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2016 Greenhouse Gas Inventory Report: Virginia Institute of Marine Science

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2016 Greenhouse Gas Inventory Report

VIRGINIA INSTITUTE OF MARINE SCIENCE

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VIMS GREEN TEAM | GHG WORKING GROUP

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Executive Summary

During summer 2016 the VIMS Green Team completed an inventory of greenhouse gas (GHG) emissions from the Virginia Institute of Marine Science (VIMS) Gloucester Point campus during FY2015. GHG emissions were estimated using the Campus Carbon Calculator maintained by the Sustainability Institute at the University of New Hampshire, and compared to a previous GHG audit from FY2010.

Our findings indicate that overall GHG emissions from the VIMS Gloucester Point campus have declined more than 22% since 2010. Summaries from each GHG source examined are presented below:

- On-Campus Stationary Fuel Sources: Propane usage on the Gloucester campus has declined 33% since 2010. Andrews Hall continues to be the single largest consumer of propane fuel, with peak use in January.
- Direct Transportation: Gasoline usage has declined 26% since 2010, but consumption of diesel fuel has increased drastically since 2012 (77% since 2010; 234% since 2012).
- Agriculture: Fertilizer application has declined 72% since 2011. Fertilizer use is not a significant contributor to GHG emissions on VIMS campus.
- Purchased Electricity: The amount of purchased electricity has declined 12% from 2010 to 2015. Andrews Hall and Chesapeake Bay Hall account for 65% of total electricity use at VIMS. Purchased electricity is the single greatest contributor to GHG emissions on VIMS campus.
- Commuting: Since 2010, primary means of commuting to the VIMS campus have not changed. Distances commuted by car have decreased for Faculty/Staff by 51% and for Students by 52%. Overall emissions from commuting have decreased by 33%.
- Business Travel: Travel miles have decreased significantly since 2010. Air miles have declined more than 30% for faculty, staff, and students. Other travel miles, including travel by Taxi, Ferry, Rental Car, Train, Bus and non-VIMS research vessels have decreased by 80%.
  Solid Waste: Solid waste disposal at VIMS campus represents a sink of GHG emissions due to landfill gas capture technology at the Middle Peninsula Landfill. Waste disposal on campus for 2010 and 2015 cannot be reliably compared due to discrepancies in estimating amounts of waste disposed between the two years.
- Wastewater: Water use on campus can vary up to 5 million gallons per year with no apparent trend since 2010.
- Paper: Paper use has declined 49% since 2010. Waterman's Hall utilizes 53% more paper than the next highest user (Print Shop), and accounts for 33% of all paper use on campus.

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Introduction

In summer 2016 the VIMS Green Team completed a GHG inventory of the Virginia Institute of Marine Science (VIMS) Gloucester Point campus for FY2015. We evaluated four major GHG emission sources as set forth by the Campus Carbon Calculator (CCC): electricity, transportation, waste and agriculture. Maintained by the Sustainability Institute at the University of New Hampshire, the Campus Carbon Calculator (http://sustainableunh.unh.edu/calculator) is used by over 1,200 colleges and universities to estimate campus GHG emissions based on emissions factors developed by the Intergovernmental Panel on Climate Change. The CCC estimates total emissions of carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_4). Since N_2O and CH_4 have greater warming potential than CO_2, we report GHG emissions as CO_2 equivalents (eCO_2; i.e., the metric tons of CO_2 that would have the equivalent warming potential).

The CCC considers three scopes of emissions:

- **Scope 1:** Direct emissions from sources owned and/or controlled by the institution, such as pool vehicle and vessel emissions.
- **Scope 2:** Indirect emissions from sources neither owned or controlled by the institution but whose products are directly linked to on-campus energy consumption, such as emissions linked to electricity generation.
- **Scope 3:** Other indirect emissions that are a consequence of the institution's activities, but are from sources neither owned or controlled by the institution, such as emissions resulting from commuting to the institution.

A similar GHG inventory of the VIMS Gloucester Point campus was performed in spring 2011 for FY2010. Direct comparison of FY2015 data with FY2010 is provided for each category. Where available, data for the intervening years is also provided to show trends over time.

Overall Greenhouse Gas Emissions

We estimate that the VIMS Gloucester Point Campus was responsible for 10218.83 metric tons of eCO_2 emissions in FY2015. Overall GHG emissions from the VIMS Gloucester Point campus have declined more than 22% since 2010 (Table 1). The overall decrease in GHG emissions is driven primarily by decreases in emissions from On-Campus Stationary Fuel sources, Commuting, Air Travel, and Wastewater emissions. Greenhouse gas emissions in all categories have gone down since 2010, excluding Direct Transportation.

Table 1. Summary of eCO_2 emissions for FY2010 and FY2015.

	eCO2 (MT)		
Source	**FY2010**	**FY2015**	**Percent Change (%)**
Scope 1			
On-Campus Stationary Fuel	2358.35	1647.22	-30.15
Direct Transportation	461.95	636.09	37.70
Fertilizer	n/a	0.03	n/a
Scope 2			
Purchased Electricity	6861.89	6203.39	-9.60
Scope 3			
Faculty / Staff Commuting	865.14	444.94	-48.57
Student Commuting	88.25	54.33	-38.44
Directly Financed Air Travel	1006.83	615.80	-38.84
Other Directly Financed Travel	212.78	124.10	-41.68
Solid Waste	-2.94	-2.18	-25.85
Wastewater	864.46	101.80	-88.22
Paper	10.30	10.03	-2.62
In-Transit Electricity Losses	424.12	383.42	-9.60
Total Emissions	**13151.15**	**10218.96**	**-22.30**
Additional Offsets	n/a	-0.14	n/a
Net Emissions	**13151.15**	**10218.83**	**-22.30**

By far the largest contributor to VIMS' FY2015 GHG emissions was purchased electricity (62.1% of the total eCO_2 emissions) (Figure 1). On-Campus stationary fuel sources of GHG make up the next largest percentage of emissions (16.5%), with most of this coming from the use of propane for heating. Direct transportation sources, including the use of VIMS vessels, is the third largest contributor to campus GHG emissions (6.4%) (Figure 1).

Total GHG emissions, including CH_4, N_2O, and CO_2 emissions, for FY2010 and FY2015 are reported in **Appendix I: GHG Emissions**. Additional information regarding data collection is provided in **Appendix II: Data Collection.**

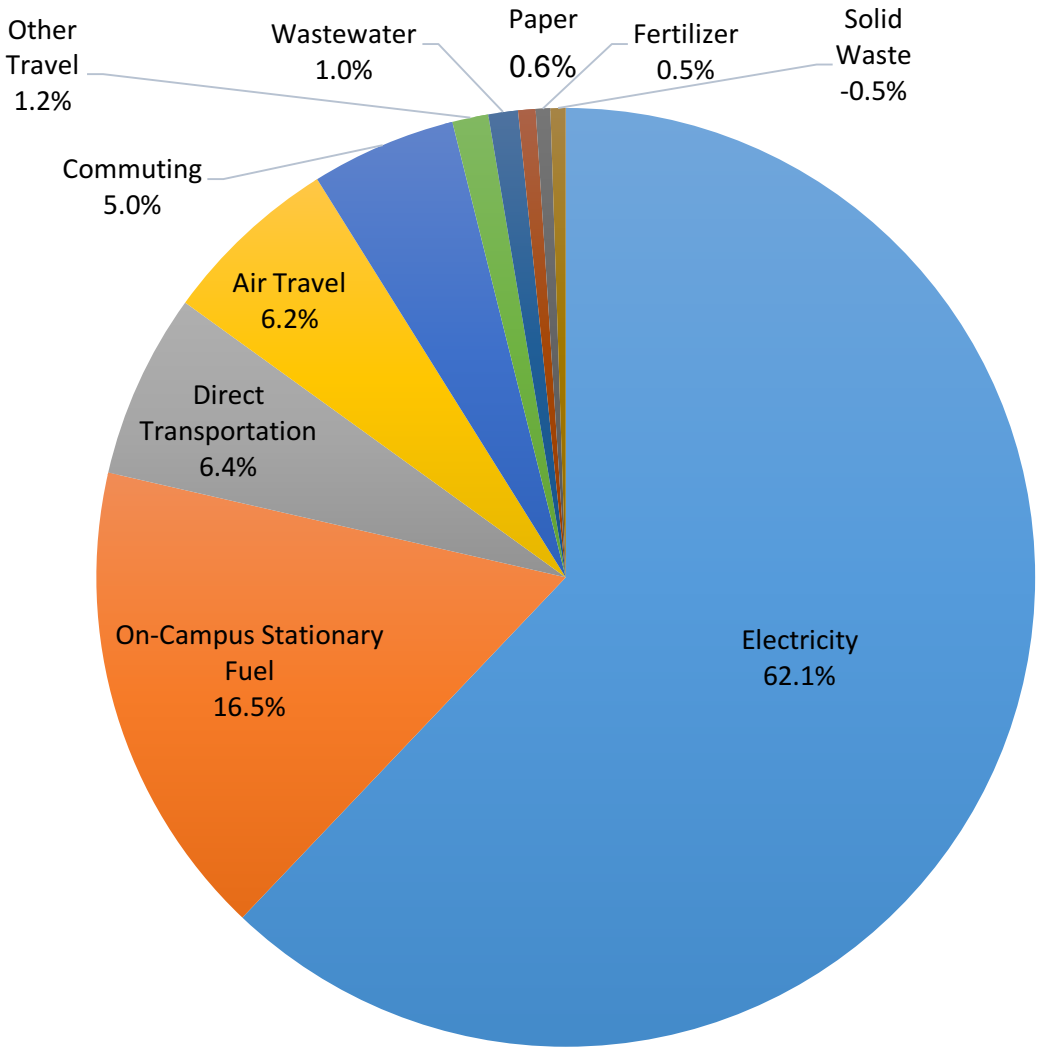

Figure 1. Percent of total eCO_2 emitted by source in FY2015.

