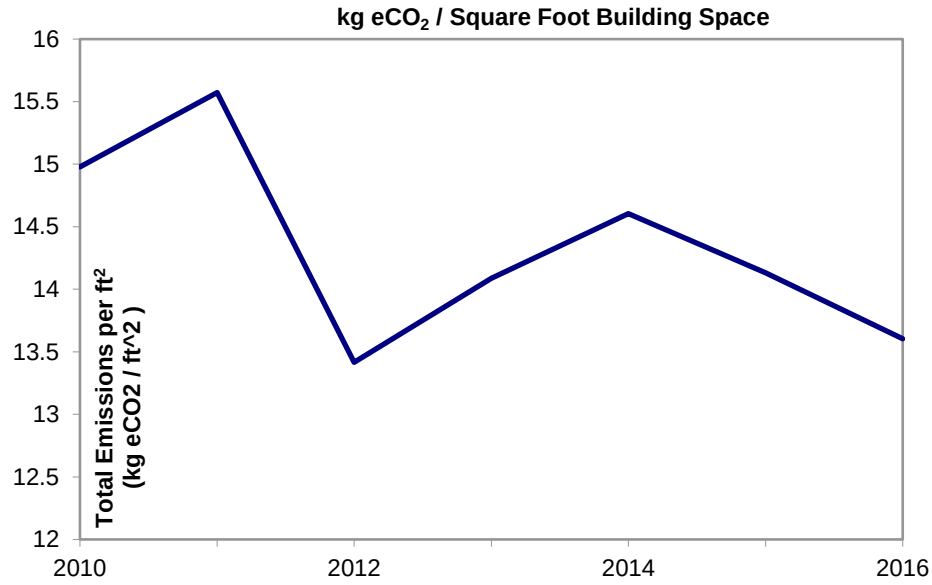



*Figure 4: Radford University Total Emissions per square foot of building space from FY2010 through FY2016.*

Since 2011, the square footage of "Total Building Space" has increased by 438,337 $ft^2$ or 18.5% (from 2,366,397 $ft^2$ to 2,804,734 $ft^2$). During that same time, total emissions per square foot decreased from approximately 15.6 kg $eCO_2/ft^2$ to approximately 13.6 kg $eCO_2/ft^2$, or 1.3%. All new and renovated space that has come online has met minimum LEED Silver standards, with some space meeting LEED Gold standard. This new energy efficient space demands much less energy than older buildings.

3. Emissions Per Student are lower than in 2010, but have increased since 2013.

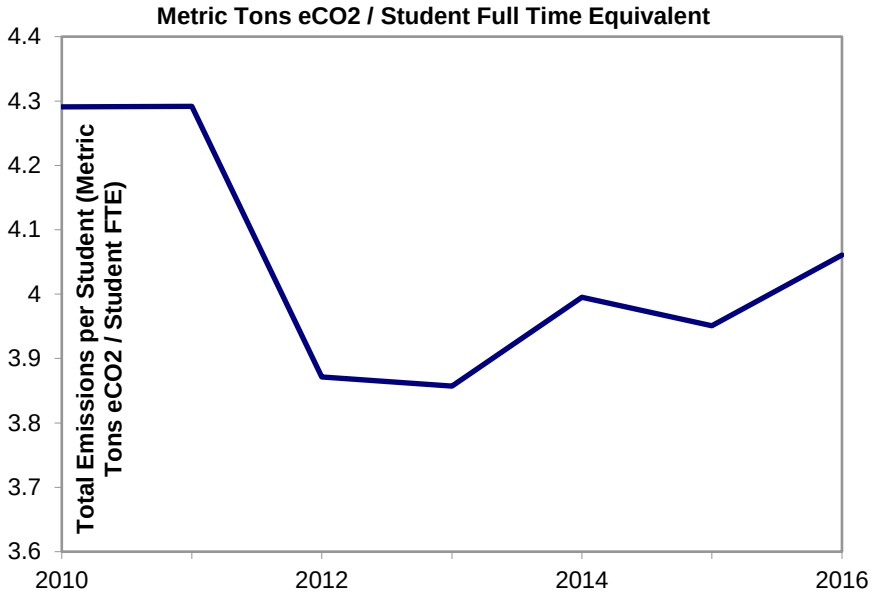



*Figure 5: Total emissions per student from FY2010 through FY2016.*

Emissions per student decreased approximately 5% from the 2010 level.

