FY 2018 Colgate University Greenhouse Gas Inventory Report

A step-by-step guide to completing the annual greenhouse gas inventory at Colgate University.

Colgate
Office of Sustainability

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EXECUTIVE SUMMARY

This year marks Colgate's tenth consecutive greenhouse gas inventory report. Colgate's gross campus carbon emissions in Fiscal Year 2018 was 9,464 metric tons of carbon dioxide equivalent ($MTeCO_2$). That represents a 7,888 ton reduction from our 2009 baseline, a 45 percent reduction. Likewise, we have reduced our net campus carbon footprint (scope 1, 2, and 3 emissions plus forest sequestration and carbon offsets) by 12,925 $MTeCO_2$, representing a 75 percent reduction. Since signing the American College and University Presidents' Climate Commitment (ACUPCC) in 2009, rebranded as Second Nature's Carbon Commitment, Colgate has implemented many changes on and off campus to achieve these reductions, moving closer toward our goal of carbon neutrality by 2019.

Colgate's historical greenhouse gas emissions vary from year to year as a result of changing emission factors, improved methodology for tracking and reporting emissions (particularly Scope 3 emissions), and changes in operational practices and campus policies/procedures.

In 2015, we switched to new finance and travel management systems, Concur and Christopherson Business Travel, respectively. This significantly improves the accuracy of how we track and obtain emissions data relating to air and ground travel. However, this influenced our Scope 3 emissions – not necessarily because our behavior changed, but because our access to data and reporting mechanisms changed.

Our emissions have gone down since our 2009 baseline due to the implementation of dozens of on-campus mitigation strategies. Projects that have contributed to reduced emissions include the heating plant upgrade that resulted in a switch from fuel oil to natural gas as a backup fuel to our wood boiler. Additionally, we have implemented several energy efficiency measures and lighting upgrades in campus buildings.

In FY 2018, we saw a decrease in our campus greenhouse gas emissions from FY 2017. This was in part due to a large difference in air miles traveled. Importantly, we continued tracking sequestration in our gross emissions in FY 2018 - in previous years we tracked forest sequestration in our net emissions. Seeing that Colgate has control over its forested land, and should be penalized when trees are removed and carbon is released, we deemed it appropriate to include biogenic emissions and carbon sequestration when calculating our gross emissions. After re-inventorying our forest carbon storage and sequestration, we learned that our trees are sequestering more than twice as much as carbon (3,776 tons) when compared with our previous inventory.

In FY 2018, Colgate continued its partnership with Patagonia Sur, LLC providing the institution with 5,000 tons of carbon offsets. This fiscal year, Colgate also purchased Renewable Energy Credits (RECs) to offset emissions for the Class of '65 Arena. As a result, the university's net footprint in FY 2018 was 4,418 $MTeCO_2$. Colgate's highest sources of emissions continue to be the on-campus use of fossil fuels for heating (7,827 $MTeCO_2$), followed by air travel paid for by Colgate for research and business purposes (1,973 $MTeCO_2$).

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Acronym	Meaning
AASHE	Association for the Advancement of Sustainability in Higher Education
ACUPCC	American College and University Presidents' Climate Commitment
B&G	Colgate's Facilities Department (Buildings & Grounds)
CA-CP	Clean Air – Cool Planet
CH_4	Methane
CO_2	Carbon Dioxide
COVE	Colgate's Center for Outreach, Volunteerism, and Education
$MTeCO_2$	Metric Tons of Carbon Dioxide Equivalents
U.S. EIA	United States Department of Energy: Energy Information Administration
ENST	Colgate's Environmental Studies Program
U.S. EPA	United States Environmental Protection Agency
FSEM	Colgate's First-year seminar
FTE	Full-time Equivalent Student
FY	Fiscal Year (July 1 to June 30)
GHG	Greenhouse Gases
GWP	Global Warming Potential
HFC	Hydrofluorocarbon
HCFC	Hydrochlorofluorocarbon
IRS	Internal Revenue Service
Kg	Kilogram
kWh	Kilowatt-hour
lbs	Pounds
N_2O	Nitrous Oxide
NSF	National Science Foundation
PFC	Perfluorocarbons
PPA	Power Purchase Agreement
RECs	Renewable Energy Credits
S-CAP	Sustainability and Climate Action Plan
SF_6	Sulfur Hexafluoride
WBCSD	World Business Council on Sustainable Development
WRI	World Resources Institute

INTRODUCTION

Colgate's Commitment to Climate Neutrality

The American College and University Presidents' Climate Commitment (ACUPCC), rebranded as Second Nature's Carbon Commitment, was officially announced in October 2006 during the AASHE (Association for the Advancement of Sustainability in Higher Education) conference at Arizona State University. Signatories made a commitment to, "achieve climate neutrality as soon as possible" by eliminating or offsetting 100 percent of the institution's greenhouse gas emissions. One mandatory component of the Carbon Commitment is to complete an annual greenhouse gas emissions inventory. By 2007, 152 presidents and chancellors became charter signatories of the Carbon Commitment. In 2018, there were a total of 475 signatories from all across the United States that have committed to carbon neutrality.