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Scope 1 Emissions: Directly Controlled Sources

On-Campus Stationary Fuel Sources (Propane)

Background: CO_2, N_2O, and CH_4 emissions are all produced during propane combustion, which is the primary source of fuel for heating at VIMS. Nearly all fuel carbon (99.5%) is converted to CO_2 during combustion [1]. Propane is the largest single stationary fuel used on VIMS campus. Propane is more efficient than the fuel oil used to heat older buildings (*e.g.* Page House, Maury, and the Customer Service Building) on campus. Although fuel oil was included in our GHG calculations, it is excluded from this report due to its small contribution to overall GHG emissions. (< 1%, Appendix I).

Results: Propane use generated 1569.1 MT of eCO_2, accounting for 15.35% of total GHG emissions from the VIMS campus in FY2015. Total propane use has declined since 2010 (Figure 2a). However recent trends indicate an overall increase in propane use since 2012. In FY2015 propane use peaked in January, likely due to heating (Figure 2b). Andrews hall is the highest current consumer of propane on campus, followed by CBH and the SRL (Figure 3).

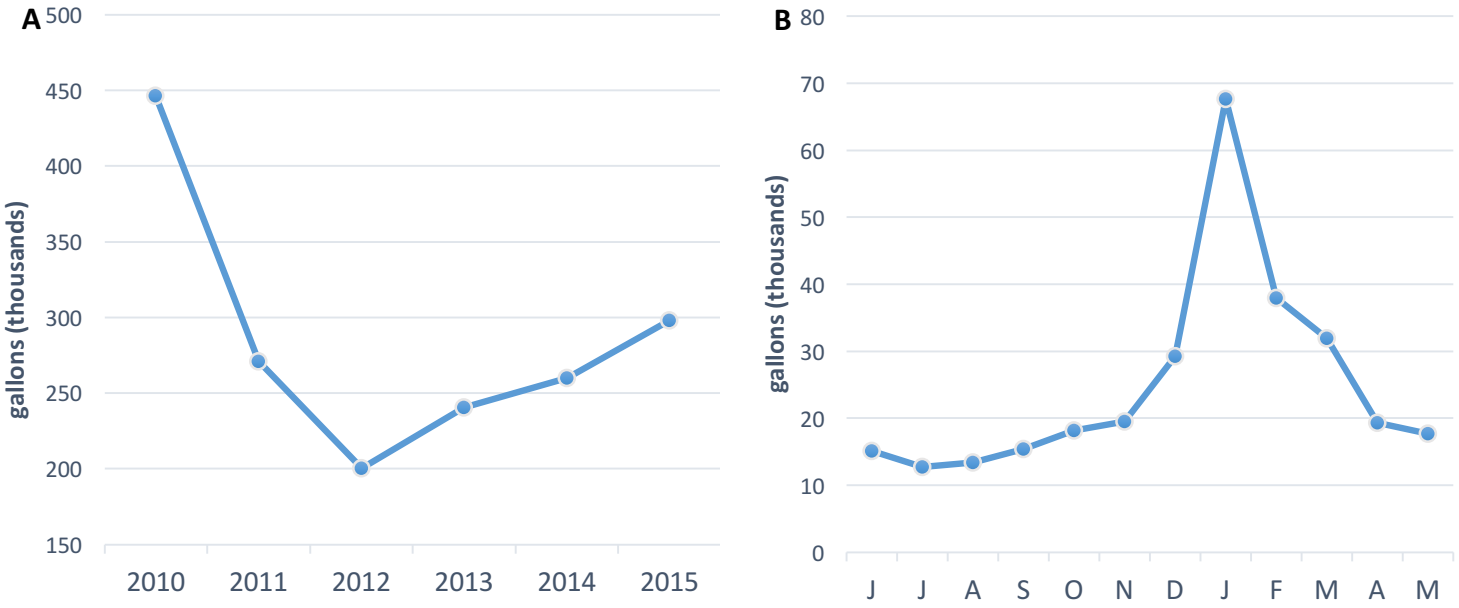

Figure 2. A) VIMS annual propane use over time; **B)** VIMS FY2015 propane use by month.

Recommendations: Increasing the efficiency of heating systems and maintaining proper weather proofing of buildings may lower wasteful propane usage.

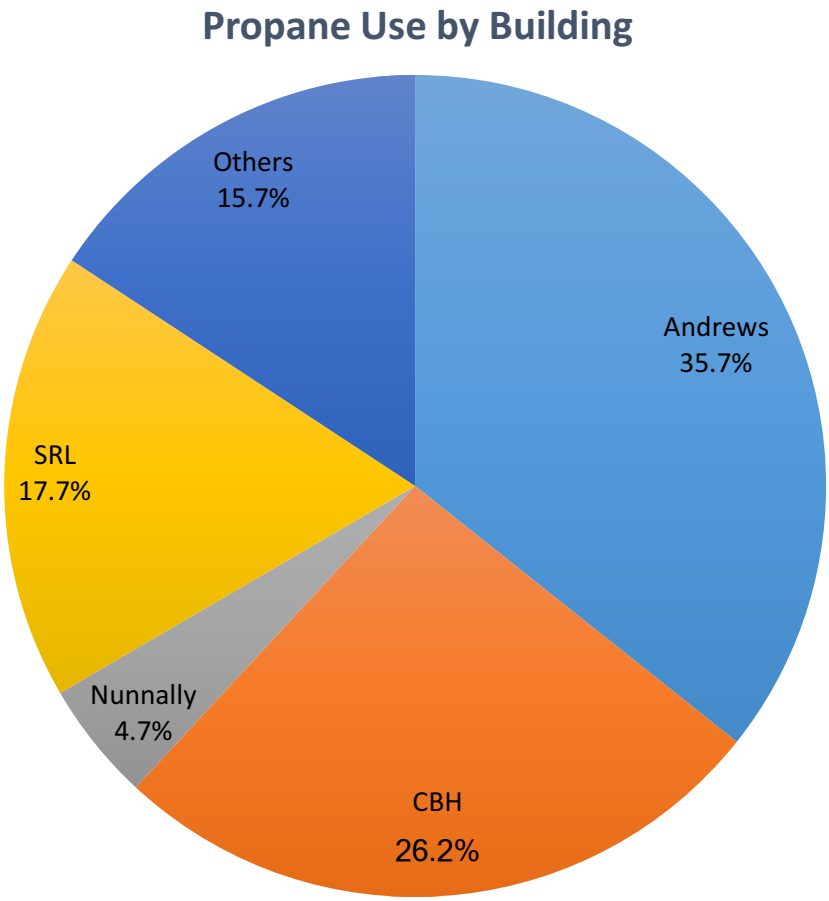

Figure 3. Percent of total propane use by building for FY2015.

Direct Transportation (Vehicles and Vessels)

Background: Gasoline and diesel combustion for vehicle/vessel operation is a widely recognized source of GHG emissions, including CO_2 as well as small amounts of CH_4 and N_2O [2]. Transportation accounted for 26% of total U.S. GHG emissions in 2014 [3]. Most VIMS vehicles and vessels use gasoline, and only a small number of VIMS vessels use diesel fuel.

Results: Direct transportation (i.e., fuel combustion by VIMS owned vehicles and vessels) generated 636.1 MT of eCO_2, accounting for 6.22% of total GHG emissions from the VIMS campus in FY2015. Although gasoline use has remained fairly constant over the past five years, a trend for lower gasoline consumption is potentially emerging. Gasoline consumption has declined since 2012, likely due to more fuel efficient engines and the retirement of the gasoline-powered R/V *Fishhawk* and replacement with the diesel-powered R/V *Tidewater*. This likely accounts for the increase in diesel fuel consumption since 2012.