4. Emissions per operating dollar have gradually decreased since 2010, with the exception of 2016, where there was a slight increase.

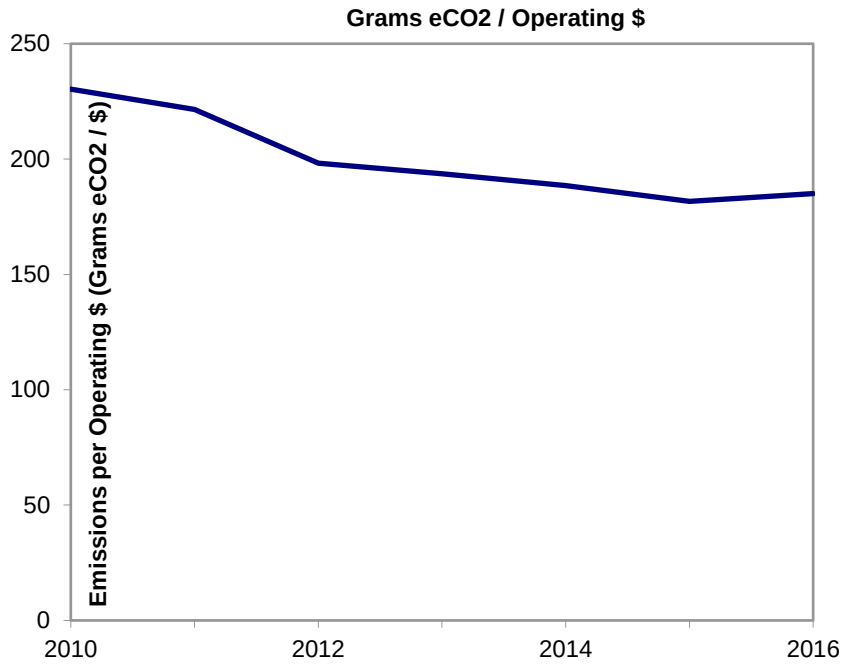



*Figure 6: Radford University total emissions per operating dollar from FY2010 through FY2016.*

Emissions per operating dollar estimates the overall emissions efficiency of the institution. For every dollar that is spent, a certain amount of emissions are released. Between 2015 and 2016, Radford University's operating budget experienced the smallest percentage increase than it did between any other years since 2010, which may explain the slight increase between 2015 and 2016.

**Looking Ahead**

Next year's GGI (2016 – 2017), will include newly constructed square footage (Center for the Sciences and College of Humanities & Behavioral Science). After the 2016 – 2017 year, there are no new construction projects currently planned, thus no increase in square footage of new building space is expected at this time. However, additional renovated square footage that was not online in 2015 – 2016, will be functional and added to the GGI in 2016 – 2017 and again in 2017 – 2018. Once all new and renovated square footage is operational, energy consumption related directly to functional building space will likely plateau and all subsequent efficiency upgrades and renovations will be direct gains towards the ultimate goal. Furthermore, the University is striving to increase enrollment. An increase in students will demand more energy, though with efficiencies and conservation measures in place, a collaborative education and outreach campaign could keep greenhouse gas emissions from increasing.

Radford University is committed to reducing greenhouse gas emissions and pursuing carbon neutrality. In 2010, the university's Sustainability Steering Committee set interim targets of a 30% reduction by 2020 and 60% reduction by 2030 from the 2010 baseline, and reaching net zero emissions in 2040. There are three primary methods for reducing net greenhouse gas

emissions: employing energy efficiency and conservation practices; purchasing or producing carbon-free energy, and purchasing offsets to carbon emissions. To achieve its emissions reduction goals, the University will implement some combination of actions and strategies from these three methods.

Radford University will benefit from an action plan for reducing greenhouse gases that considers new data and all available options. This plan will outline specific reductions strategies, their cost and impact on greenhouse gas emissions, and the most effective and feasible combination of strategies for achieving the interim and final goals. Once complete, Radford University, the community, and its partners will have a transparent roadmap for reaching its emissions reduction targets. The plan should be a working document, as technology is improving rapidly and the cost of renewable energy is now competitive with more traditional fuel sources.