In 2009, Colgate University signed the Carbon Commitment (called the ACUPCC at the time) and completed our first greenhouse gas inventory. This is our tenth consecutive year completing the inventory.

Throughout this report, we provide the results of Colgate's 2009-2018 inventories; however, our focus here is the 2018 inventory. More specifically, the goals of this report are to: 1) meet a key requirement of the Carbon Commitment by tracking progress compared to our 2009 baseline inventory, 2) highlight the methodology and results of Colgate's 2018 Greenhouse Gas Inventory, and 3) provide step-by-step instructions on how to collect the inventory data and make calculations so this report can serve as a guide for future inventories.

Conservation and efficiency is saving the university approximately $1,212,067 (Table 1) annually in avoided operating costs, while enhancing our liberal arts education, as student participation is integral to these results through academic research, governance, and co-curricular student group activities. Our progress towards a more sustainable campus have resulted in numerous awards for the institution. In 2018, Colgate was rated as a top performer in the AASHE Sustainable Campus Index.

Table 1. *Annual avoided spending as a result of resource conservation and efficiency, FY 2009 vs. 2018*

Colgate Resource	Amount Reduced	Unit Cost	Annual Avoided Cost
Heat Energy (MMBtu)	52,470 MMBtu	$13.11/MMBtu	$1,044,678
Electricity (kWh)	1,557,314 kWh	$0.045/kWh	$70,079
Paper (lbs)	7,483 lbs	$1.25/lb	$9,354
Water (gal)	4,124,397 gal	$0.013/gal	$54,523
TOTAL			**$1,212,067**

UNDERSTANDING COLGATE'S GREENHOUSE GAS INVENTORY

According to the United States Environmental Protection Agency (U.S. EPA), a greenhouse gas inventory is an accounting of greenhouse gases (GHGs) emitted to or removed from the atmosphere over a period of time. Colgate's comprehensive greenhouse gas inventory is an essential step to track our emissions over time. Understanding the basic concepts and calculations of the inventory is not only important for the individuals carrying out the methodology, but it is also important for anyone interested in what the inventory is telling us and how the results are derived.

Colgate's greenhouse gas inventory quantifies our institution's contribution to global climate change by revealing our net greenhouse gas emissions (total emissions minus the sum of our offsets). Offsets can be any process or activity that avoids emissions or removes greenhouse gases from the atmosphere (e.g., methane capture and recovery, forestry-based carbon sequestration, composting, and others) or any strategy that increases the amount of energy produced from clean, renewable sources (e.g., investing in wind energy or solar photovoltaic arrays or other renewable technologies). Because Colgate is committed to carbon neutrality by 2019, the goal is to balance our greenhouse gas budget at zero, where total emissions equals total offsets. Once equipped with a greenhouse gas budget, the Colgate community can make informed decisions on how to reduce our emissions and increase our offsets. This was the purpose of the Sustainability and Climate Action Plan published in September 2011 and the 2016-2019 Sustainability Bicentennial Plan underwent publication in 2016.

INVENTORY BOUNDARIES

Colgate, like other signatories to Second Nature's Carbon Commitment, follows the international protocol established by the World Business Council for Sustainable Development (WBCSD) and the World Resources Institute (WRI) and the Climate Registry's General Reporting Protocol. Second Nature's *Implementation Guide* outlines these protocols as they relate to higher education institutions. Complying with these protocols, we have established the following boundaries when conducting Colgate's Greenhouse Gas Inventory.

Fiscal Year

Colgate's Greenhouse Gas Inventory tracks emissions over the fiscal year (as opposed to the calendar year or academic year). Colgate's fiscal year runs from July 1 through June 30 of the following year. Throughout this report, whenever a year is mentioned (e.g., 2018), we are referring to the fiscal year unless otherwise noted. Additionally, "fiscal year" is abbreviated to "FY" throughout this report.