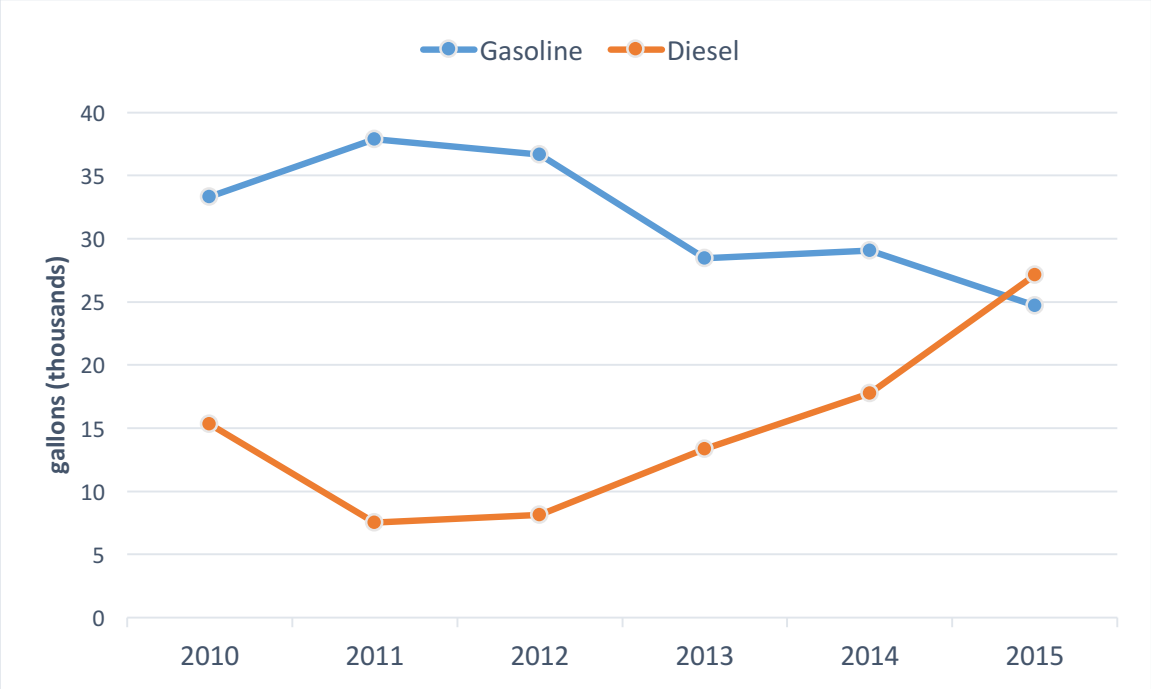

Figure 4. VIMS annual fuel use over time.

Recommendations: GHG emissions associated with direct transportation are directly related to field operations and other research/outreach activities at the institute. Since it is impractical, if not impossible to decrease miles travelled for these activities, we recommend continuing to phase out older, less efficient vehicles and vessels, and replace them with more fuel-efficient technology. Bio-diesel should also be phased in to reduce harmful emissions from diesel fuel use.

Agriculture

Background: There are two main pathways through which fertilizer use contributes to greenhouse gas emissions. First, the production of synthetic fertilizers is an energy intensive process resulting in substantial CO_2 emissions by fossil fuel combustion [4]. The application of nitrogen from synthetic fertilizers then results in the emission of a second GHG, nitrous oxide (N_2O), as microbes break down the nitrogen in the soil [5,6].

Results: Agriculture (i.e., fertilizer application) generated 0.03 MT of eCO_2, accounting for < 1% of total GHG emissions from the VIMS campus in FY2015. 2010 fertilizer data was not included in this analysis due to discrepancies in data collection. However, fertilizer application at the VIMS campus has been declining steadily since 2011. In 2015, it is estimated that the VIMS campus applied 35 lbs. of a 12% nitrogen content synthetic fertilizer; this is less than 1/3 of what was applied in 2011 (Figure 4).

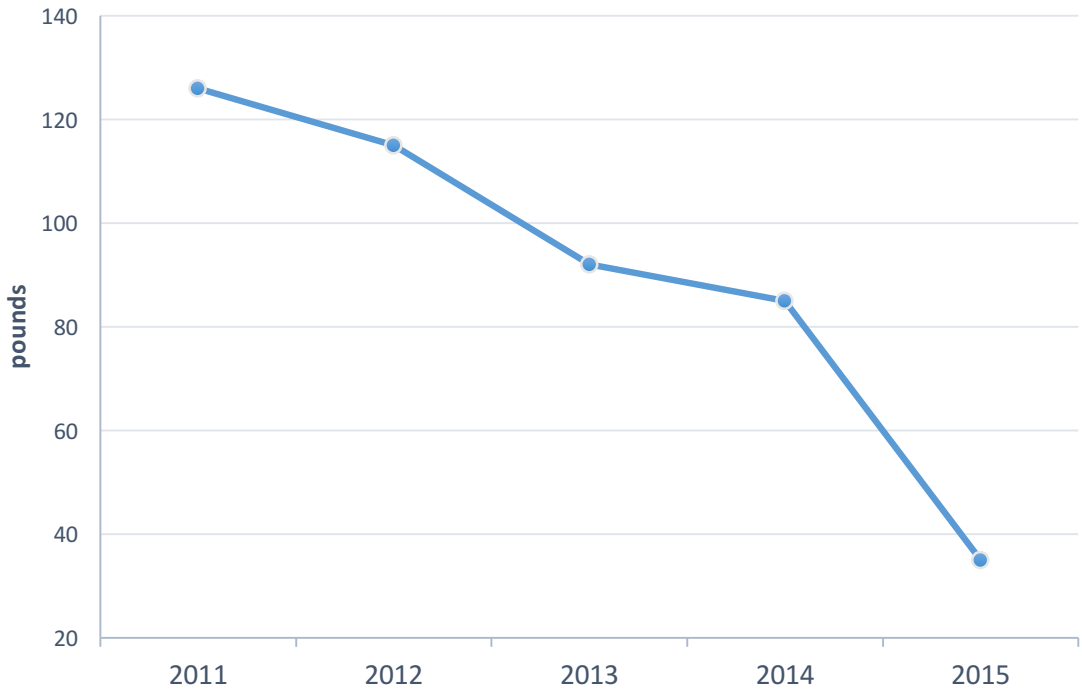

Figure 5. VIMS annual fertilizer application over time (Gloucester Point campus only).

Although not included in the overall GHG emission survey, we also obtained information regarding fertilizer use at VIMS Eastern Shore Lab (ESL). The ESL applies an estimated 500 lbs. of 21.6% nitrogen content synthetic fertilizer each year. This is about 143 lbs. of fertilizer per acre of the ESL campus.

Recommendations: The VIMS campus has done a great job decreasing fertilizer use over the past five years. We recommend that VIMS continue with its current fertilizer practices, making sure to apply fertilizer only as needed. Although fertilizer application does not comprise a

significant portion of GHG emissions, nutrient loading poses a serious environmental threat. The ESL should look for ways to decrease fertilizer application, thus minimizing the negative consequences of nutrient loading on the Wachapreague shore.

Scope 2 Emissions: Off-Campus Electricity Generation

Purchased Electricity

Background: Electricity production is one of the primary sources of GHG emissions in the United States. Nearly 70% of electricity is supplied by fossil fuel combustion of mostly coal and natural gas [7]. Electricity use is reported as kilowatt hours (KWH).

Results: Purchased electricity generated 6203.39 MT of eCO_2, accounting for 62.1% of total GHG emissions from the VIMS campus in FY2015. VIMS' electricity use follows a seasonal pattern, peaking each summer, likely due to cooling. Overall electricity use at VIMS declined by 15% from 2010 – 2013 and then increased slightly by 3% from 2013 – 2015 (Figure 5). Institutional changes that may have contributed to the decrease in energy use include the installation of more energy efficient boilers on campus, as well as more efficient lighting in Chesapeake Bay Hall, Waterman's Hall and Nunnally Hall (Debbie Galvez, personal communication). Five buildings were responsible for 90% of VIMS electricity use in FY2015: Andrews Hall, Chesapeake Bay Hall, Waterman's Hall, Seawater Research Lab and Nunnally Hall (Figure 6).