**Acknowledgements**

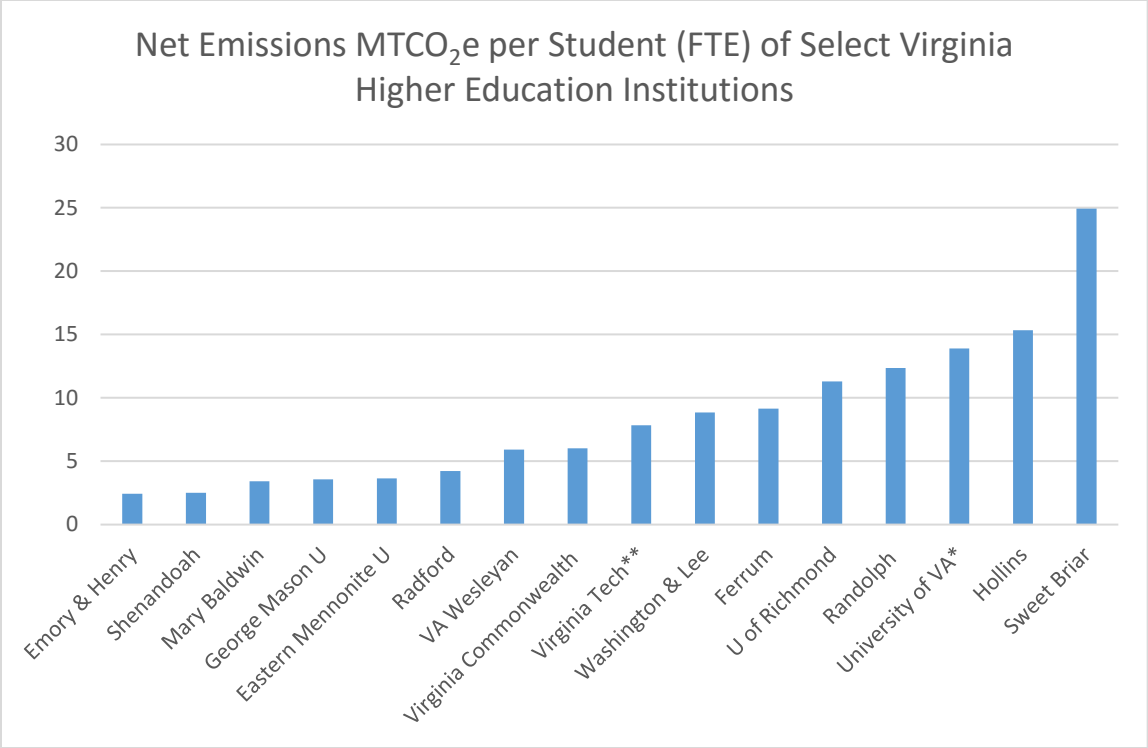
Completing a Greenhouse Gas Inventory is a collaborative effort and requires contributions from every corner of the University. RU Sustainability is grateful to everyone for participating and assisting the university in achieving its ambitious goals for reducing greenhouse gas emissions.

A special thanks to Accounting Services, Christian Travel, Department of Geospatial Sciences, Enterprise Holdings, Facilities Management, Institutional Research, Procurements and Contracts, the Sustainability Steering Committee, and all others who collaborated during the process.