Scope of Emissions

Sources of greenhouse gas emissions are organized into three categories called "scopes" as established by the World Resources Institute and followed by the Clean Air-Cool Planet (CA-CP) Campus Carbon Calculator (now maintained by the University of New Hampshire Sustainability Institute). The three-scope format ensures that there is consistency in measurement between institutions. The scopes are essentially levels of how responsible Colgate is for various sources of emissions. For example, travel carried out by Colgate's own fleet of vehicles is categorized as "Scope 1" emissions because Colgate has complete control over what vehicles we decide to purchase and our driving behavior. On the other hand, faculty and staff commuting to and from campus are considered "Scope 3" because Colgate is not responsible for the decisions employees make in purchasing their vehicles, nor where they choose to live or how they commute to campus. The three scopes of greenhouse gas emissions recorded in Colgate's Inventory are as follows:

- *Scope 1 Emissions:* Scope 1 refers to direct greenhouse gas emissions occurring from sources that are owned or directly controlled by the institution. At Colgate, this includes on-campus stationary combustion of fossil fuels (such as natural gas, fuel oil #2, kerosene, and propane), vehicle fleet emissions, fugitive refrigerant chemicals, and emissions associated with grounds maintenance.

- *Scope 2 Emissions:* Scope 2 refers to indirect emissions generated in the production of electricity consumed by the institution. To calculate these emissions, we have to determine how our electricity is produced (e.g., hydroelectric, coal, wind, etc.) and calculate the greenhouse gas emissions for each source.

- *Scope 3 Emissions:* Scope 3 refers to all other indirect emissions–those that are a consequence of activities of the institution, but occur from sources not owned or controlled by the institution. Colgate's Scope 3 emissions include faculty and staff commuting, bus commuting, air travel and business ground travel (paid by or through the university), paper use, and solid waste.

De Minimus Emissions

Colgate is a residential campus with only ~250 students (7.5% of population) renting apartments or houses that are not affiliated with the university. The vast majority of students live within walking distance of class. More specifically, all first- and second-year students live in residence halls on campus. Third- and fourth-year students either live in university-owned apartments, townhouses, or special-interest housing with provided shuttle bus transit to and from campus. Those fourth-year students who do not live in university-owned housing tend to rent apartments or homes within a three-mile radius of campus and share rides to campus in their private vehicles. Emissions associated with these activities are minimal, since the distances are so short. Additionally, residential students are not permitted to park their vehicles on campus between the hours of 8:00 AM and 3:30 PM on weekdays, forcing them to take Colgate-provided transportation or shared carpool. As a result, we assumed that greenhouse gas emissions associated with student commuting are de minimus (less than 5% of gross emissions). Moreover, attempting to quantify student commuter emissions would be difficult based on major assumptions and extrapolations. For these reasons, student commuting is not required or included in Colgate's Greenhouse Gas Inventory.

In addition to student commuting to and from campus, we have chosen to leave out emissions associated with Ubers, taxis, trains and shuttles during business travel. Due to varying prices for these forms of transportation, it was challenging to determine a representative way to reflect the associated emissions. We also deemed that the emissions from these sources would amount to less than 5% of gross emissions.

Operational Boundaries

In compliance with international and Carbon Commitment guidelines, Colgate University tracks each of the six greenhouse gases covered under the Kyoto Protocol: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorinated compounds (PFCs), and sulfur hexafluoride (SF_6). Under Second Nature's Carbon Commitment, Colgate is required to account for and report all Scope 1 and Scope 2 emissions. Additionally, Colgate is required to report Scope 3 emissions from air travel (paid by or through the university) and employee commutes to and from campus. This inventory accounts for all of these requirements, plus additional Scope 3 emissions highlighted above.

Organizational Boundaries

In order to calculate Colgate's greenhouse gas emissions, it is necessary to determine the organizational boundaries. Following the Greenhouse Gas Protocol, Colgate defined its organizational boundary by using the operating lease and operational control approach[1]. As a result, we have included emissions for buildings that Colgate owns and operates as well as buildings that Colgate leases for business purposes from the Hamilton Initiative, LLC such as the Colgate Bookstore and 14 Utica Street, home to Institutional Advancement and Alumni Relations.

INVENTORY CALCULATIONS

Global Warming Potentials

Global warming potentials (GWPs) are measures of each greenhouse gas' influence to warm the Earth's atmosphere (called radiative forcing). The greater the GWP, the more potent the GHG (Table 1). Carbon dioxide is used as the standard for which the other greenhouse gases are compared, hence the term carbon dioxide equivalent, and therefore, has the GWP of 1. Methane has a GWP of 28, meaning that one kilogram of methane has a radiative forcing that is 28 times greater than one kilogram of carbon dioxide over a 100 year period.

Table 2. *Global warming potentials for Colgate's 2018 greenhouse gas inventory*

Greenhouse Gas	100-Year GWP
CO_2	1
CH_4	28
N_2O	265
HFC-134a	1,300
HCFC-22	1,760

Metric Tons of Carbon Dioxide Equivalents ($MTeCO_2$)

Colgate's greenhouse gas emissions are measured in the international recognized units of metric tons of carbon dioxide equivalents ($MTeCO_2$). International protocol designates carbon dioxide as the standard by which other gases are measured for two specific reasons: 1) in order to provide a standard unit of measurement across the board and 2) carbon dioxide is the most abundant anthropogenic greenhouse gas.