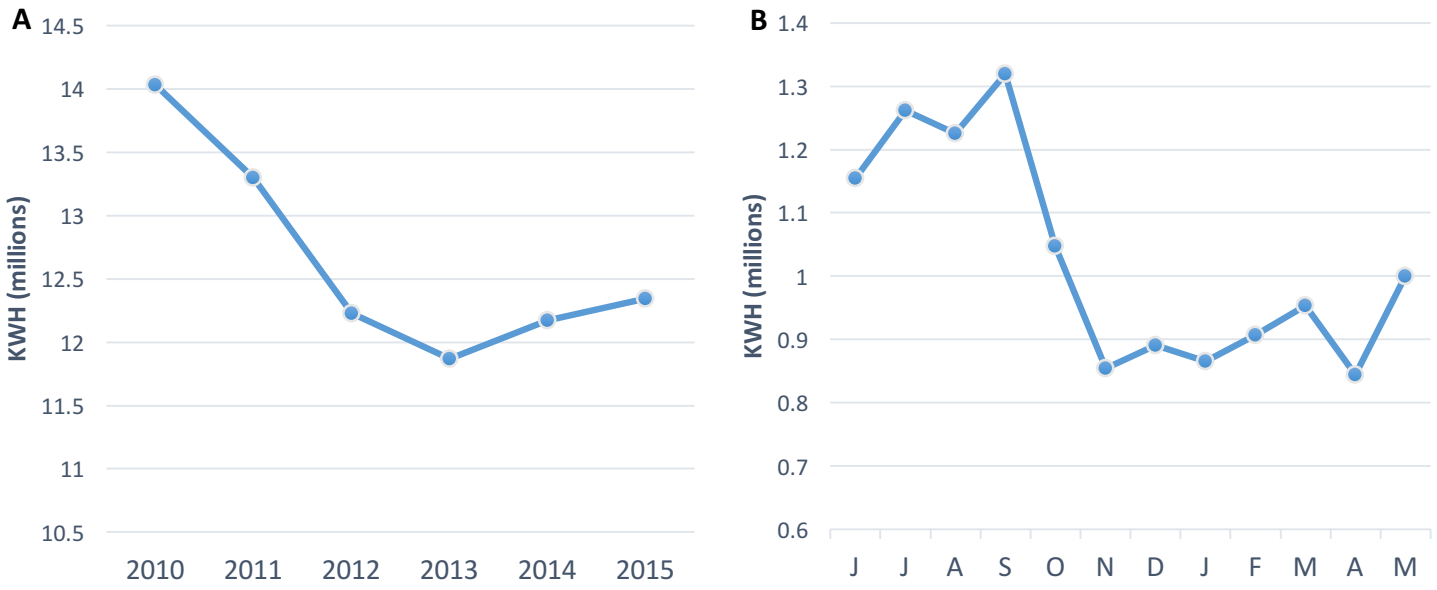

Figure 5. A) VIMS annual electricity use over time; **B)** VIMS FY2015 electricity use by month.

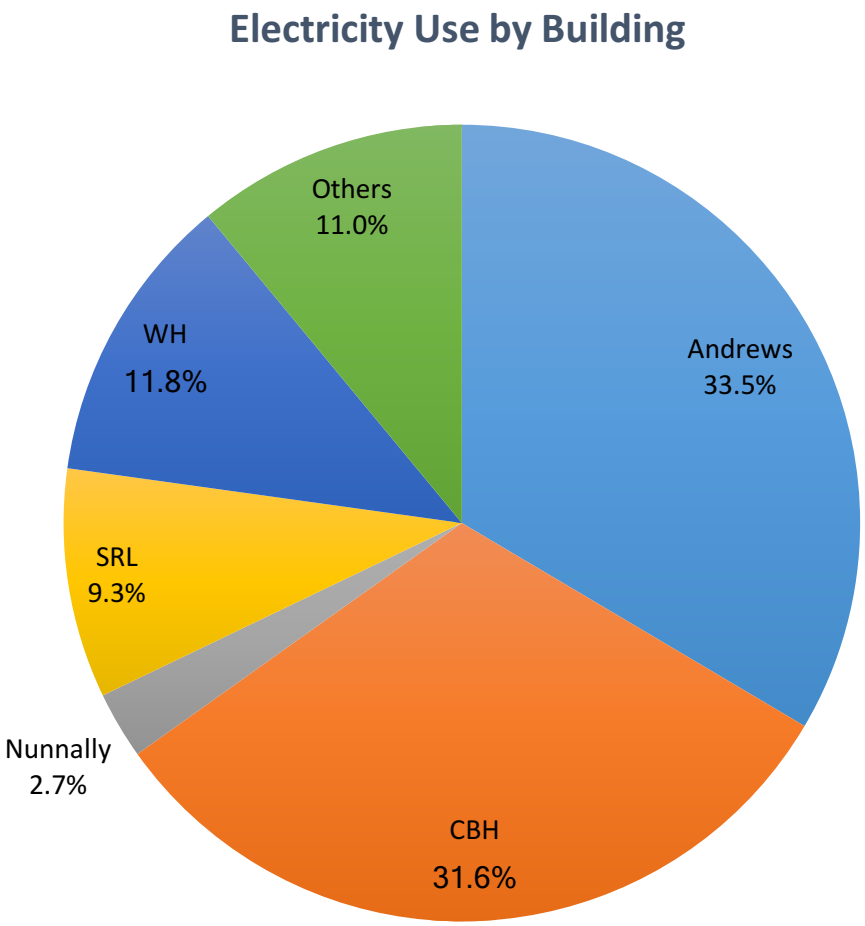

Figure 6. FY2015 electricity use by building.

Recommendations: We recommend that VIMS continue installing energy efficient/motion activated lighting in additional buildings and outdoor areas. Energy efficiency in Chesapeake Bay Hall should improve after the impending renovations to the building envelope and HVAC system.

Scope 3 Emissions: Off-Campus Emissions

Commuting

Background: Commuting to work is included in VIMS' GHG emissions data because it is necessary for the institute to function. A commuting habits survey was distributed to faculty, staff and students, who self-reported means of commuting, average distance traveled, and how many times per week they commute. Driving alone and carpooling are the only means of commuting that contribute to GHG emissions, but information is also provided regarding walking and biking to work.

Results: 83% of the VIMS community commutes to campus by driving alone, 8% carpool, and the remaining 9% either walk or bike to work. This is not a significant change in commuting habits from FY2010 (Figure 7). FY2015 commuting by Faculty and Staff, contributed 444.94 MT eCO_2, or 4.35% of total emissions. Student commuting resulting in 53.44 MT eCO_2, which is < 1% of total emissions for FY2015.

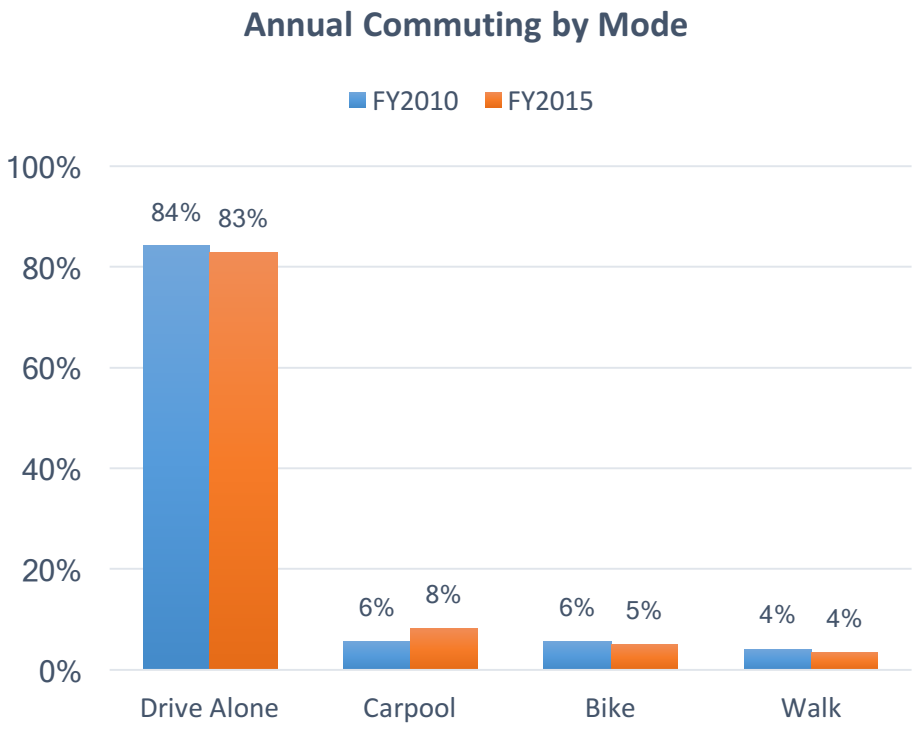

Figure 7. Percent of VIMS commuting methods over time.

74% of students commute to VIMS by car, with an average commute distance of 5.4 miles. In contrast, 99% of faculty and staff commuting is by car, with an average commute distance of 15.6 miles (Figure 8). The combination of more faculty and staff commute by car a farther

distance to reach VIMS results in a higher amount of eCO_2 emitted by faculty and staff than students.