**Appendices**

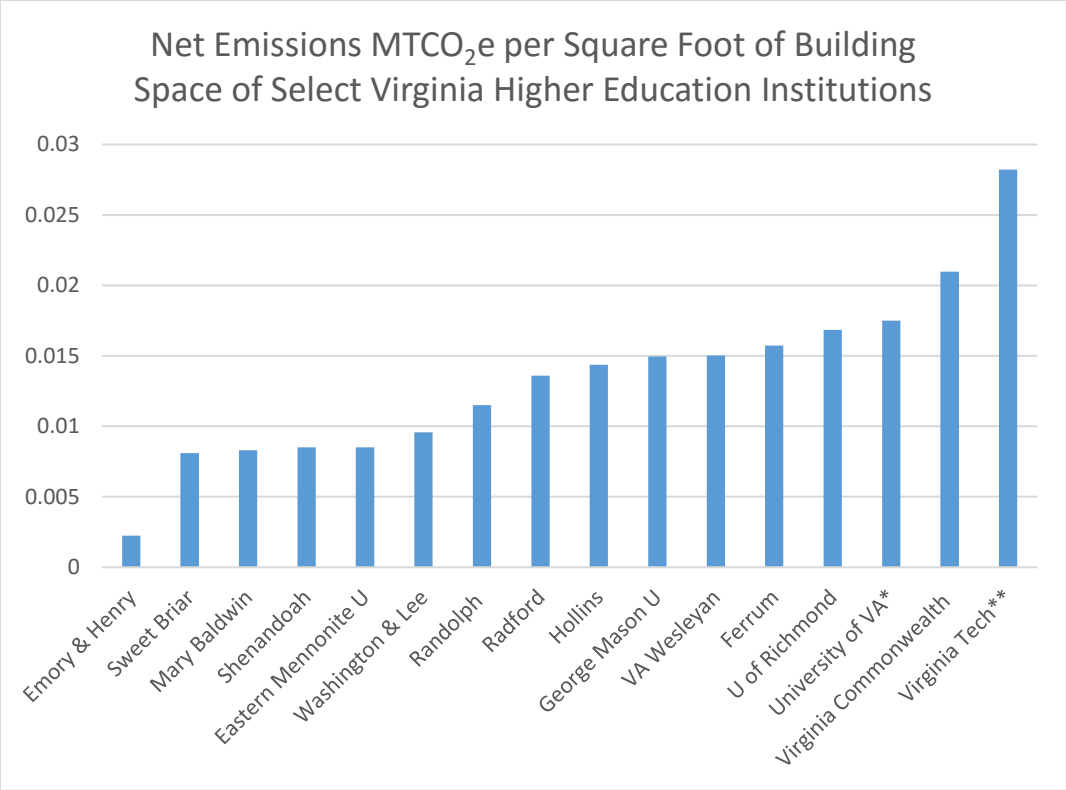
### A. Normalization & Benchmarking with Other Virginia Institutions

Making meaningful comparisons between higher education institutions is a challenging endeavor; each institution is unique, information is unverified, and unbiased normalization metrics are not available. This data, unless otherwise noted, is from Second Nature's online reporting dashboard and is the most up to date information available. Second Nature is the organization managing the implementation of the ACUPCC (now Carbon or Climate Commitment) and there are currently 15 higher education institutions in Virginia that are ACUPCC reporting signatories. Radford University is one of only three public higher education institutions in this group (George Mason University and Virginia Commonwealth University). Both the University of Virginia and Virginia Tech are public universities and are not signatories, but recently reported their emissions; as such, they are included in this comparison.




*Not an ACUPCC signatory. Data pulled from the University of Virginia's 2016 Greenhouse Gas Inventory. https://sustainability.virginia.edu/docs/UVA%20CY2016%20Greenhouse%20Gas%20Inventory%20Report_April%202017.pdf

**Not an ACUPCC signatory. Data pulled from Virginia Tech's most recent STARS report in 2014. https://stars.aashe.org/institutions/virginia-tech-va/report/2014-10-15/




*Not an ACUPCC signatory. Data pulled from the University of Virginia's 2016 Greenhouse Gas Inventory. https://sustainability.virginia.edu/docs/UVA%20CY2016%20Greenhouse%20Gas%20Inventory%20Report_April%202017.pdf

**Not an ACUPCC signatory. Data pulled from Virginia Tech's most recent STARS report in 2014. Scopes 1 & 2 only. https://stars.aashe.org/institutions/virginia-tech-va/report/2014-10-15/

### B. Links to Other Reports & Resources

Airlines for America: AFA Monthly Passenger Yield: http://airlines.org/dataset/a4a-monthly-yield/

American College and University President's Climate Commitment: http://www.radford.edu/content/dam/departments/administrative/Sustainability/Documents/ACUPCC-Commitment.pdf

Radford University Climate Action Plan: http://www.radford.edu/content/sustainability/home/climate-plan.html

Radford University 2010 Greenhouse Gas Inventory Narrative: http://www.radford.edu/content/dam/departments/administrative/Sustainability/Documents/greenhouse-gas-narrative.pdf

Second Nature: www.secondnature.org