[1] Greenhouse gas protocol document outlining organizational boundaries can be found here: https://ghgprotocol.org/sites/default/files/standards_supporting/Categorizing%20GHG%20Emissions%20from%20Leased%20Assets.pdf

Emissions Factors

Emissions factors are the key to calculating Colgate's greenhouse gas inventory. They measure the average rate of emission of each greenhouse gas from a particular source converted to metric tons of carbon dioxide equivalents ($MTeCO_2$). Certain activities, whether it is consuming oil for space heating or using gasoline for transportation, release different greenhouse gases into the atmosphere at different rates. Fuel oil #6, for example, releases three greenhouse gases into the atmosphere: carbon dioxide, methane, and nitrous oxide. The rate of emission for each of these greenhouse gases is 11.24 kg CO_2, 0.0395 kg of CH_4, and 0.02831 kg of N_2O for every gallon of fuel oil #6 combusted. The emission factor of fuel oil #6 is 0.01130 $MTeCO_2$/gallon, determined by multiplying the GWP for each greenhouse gas by its rate of emission and adding each together (Figure 1).

Note: In previous years, total $MTeCO_2$ for each emissions source were calculated using that year's emission factors. In the past, we did not retroactively update past calculations as emission factors were updated. This year, however, all previous calculations have been updated with the most recent emission factors provided by the Campus Carbon Calculator v8.0. This allows us to more accurately compare the efficacy of climate mitigation strategies by removing gains or losses attributed to changing emission factors.

Figure 1. *Determining the emission factor for each source of greenhouse gas emissions using fuel oil #6 as an example*

	Greenhouse Gas #1		Greenhouse Gas #2		Greenhouse Gas #3
Emission Factor =	(Global Warming Potential) X (Rate of Emissions)	+	(Global Warming Potential) X (Rate of Emissions)	+	(Global Warming Potential) X (Rate of Emissions)
	Carbon Dioxide (CO_2)		Methane (CH_4)		Nitrous Oxide (N_2O)
Fuel Oil #6 =	1 x 11.24 kg/gallon	+	28 x 0.00158 kg/gallon	+	265 x 0.000095 kg/gallon
	Carbon Dioxide (CO_2)		Methane (CH_4)		Nitrous Oxide (N_2O)
Fuel Oil #6 =	11.24 kg/gallon	+	0.04424 kg/gallon	+	0.025175 kg/gallon

Table 3. *Emission factors in $MTeCO_2$ per unit consumed to quantify Colgate's 2018 greenhouse gas emissions*

Emissions Source	Emissions Factor
Scope 1	
Fuel Oil #6 (Gallons)	0.011272
Fuel Oil #2 (Gallons)	0.010484
Natural Gas (MMBtu)	0.054494
Propane (Gallons)	0.005741
Biomass (Wood Chips)	1.639507467
Gasoline Vehicles (Gallons)	0.008782
Diesel Vehicles (Gallons)	0.010211
Refrigerant (HFC-134a)	0.6486666
Other Refrigerants	0.81 - 1.78
Organic Fertilizer (lbs of nitrogen)	0.0041387
Synthetic Fertilizer	0.0041959
Scope 2	
Electricity (kWh)	0.00001356
Scope 3	
Faculty/Staff Commuting (Gallons)	0.008782
Colgate Cruisers (Gallons)	0.008782
Outsourced Bus Travel (Gallons)	0.010211
Air Travel (Miles)	0.0004824186558
Landfill Waste (w/ CH_4 recovery and electricity production)	-0.03
Non-recycled Paper (lbs)	0.001365993
10% Recycled Paper (lbs)	0.00136595
20% Recycled Paper (lbs)	0.0013659
30% Recycled Paper (lbs)	0.0013658
50% Recycled Paper (lbs)	0.0013657
100% Recycled Paper (lbs)	0.0013654

DATA COLLECTION

Annual Reporting

Data collection is the most time consuming part of Colgate's greenhouse gas inventory. Each year the data collection process commences in September for the previous fiscal year, giving employees the necessary time to finish their end of the fiscal year reporting. Additionally, with proper oversight, we recommend using the Office of Sustainability interns to help in the data collection in order to better facilitate this collection.

The annual data collection process has become routine for most of the stakeholders we contact, and therefore, much easier if we are consistent in the timing and type of data we request. A total history of our contact with stakeholders can be found in the archives of the Sustainability Office email account (sustainability@colgate.edu). Allow a few weeks for employees to provide requested data, anticipating that multiple inquiries might need to be made for the same data.

Once the appropriate data is collected, it should be entered into the "Colgate Carbon Inventory Workbook" created by former Office of Sustainability Intern, Andrew Pettit '11. The workbook contains data entry fields and performs the necessary calculations through built-in formulas. The workbook can be obtained through Colgate's Office of Sustainability.