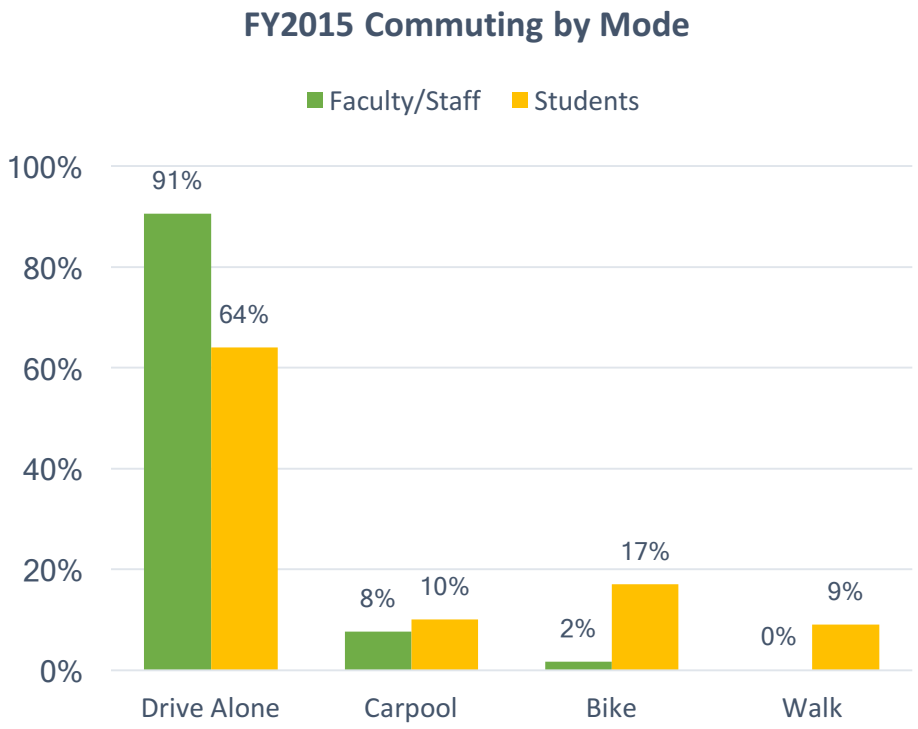

Figure 8. Percent of FY2015 Faculty/Staff and Student commuting methods.

Recommendations: Of the available commuting methods, driving alone generates the most carbon emissions per capita. Since public transportation is not available in this area, the most efficient method of reducing emissions is to encourage more carpooling by faculty, staff, and students. We recommend establishing a carpooling list-serve to facilitate ride sharing, and perhaps a discounted parking permit for carpooling vehicles. For those who commute less than two miles to VIMS, we recommend walking or riding a bike whenever practical. Gloucester Point is currently not a walk/bike friendly community, so we encourage the administration to appeal to the local government to establish crosswalks and bike-lanes near campus.

Directly Outsourced Financed Travel

Background: This category refers to business travel not utilizing VIMS vehicles or vessels. Travelling away from the institution is often necessary for field work, to present research at conferences and meetings, and for faculty service on professional committees. Air travel is among the most notorious of GHG polluters, contributing 11% of the CO_2 emissions from all transportation modes in the U.S [2].

Results: Air travel in FY2015 contributed 615.80 MT eCO_2 to the atmosphere, and comprised 6.02% of total VIMS GHG emissions. Faculty and Staff traveled 873,447 miles by air, and students traveled 439,045 miles (Figure 9). Air travel miles have decreased by 60% since FY2010.

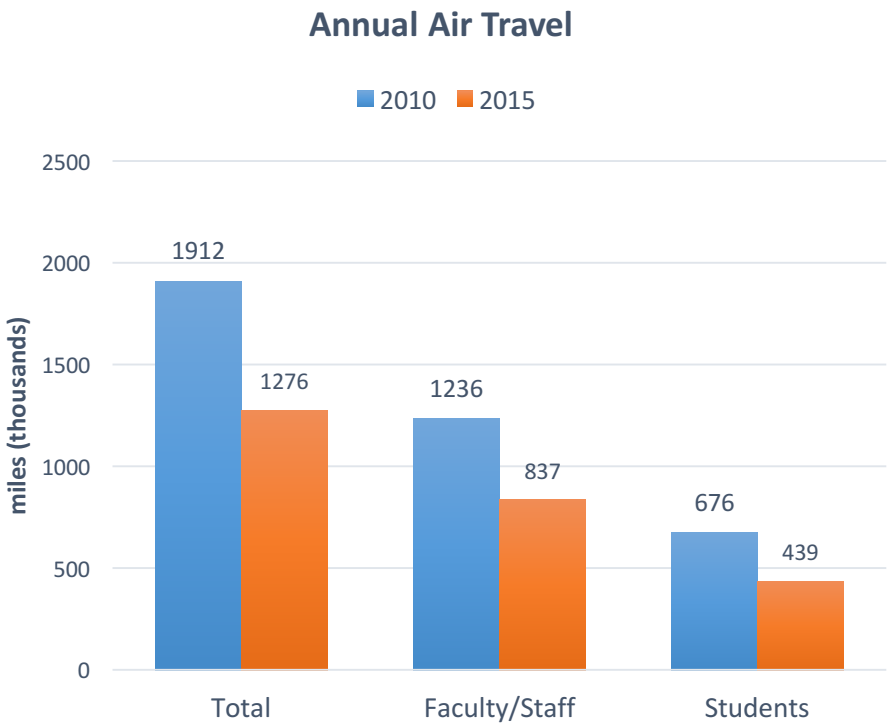

Figure 9. VIMS annual air travel in FY2010 and FY2015.

"Other travel" miles, including taxi, rental car, bus, train, personal mileage reimbursement and non-VIMS vessels, contributed 124.10 MT eCO2 in FY2015, or about 1.21% of total VIMS emissions. Personal mileage reimbursement accounts for nearly 72% of "other travel" from FY2015, but was not surveyed in FY2010. Excluding personal mileage, miles accrued by "other travel" means in FY2015 was 80% less than in FY2010 (Figure 10).

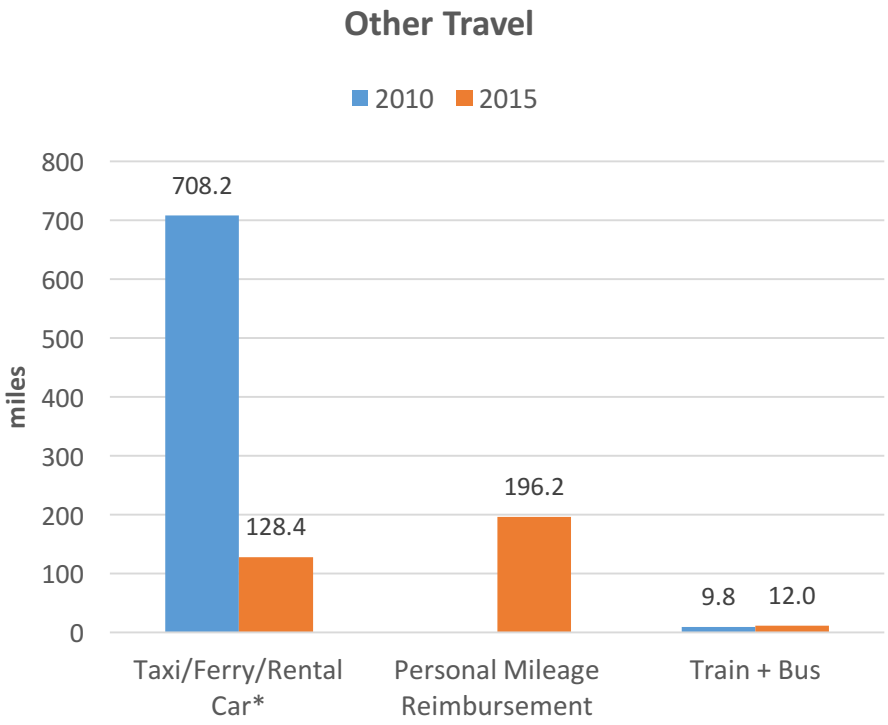

Figure 10. VIMS annual travel miles by other means, including personal mileage.

Recommendations: Where practical the VIMS community should consider traveling by train to cut emissions from air travel. When it is not possible or practical to travel by train, travelers should consider donating to the William & Mary Carbon Offset program (http://offset.wm.edu). 100% of funds go towards energy reducing projects on campus. Carbon offset programs allow people to compensate for their personal carbon emissions by donating to projects that reduce CO_2 emissions.

Solid Waste

Background: In the United States, most solid waste is managed by landfilling, which produces primarily CH_4 and CO_2. Large municipal waste landfills are required by law to collect and combust landfill gas, and many are landfill gas-to-energy (LFGTE) facilities, which harvest landfill gas and use it for energy production [8]. VIMS solid waste ultimately ends up at the Middle Peninsula Landfill, a LFTGE facility.

Results: Waste Management does not currently audit waste removal at VIMS. Instead Waste Management provided a simple calculation to estimate the weight of solid waste removed from campus per month. A different conversion factor was used to estimate the weight of solid waste in FY2010, leading to the discrepancy in the reported numbers between the two years (Figure 11). Regardless, solid waste collection is considered an offset of our eCO_2 GHG emissions due to the LFGTE technology employed by the Middle Peninsula Landfill. Offsets in FY2015 totaled 2.2 MT eCO2, which is about 25% less than offsets from solid waste disposal in FY2010.

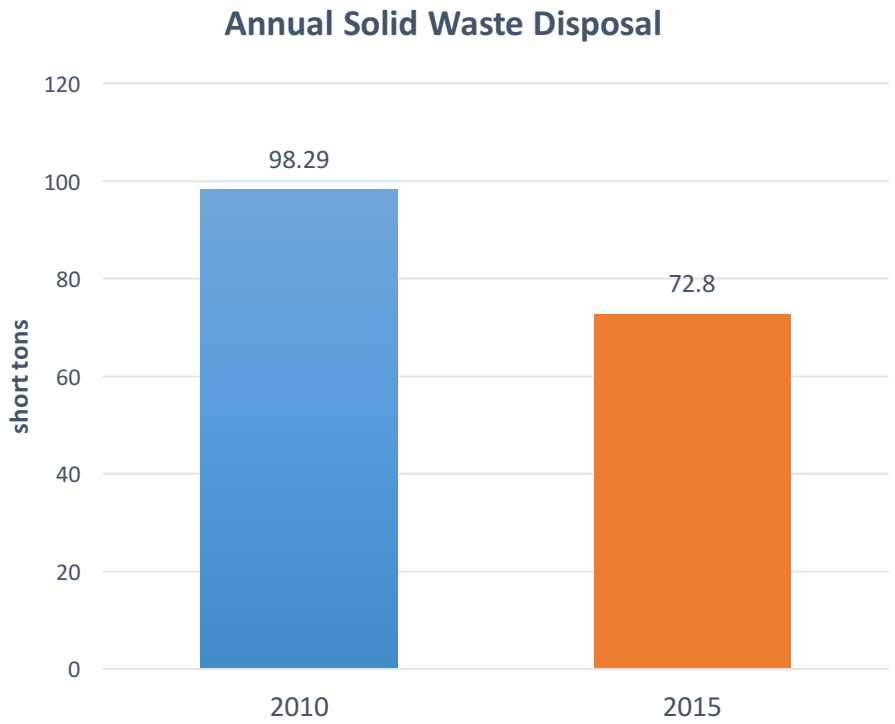

Figure 11. Estimated VIMS annual solid waste disposed in FY2010 and FY2015.

Recommendations: The only way to remedy the discrepancy between these two years is to have Waste Management audit VIMS waste for one year. Unless waste practices on campus change dramatically, the same number can be used each year. VIMS can also continue to reduce waste by increasing recycling efforts and utilizing electronic and other means of communication in lieu of paper.

Wastewater

Background: Wastewater treatment processes produce methane (CH_4) and nitrous oxide (N_2O) emissions, which are much more potent greenhouse gases than CO_2 [8]. Wastewater from VIMS is treated at the Hampton Roads Sanitation District York River Treatment Plant. The plant uses a combination of aerobic and anaerobic processes and ultimately discharges treated wastewater into the York River. Wastewater discharge from VIMS is not directly metered, thus we present VIMS water use as a proxy for wastewater discharge.

Results: GHG emissions from wastewater totaled 101.8 MT eCO_2 in FY2015. This is an 88% decrease from FY2010, when emissions totaled 865.46 MT eCO_2. Emissions from VIMS wastewater treatment accounts for 1% of total emissions from the campus in FY2015. Water use varies depending on what projects are active on campus, and this is reflected in the yearly water use (Figure 12A). The drastic reduction of water use between 2010 and 2011 can be attributed to the replacement of faulty water meters on campus in 2011 [Debbie Galvez, personal communication]. We have isolated the data post-replacement of the meters to more accurately show the fluctuations in water use on campus (Figure 12B). Water use again decreased significantly in FY 2013, but the cause is unknown.

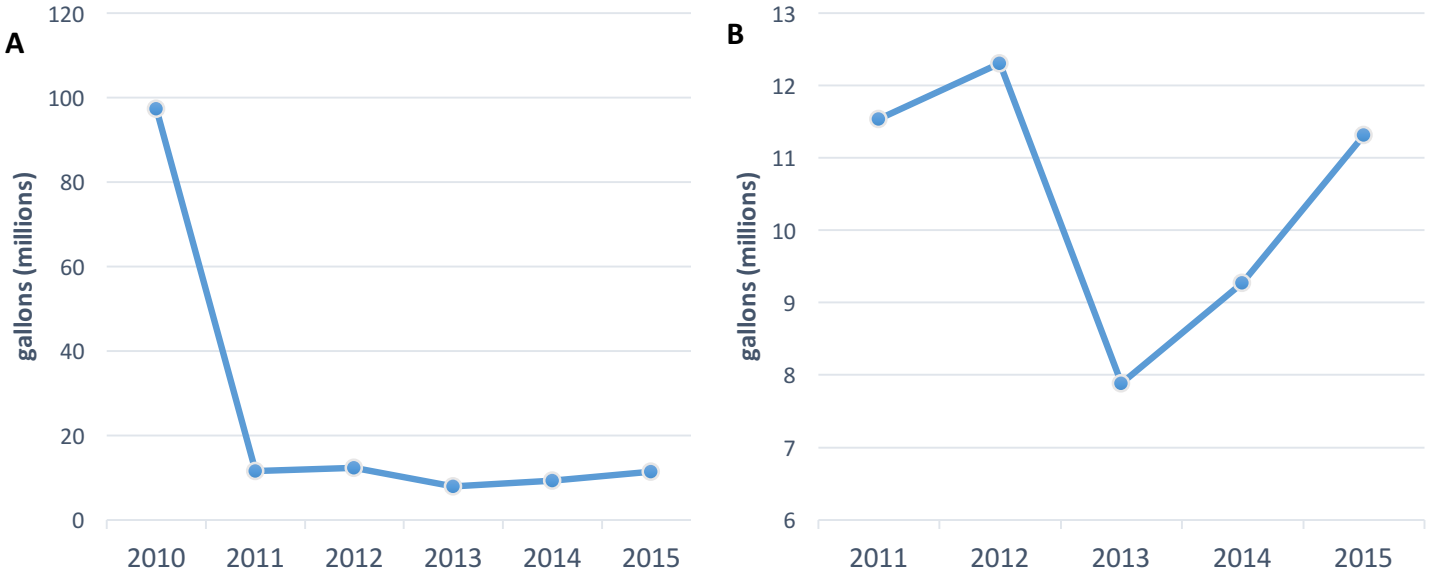

Figure 12. VIMS annual water use. **A)** Including 2010, before faulty water meters were replaced; **B)** Excluding 2010, after meters were replaced in 2011.

Recommendations: VIMS has already begun to take steps to reduce water consumption on campus. The VIMS Community Garden installed a rain collection barrel so that gardeners can use rainwater for watering plants throughout the dry months instead of piped water. Additionally, VIMS Green Team recently submitted a W&M Green Fee proposal to retrofit 46 toilets with dual-flush capabilities, potentially reducing water use by 78,300 gallons per year. Other projects that could be implemented include rain collection barrels for irrigation and other non-potable water purposes.

Paper

Background: Paper is undoubtedly an important resource utilized throughout VIMS campus. Without paper, it would be difficult to conduct daily business, communicate information, and keep pace with the constantly changing field of marine science. However, for many services, there are new tools and methods available to replace paper use and provide the service more efficiently and potentially at less cost. Currently, the average American office worker is estimated to use a sheet of paper every 12 minutes and dispose of 100-200 lbs of paper every year [9]. The number of pages in U.S. offices is also growing by 20 percent each year [10].

Results: Paper use contributed 10.03 MT eCO_2 emissions during FY2015, an insignificant reduction from 10.30 MT eCO_2 produced in FY2010. Paper use on campus has decreased overall by nearly 1000 lbs since FY2010, with a spike in 2011 (Figure 13).