Overall, we recommend that the inventory data be collected by the target date of December 15 of each year, with the final inventory report being completed by January 15 of the following year.

Institutional Data

Tracking institutional data is useful because it establishes a frame of historical reference and facilitates the comparison of Colgate's level of emissions in relation to other colleges and universities. Furthermore, significant changes in budget allocations, population, or square-footage of the built-environment can have a great impact on Colgate's activities and energy consumption, and therefore, greenhouse gas emissions. Table 4 provides an overview of Colgate's institutional data for FY 2009-2018.

Table 4. *Colgate's institutional data for FY 2009-2018*

Fiscal Year	Budget (dollars)			Population			Physical Size (square-feet)
	Operating Budget	Research Budget	Energy Budget	Full-Time Students	Faculty	Staff	Total Building Space
2009	$147,320,539	$614,403	$4,712,740	2,784	280	688	2,331,239
2010	$149,220,020	$300,220	$3,950,587	2,770	278	678	2,331,239
2011	$148,433,361	$592,076	$4,310,783	2,876	280	659	2,305,648
2012	$152,207,713	$630,286	$4,585,035	2,934	293	663	2,340,773
2013	$157,766,968	$686,572	$4,819,008	2,927	318	648	2,310,726
2014	$164,695,978	$735,760	$5,763,339	2,927	344	648	2,318,703
2015	$174,437,066	$736,824	$4,732,972	2,863	359	672	2,234,931
2016	$179,846,306	$739,256	$4,796,517	2,837	347	672	2,422,000
2017	$185,871,542	$745,000	$5,091,169	2,865	364	692	2,343,085
2018	$193,927,610	$ 787,100	$5,100,000	2,865	360	709	2,425,244

Budget Information
Data Requested: The operation, research, and energy budgets for FY 2018.
Data Source: Drew Porter, Senior Budget Analyst and John Collins, Associate Vice President for Budget and Financial Planning.

Population Information
Data Requested: The headcount of faculty and staff members for FY 2018.
Data Source: Jill Dinski, Human Resources.

Physical Size
Data Requested: The university's total building space in square-feet for FY 2018.
Data Source: Joe Bello, Director of Planning, Design, and Construction.

Energy and Water Costs

Tracking energy and water costs is valuable because it establishes a frame of historical reference and allows us to perform useful climate action planning analyses. Moreover, relatively small changes in our energy and water costs per unit can have big impacts on our operating budget. For these reasons, it is necessary to track energy and water costs as part of our inventory data collection process (Table 5).

Table 5. *Colgate's energy and water cost per unit, FY 2009-2018*

Fiscal Year	Wood Chips	Natural Gas	Fuel Oil #6	Fuel Oil #2	Kerosene	Propane	Electricity	Water
	($/ton)	($/CCF)	($/gallon)	($/gallon)	($/gallon)	($/gallon)	($/kWh)	($/1,000 gallons)
2009	$40.00	-	$2.24	$3.50	-	$2.15	$0.043	$8.26
2010	$40.00	-	$1.39	$2.30	-	$1.45	$0.042	$9.12
2011	$42.00	-	$2.01	$2.29	$2.53	$1.52	$0.045	$9.28
2012	$44.00	-	$2.18	$2.91	$3.87	$1.95	$0.041	$9.68
2013	$41.88	-	$2.53	$2.96	$2.53	$1.59	$0.041	$9.18
2014	$42.00	-	-	$3.40	$4.15	$1.48	$0.051	$9.58
2015	$45.00	$0.88	-	$3.29	$3.02	$1.73	$0.047	$9.63
2016	$65.00	$1.53	-	$ 2.86	$ 2.24	$ 1.20	$0.044	$ 9.49
2017	$69.82	$2.91	-	$1.99	-	$1.04	$0.045	$11.54
2018		$0.10	-	$ 2.00		$ 1.09	$0.045	$13.22

Wood Chips Cost
Data Requested: Cost per ton of wood chips for FY 2018.
Data Source: Howard Lewis, Mechanical Trades, Heating Plant, and Energy Manager.

Natural Gas Costs
Data Requested: Cost per CCF (100 cubic feet) of natural gas for FY 2018.
Data Source: John Collins, Associate Vice President For Budget And Financial Planning; Howard Lewis, Energy Manager.
Calculation: Divide total amount spent on natural gas (from John) by the amount consumed in CCF (from Howard). This will provide the cost of gas for the Central Plant. Also need to factor in the amount spent and used for auxiliary services (e.g., buildings on Broad Street).

Fuel Oil #2, Kerosene, and Propane Costs
Data Requested: Cost per gallon of fuel oil #2, kerosene, and propane for FY 2018.
Data Source: Simon Fritz, Director of Purchasing.

Electricity and Water Cost
Data Requested: Cost per kilowatt-hour (kWh) of electricity and cost per 1,000 gallons of water for FY 2018.

Data Source: Manually calculated from monthly utility bill summaries. Spreadsheet provided by John Pumilio
Calculations: To calculate the cost of electricity per kWh and water per 1,000 gallons, we divided the total annual cost by the total annual usage. For electricity, the total cost includes:

- Normal Rate Charge: The Village of Hamilton uses primarily hydropower, which is obtained from Niagara Falls. The Village is allotted a designated amount of hydropower each month to be used by its customers (including Colgate). The rate is set by the Village and does not fluctuate from month to month unless a rate change is approved by the utilities commission.
- Purchased power adjustment (PPA): When the Village exhausts its hydropower allotment, they are forced to purchase additional electricity from the grid. These purchases are made at a different (and often higher) rate than the normal electricity rate.
- Demand charge: Demand charges intermittently cover start up and equipment costs when electricity is needed, often during peak hours. Demand charges are based on maximum demand, which is the greatest usage of electricity that occurred over a period, usually a month. Once established, the rate remains in effect for eleven months, or until a new maximum is established. To minimize demand charges, electricity usage should be spread out over a period to reduce the peak demand that may occur during any given timeframe.

For water, total cost includes the normal rate charge plus sewer costs. The Village bills Colgate in units of cubic feet. Therefore, cubic feet are converted to gallons (one cubic foot equals 7.48 gallons) and multiplying by 100 to get cost per 1,000 gallons.

Biomass (Wood Chips)

In 1981, Colgate University began using wood chips as the primary source of energy for space heating and domestic hot water. Although the wood firing capacity of Colgate's biomass plant is only about 40% of the peak cold day campus steam requirement, that capacity is used year-round so that Colgate can derive 75-85% of our annual heating requirement from wood chips.

In FY 2016, Colgate began to use more natural gas for heating across campus, resulting in a decreased use of biomass. This year, Colgate derived 39% of our annual heating requirement from wood chips.

Burning wood chips for energy releases stored carbon into the atmosphere. However, according to international protocol specified in the GHG Protocol guidelines, this carbon does not add to Colgate's greenhouse gas footprint or contribute to anthropogenic climate change. Carbon released from combusting wood chips is on the natural and short carbon cycle and would eventually cycle back into the atmosphere through death and decomposition. In other words, the carbon that is released from Colgate's biomass plant was removed relatively recently from the atmosphere through photosynthesis as the tree grew. Therefore, burning wood for energy may not increase the total amount of carbon in the carbon cycle if the source of biomass comes from sustainable forestry practices. Though recent science and discourse is challenging this, the current protocol suggests that we track emissions associated with Colgate's biomass plant, but report them separately from our emissions (Table 6).

Table 6. *Colgate's emissions associated with wood chip combustion, FY 2009-2018*

Fiscal Year	Wood Chips	Emissions Factor	GHG Emissions
	(tons)	(MTeCO/ton)	(MTeCO)
2009	22,249	0.155462469	39,681
2010	23,898	0.155462469	42,623
2011	23,058	0.155462469	41,124
2012	21,718	0.1583576989	38,734
2013	23,294	0.1442541467	41,545
2014	22,378	0.1569248447	39,912
2015	21,287	0.1569248447	37,965
2016	8,301	1.78351514	14,805
2017	6,690	1.78351514	11,932
2018	11,040	1.639507467	18,100

Wood Chips
Data Requested: Tons of wood chips for FY 2018.
Data Source: Dan McCoach, Associate Director of Facilities and Manager of Engineering Services.

SCOPE 1 EMISSIONS

Scope 1 emissions are direct emissions from sources that are owned and/or directly controlled by Colgate University. This includes combustion of fossil fuels in university-owned facilities or vehicles, fugitive emissions from refrigerant chemicals, and emissions associated with grounds maintenance.

On-campus Stationary Combustion of Fossil Fuels

Colgate University uses four types of fossil fuels to provide heat and hot water to campus buildings: natural gas, fuel oil #2, kerosene, and propane (Table 7).

Colgate's central steam plant heats more than 35 main campus buildings and provides the heat source for laundry equipment, domestic water heating, dining hall food preparation, laboratory, library, ice rink humidity

control, and building humidification. While Colgate's primary source of steam comes from the campus 900 boiler horsepower (BoHP) wood chip boiler, we use natural gas as our secondary fuel in the central steam plant, which replaced fuel oil. Fuel oil #2 and natural gas are used as the primary sources of heat energy used for facilities that do not have access to the steam from the Central Plant. This includes Colgate's buildings on Broad Street (e.g., fraternity and sorority houses, Sanford Field House, Townhouses, and others). Kerosene provides heat energy to a few buildings, including 80 Broad Street and the Seven Oaks Golf Club. Propane is used for fireplaces, heating, cooking, and hot water in a few buildings including those on Broad Street, the Coop, Parker Commons, Frank Dining Hall, and a few academic buildings.