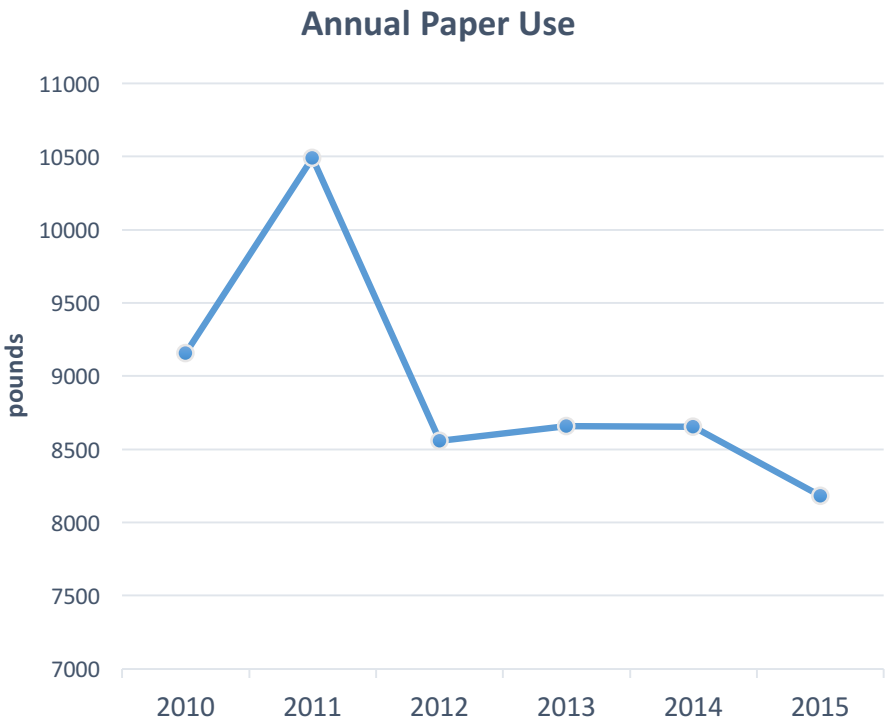

Figure 13. VIMS paper use overtime. Consumption spiked in 2011 and has been decreasing.

Despite the overall decrease in paper consumption, some departments have increased their paper use (Figure 14). Waterman's Hall and associated departments (Information Technology, Advisory Services, Office of the Dean, Sponsored Programs, Academic Studies, etc) have increased their paper usage by 264% since FY2010. This apparent increase may be due in part to differences in reporting and past record keeping of paper purchased.

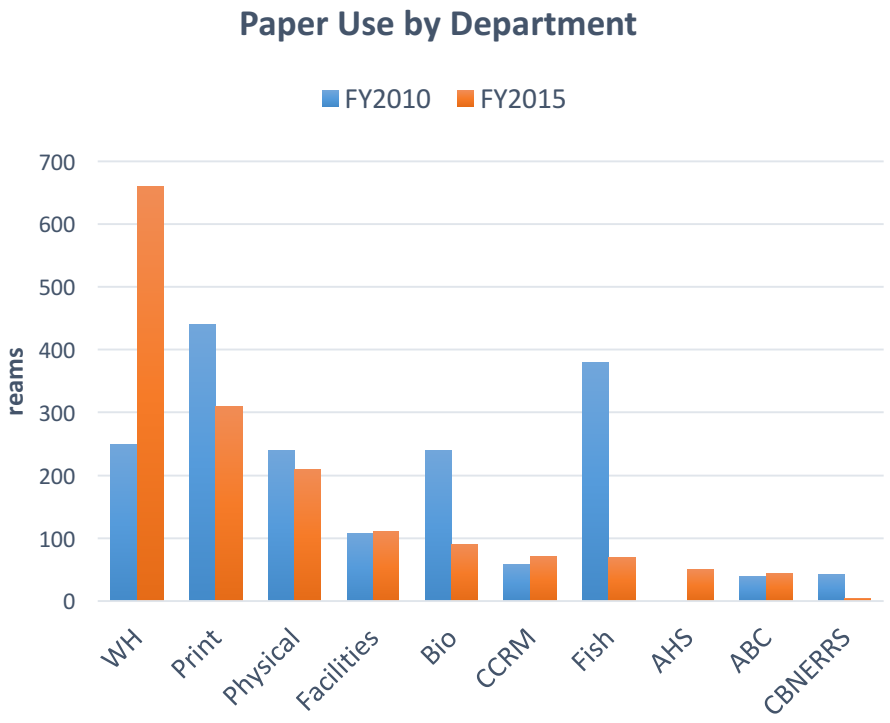

Figure 14. VIMS annual paper use by department. Waterman's Hall, Facilities, and the ABC have increased their paper use since FY2010.

Recommendations: VIMS is already taking important measures to decrease paper use, such as printing double sided, ordering paper manufactured with recycled content, and converting manuals and brochures into distributable electronic PDFs. As a campus, we should continue to look for ways to reduce paper consumption.

To aid in future GHG inventories, business managers should consider keeping a spreadsheet of paper purchases, including reams, recycled content, and size. This will help identify changes in use over time as our world becomes increasingly digital.

Summary of Recommendations

Overall, VIMS' annual GHG emissions appear to be declining, but there is plenty of room for improvement. We recommend the following actions be taken:

1. Investigate the purchasing of bio-diesel in lieu of traditional diesel products
2. Continue to phase out older, less efficient engines and replace with more fuel-efficient technologies
3. Investigate increasing the efficiency of heating systems throughout campus
4. Continue installing energy efficient and motion activated lighting in additional buildings and outdoor areas
5. Seek to maintain building weather proofing and HVAC systems
6. Establish a carpool email list-serve and offer discounted parking or premium parking spots to carpooling vehicles
7. Lobby for proper crosswalks and bike lanes in the areas surrounding campus
8. Encourage donating to the William & Mary Carbon Offset program when traveling by car or air for business travel
9. Install rain collection barrels for irrigation and non-potable water uses
10. Install dual-flush toilets to reduce water waste
11. Increase recycling and utilization of electronic communications in lieu of paper forms
12. Track paper purchasing more closely, including reams purchases, recycled content, and paper size, to help identify use trends over time and allow for further recommendations to be made

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Appendix I: Total GHG Emissions

Table 2. VIMS GHG Emissions for FY2010.

Source	Energy Consumption (Mmbtu)	CO_2 (kg)	CH_4 (kg)	N_20 (kg)	eCO_2 (MT)
Scope 1					
On-Campus Stationary Fuel	37938.53	2341186.71	400.25	24.02	2358.35
Direct Transportation	6268.43	452812.04	70.85	24.73	461.95
Fertilizer	0.00	0.00	0.00	0.07	0.02
Scope 2					
Purchased Electricity	47844.43	6833886.96	132.81	82.83	6861.89
Scope 3					
Faculty / Staff Commuting	11814.88	843030.74	177.34	59.31	865.14
Student Commuting	1205.21	85995.56	18.09	6.05	88.25
Directly Financed Air Travel	5143.67	1003170.83	9.94	11.43	1006.83
Other Travel	2908.13	207371.99	43.38	14.52	212.78
Solid Waste	0.00	0.00	-117.60	0.00	-2.94
Wastewater	0.00	0.00	32688.27	158.58	864.46
Paper	0.00	0.00	0.00	0.00	10.30
In-Transit Electricity Losses	2957.16	422387.75	8.21	5.12	424.12
Total Emissions	**116080.43**	**12189842.59**	**33431.55**	**386.65**	**13151.15**
Additional Offsets	0.00	0.00	0.00	0.00	0.00
Net Emissions	**116080.43**	**12189842.59**	**33431.55**	**386.65**	**13151.15**

Table 3. VIMS GHG Emissions for FY2015.