Table 7. *Greenhouse gas emissions from on-campus stationary sources, FY 2009-2018*

Fiscal Year	Fuel Type	Unit	Consumption	Emissions Factor	GHG Emissions
2009	Fuel Oil #6	Gallons	371,457	0.011757907	4,368
	Fuel Oil #2	Gallons	185,503	0.01004635	1,864
2010	Fuel Oil #6	Gallons	283,974	0.011757097	3,339
	Fuel Oil #2	Gallons	174,399	0.01004635	1,752
	Kerosene	Gallons	4,604	0.01004635	46
2011	Fuel Oil #6	Gallons	293,425	0.011761262	3,451
	Fuel Oil #2	Gallons	189,944	0.010049435	1,909
	Kerosene	Gallons	8,212	0.01004935	83
	Propane	Gallons	32,569	0.005440764	177
2012	Fuel Oil #6	Gallons	215,397	0.01130298575	2,435
	Fuel Oil #2	Gallons	167,539	0.01031982667	1,729
	Kerosene	Gallons	8,085	0.01031982667	83
	Propane	Gallons	31,329	0.00526604196	165
2013	Fuel Oil #6	Gallons	264,643	0.01130298575	2,991
	Fuel Oil #2	Gallons	182,090	0.01031982667	1,879
	Kerosene	Gallons	7,102	0.01031982667	73
	Propane	Gallons	30,913	0.00522771857	162

2014	Fuel Oil #2	Gallons	689,544	0.01031345245	7,309
	Kerosene	Gallons	3,355	0.01031345245	35
	Propane	Gallons	35,000	0.005257712	184
2015	Natural Gas	MMBtu	61,329	0.053166722	3,261
	Fuel Oil #2 (Central Plant)	Gallons	51,229	0.01031345	528
	Fuel Oil #2 (External Bldgs.)	Gallons	194,630	0.01031345	2,007
	Kerosene	Gallons	3,439	0.01031345	35
	Propane	Gallons	34,141	0.005257712	180
2016	Natural Gas	MMBtu	99,787	0.0531667	5,305
	Fuel Oil #2 (Central Plant)	Gallons	29,248	0.01022138	299
	Fuel Oil #2 (External Bldgs.)	Gallons	119,836	0.01022138	1,225
	Kerosene	Gallons	388	0.01022138	4
	Propane	Gallons	35,601	0.0052207	186
2017	Natural Gas	MMBtu	128,357	0.0531667	6824
	Fuel Oil #2 (Central Plant)	Gallons	10,000	0.010313452	103
	Fuel Oil #2 (External Bldgs.)	Gallons	81,803	0.010313452	844
	Propane	Gallons	28,918	0.005257712	152
2018	Natural Gas	MMBtu	125,989	0.054494	6,819
	Fuel Oil #2 (Central Plant)	Gallons	676	0.010484	7
	Fuel Oil #2 (External Bldgs.)	Gallons	72,841	0.010484	764
	Kerosene	Gallons	83	0.010484	0.87
	Propane	Gallons	33,028	0.005741	190

Fuel Oil #2, Natural Gas
Data Requested: CCF of natural gas[2] consumed for FY 2018.
Data Source: Howard Lewis, Facilities Services Manager.

Propane, Kerosene
Data Requested: Gallons of fuel oil #2, propane, and kerosene consumed for FY 2018.
Data Source: Simon Fritz, Director of Purchasing and Howard Lewis, Mechanical Trades, Heating Plant and Energy Manager.

Colgate Vehicle Fleet

Colgate University, like most colleges and universities, owns and maintains a fleet of vehicles. The decisions Colgate makes regarding the purchase and operation of this fleet has a direct impact on our institution's greenhouse gas emissions. Therefore, it is important to keep track of Colgate's fleet fuel use, as it is a direct contribution to climate change. The Colgate vehicle fleet consists of about 100 vehicles and was responsible for 515 tons of emissions in 2018 (Table 8).

Table 8. *Colgate's greenhouse gas emissions from university vehicle fleet, FY 2018*

Facilities Gasoline Pump	Golf Course Gasoline Pump	Total Gasoline	Emissions Factor	GHG Emissions
(gallons)	(gallons)	(gallons)	($MTeCO_2$/gallon)	($MTeCO_2$)
35,106	4,270	39,376	0.008782	346
Facilities Diesel Pump	**Golf Course Diesel Pump**	**Total Diesel**	**Emission Factor**	**GHG Emissions**
(gallons)	(gallons)	(gallons)	($MTeCO_2$/gallon)	($MTeCO_2$)
10,145	3,765	13,910	0.010211	142
			Total	**488**

Capturing fuel consumption for Colgate's vehicle fleet comes from these sources:

1. Facilities gasoline and diesel pumps
2. Seven Oaks golf course gasoline and diesel pumps

The minimal emissions associated with facilities vehicles fueled off-campus after hours or during long-term rentals and Campus Safety vehicles fueled after hours are captured in the ground transportation category.