Source	Energy Consumption (Mmbtu)	CO_2 (kg)	CH_4 (kg)	N_20 (kg)	eCO_2 (MT)
Scope 1					
On-Campus Stationary Fuel	26295.81	1636529.39	249.24	14.95	1647.22
Direct Transportation	8615.53	624554.79	88.19	31.32	636.09
Fertilizer	0.00	0.00	0.00	0.11	0.03
Scope 2					
Purchased Electricity	43253.05	6178075.00	120.06	74.88	6203.39
Scope 3					
Faculty / Staff Commuting	6076.34	433567.22	91.23	30.50	444.94
Student Commuting	741.91	52937.88	11.14	3.72	54.33
Directly Financed Air Travel	3146.01	613565.89	6.08	6.99	615.80
Other Travel	1697.05	120960.36	25.12	8.42	124.10
Solid Waste	0.00	0.00	-87.36	0.00	-2.18
Wastewater	0.00	0.00	3852.02	18.45	101.80
Paper	0.00	0.00	0.00	0.00	10.20
In-Transit Electricity Losses	2673.38	381853.43	7.42	4.63	383.42
Total Emissions	**92499.09**	**10042043.96**	**4363.15**	**193.99**	**10219.13**
Additional Offsets	0.00	0.00	0.00	0.00	-0.14
Net Emissions	**92499.09**	**10042043.96**	**4363.15**	**193.99**	**10218.99**

Appendix II: Data Collection

Institutional Data:
Numbers of current and past Faculty, Staff and Students was provided by Elizabeth MacDonald, Assistant to the Dean and Director.
Contact: ehmacd@vims.edu, ext. 7201

Operating, Research and Energy Budget information was provided by Betty Barrack, Executive Budget Administrator.
Contact: blb@vims.edu, ext. 7030

Physical Size data were provided by Mark Brabham, Facilities Manager.
Contact: mbrabham@vims.edu, ext. 7048

Scope 1

On-Campus Stationary Fuel Sources:
Monthly propane and residual oil data by building were provided by Robin Rennie, the Facilities Management Administrative Assistant. Data were summed over each month to provide yearly totals and entered into the calculator.
Contact: rennie@vims.edu, ext. 7096

Direct Transportation:
Gasoline use by pool vehicles was provided by Robin Rennie, Facilities Management Administrative Assistant.
Contact: rennie@vims.edu, ext. 7096

Gasoline and diesel use by VIMS vessels were provided by Terri Major, Financial Manager for Field Operations.
Contact: tcmajor@vims.edu, ext. 7056

Gasoline from pool vehicles and vessels were summed to provide the total gasoline usage in Scope 1.

Agriculture:
Fertilizer data for VIMS was provided by Kenneth Borkey, from Facilities Management/Grounds.
Contact: kborkey@vims.edu, ext. 7067

Fertilizer data for ESL was provided by Justin Paul, acting Facilities Manager at ESL.
Contact: jpaul@vims.edu, (757) 787-5832

Scope 2

Purchased Electricity:
Electricity data was provided by Facilities Management Business Manager, Debbie Galvez. Contact: dagalv@vims.edu, ext. 7090

Scope 3

Faculty/Staff & Student Commuting:
A commuter survey was distributed via WM Forms on September 2, 2016. Responses were solicited from VIMS staff, faculty and students for a two-week period, ending on September 16, 2016. Post-Doctoral staff were counted as Students. The Student response rate was 59%, 54% for Faculty, and 35% for Staff. All data entered was scaled up from the responses to represent the entire student/faculty/staff body. This survey can be found in **Appendix III: Commuter Survey**.

- The same analyses were done for each category of Student, Faculty, and Staff, and entered into their respective slots in the calculator.
- The number of commuters was entered as total populations for each group, as there is no on-campus housing.
- The number of one way trips per week was entered as the average of all responses. The same was done for the number of weeks per year that each responded entered they travel to VIMS. Any responses that were '0' for these two average were considered as participate who were not yet at VIMS during fiscal year 2015, and were not considered in the average.
- The percent of respondents that commute by each mode of travel was calculated by taking the total respondents per each mode divided by the total number of respondents. 0% was entered for any mode that no respondents claim to use.
- The miles per one-way trip of each mode of transportation was entered as the average one-way commute distance per all the respondents that claimed that as their primary mode of transportation.

Directly Financed Travel:
The commuter survey distributed also captured information related to directly financed travel.

- For the Staff, Faculty, and Students, the average miles traveled by each respondent was averaged over the entire category (all faculty, all students, or all staff responses).
- For air travel, the average of the faculty and staff responses were averaged together and entered into the calculator, since it requested the combined number. Student average for air travel was separately entered.

- For train, bus, and personal reimbursement, the average of all three categories was entered into the calculator.
- Research cruise miles were averaged for all three categories and entered into the "Taxi/Ferry/Rental Car" section along with the average of the 'other' category.
- Study abroad, alternative fuel bus, and student travel home were not considered.

Solid Waste:
Solid waste data was provided by Mark Brabham, Facilities Management Director, who in turn contacted Waste Management. The calculation used to determine tons of solid waste produced per year is as follows:

$$7 \text{ containers} \times 8 \text{ yard}^3 = 56 \text{ yard}^3 \text{ serviced weekly}$$

$$56 \frac{\text{yard}^3}{\text{wk}} \times 52 \frac{\text{wk}}{\text{yr}} = 2912 \frac{\text{yard}^3}{\text{yr}}$$

$$2912 \frac{\text{yard}^3}{\text{yr}} \times 50 \frac{\text{lb}}{\text{yard}^3} \div 2000 \frac{\text{lb}}{\text{ton}} = 72.8 \text{ ton/yr}$$

Contact: mbrabham@vims.edu, ext. 7048

Wastewater:
HRSD bills were provided by Debbie Galvez, Facilities Management Business Manager. Gallons of water used were tallied from each monthly bill for each fiscal year to arrive at yearly use. The Campus Carbon Calculator provides 3 treatment columns in which to enter data: aerobic, anaerobic, and anaerobic digestion. It is unknown how the VIMS wastewater stream is diverted once at the York River facility, so data was entered into the anaerobic column with the reasoning that most of our waste is liquid in nature and to match with the previous greenhouse gas assessment.

Contact: dagalv@vims.edu, ext. 7090

Paper Purchasing:
Data was collected for fiscal years 2011-2015, however, some records were better kept than others so estimates by department were only based on purchasing records from FY 2015. To collect data, business managers were first contacted to obtain paper use for FY 2011-2015. Most responded within two weeks of original email. If records could not be obtained by the business manager, contact information was given for the actual paper supplier. Some business managers only gave broad estimates of paper purchased, which was acceptable for the purposes of this inventory, but actual purchasing orders were preferred. In addition, some departments only keep records for past five years due to policy so keeping account of paper use

every year, rather than retroactively for the next greenhouse gas inventory, is strong suggested. A contact list of business managers contacted is provided. An added contact for The Supply Room is also given as they were extremely useful in supplying purchase orders.

Each ream of paper was estimated at being 5 lbs based on the methods used by the 2010 inventory. The actual weight of the paper, varied by the size of the paper purchased (i.e., 8 ½ x 11" or 11 x 17") but this difference was not specified in the 2010 analysis. Therefore, data has been calculated for FY 2011-2015 with the same methods used in 2010 to compare change in paper usage overtime as well as using a different conversion from reams to pounds based on paper size. It is suggested in future inventories this differentiated method be used as a more accurate conversion.

Conversions:

$$1 \text{ ream } 11\text{x}17\text{" paper} = 4.75\text{lbs}$$
$$1 \text{ ream } 11\text{x}17\text{" paper} = 2 \text{ reams } 8.5\text{x}11\text{" paper}$$
$$1 \text{ ream } 8.5\text{x}11\text{" paper} = 2.36\text{lbs}$$

Business manager contact list:

Name	**Department**	**Contact information**
Cynthia Harris	Physical Sciences	harris@vims.edu
Maxine Butler	Biological Sciences	maxine@vims.edu
Mike Ivey	Aquatic Health Sciences	mivey@vims.edu
Cindy Forrester	Fisheries Sciences	cforrest@vims.edu
Susan Stein	Print Shop	sstein@vims.edu
Sally Lawrence	CBNERRS	slawrence@vims.edu
Dawn Fleming	CCRM	dawnf@vims.edu
Debbrah Pelata	ABC-hatchery/Kauffman Center	dpelata@vims.edu
Linda Ward	Eastern Shore Laboratory	lward@vims.edu
Cheryl Teagle	Advisory Services	cteagle@vims.edu
Carol Birch	Waterman's copiers/printers	cjbirch@vims.edu
Debbie Galvez	Facilities Management	dagalv@vims.edu
Matt Bristow	The Supply Room	mbristow@tsrcinc.net

Appendix III: Commuter Survey

VIMS | WILLIAM & MARY
VIRGINIA INSTITUTE OF MARINE SCIENCE

Commuter Survey

What is your role at VIMS?

- ◯ Student
- ◯ Faculty
- ◯ Staff/Administrator

Daily Commute

What is your PRIMARY mode of transportation to VIMS?

- ◯ Walk
- ◯ Bike
- ◯ Drive (alone)
- ◯ Drive (carpool)

How far is your commute to VIMS (one-way only)? Please estimate in miles.

On average, how many times a week do you commute to VIMS ?

How many weeks did you commute to VIMS in FY2015 ?

If you participated in a research cruise on a non-VIMS vessel in FY2015, please answer the following question.

How far did you travel on research cruises in FY2015? Please estimate in miles.

If you travelled for business or research in FY2015, please answer the following questions regarding transportation.

How far did you travel by AIR for business in FY2015? Please estimate in miles.

How far did you travel by TRAIN for business in FY2015? Please estimate in miles.

How far did you travel by BUS for business in FY2015? Please estimate in miles.

How far did you travel by TAXI, FERRY or Rental CAR for business in FY2015? Please estimate in miles.

How far did you travel in a Personal CAR in FY2015 for business? Please estimate in miles.