[2] To convert CCF of Natural Gas to MMBtu we used this online calculator: https://www.abraxasenergy.com/energy-resources/toolbox/conversion-calculators/energy/

Facilities Gasoline and Diesel Pumps
Data Requested: Gallons of gasoline and diesel consumed for FY 2018.
Data Source: Simon Fritz, Director of Purchasing.

Seven Oaks Golf Course Gasoline and Diesel Pumps
Data Requested: Gallons of gasoline and diesel consumed for FY 2018.
Data Source: Simon Fritz, Director of Purchasing.

Campus Safety Vehicles Fueled Off-Campus (N/A for the last few years, however keep this in mind for the future)
Data Requested: Gallons of gasoline consumed.
Data Source: Sue Marks, Campus Safety Administrative Assistant.

Refrigerants (HFC-314a and others)
Colgate University has an on-campus chiller for space cooling, water fountains, and refrigerators across campus that use HFC-134a refrigerant. Additionally, Starr Hockey Rink, The Class of '65 Arena, and and the Dana Arts Center use a variety of refrigerants. These refrigerant hydrocarbons meet all the required standards specified by the U.S. EPA in order to reduce the rate of ozone depletion. Unfortunately, hydrocarbons are powerful GHGs. HFC-134a, for example, has a GWP of 1,430 (meaning that it is 1,430 times more potent as a greenhouse gas than carbon dioxide). Therefore, it is important to calculate the amount of refrigerant chemicals Colgate uses on an annual basis. In 2011, refrigerants accounting for more than 632 tons of GHG emissions, but that number has fallen dramatically in recent years (Table 9).

Table 9. *Greenhouse gas emissions from HFC-134a and other refrigerant chemical use, FY 2011-2018*

Fiscal Year	HFC-134a Refrigerant Loss	Emission Factor	GHG Emissions	HCFC-22 / Other Refrigerant Loss	Emission Factor	GHG Emissions	Total GHG Emissions
	(lbs)	(MTeCO$_2$/lb)	(MTeCO$_2$)	(lbs)	(MTeCO$_2$/lb)	(MTeCO$_2$)	(MTeCO$_2$)
2011	108	0.589670081	64	685	0.771107029	528	592
2012	46	0.648637089	30	543	0.771107029	419	449
2013	1	0.648637089	0.6	281	0.82100219	231	232
2014	12	0.648637089	8	128	0.82100219	105	113
2015	20	0.648637089	13	120	0.82100219	99	111
2016	17	0.648637089	11	109	0.82100219	89	100
2017	9	0.648637089	5.8	171.2	0.82100219	140	146
2018	30	0.6486666	19	68	0.81 - 1.78	55	75

HFC-134a, HCFC-22 (N/A in FY 2018), R-407C, R-404A, R-410A, R-414B (Hot Shot)
Data Requested: The total usage (in pounds) of the refrigerants type HFC-134a and HCFC-22 for FY 2018.
Data Source: Brian Belden, Physical Plant Foreperson

Organic Fertilizer Application

Fertilizer is used for campus landscaping and on the golf course release nitrous oxides into the atmosphere due to its nitrogen content. Even though nitrous oxide is 298 times more powerful as a global warming agent than carbon dioxide, Colgate's emissions from fertilizer use is relatively small (Table 10). Nevertheless, they do contribute to climate change and our annual use of fertilizer is relatively easy to track.

Table 10. *Greenhouse gas emissions from fertilizer application, FY 2009-2018*

Fiscal Year	Landscaping	Golf Course	Total Fertilizers	Emission Factor	GHG Emissions
	(lbs of nitrogen)	(lbs of nitrogen)	(lbs of nitrogen)	(MTeCO/lb)	(MTeCO)
2009	10,080	1,059	11,139	0.004113463	46
2010	4,800	297	5,097	0.004113463	21
2011	5,600	275	5,875	0.00414123	24
2012	4,656	2,027	6,683	0.00414123	28
2013	2,925	173	3,098	0.00414123	13
2014	3,360	1,535	4,895	0.00414123	20
2015	2,000	875	2,875	0.00414123	12
2016	5,513	2,337	7,849	0.00414123	33
2017	2,800	195	2,995	0.00414123	12
2018	1,225	2,245	3,470	0.0041387	15

Organic Fertilizer
Data Requested: The type, total amount (in pounds), and percent nitrogen of fertilizer used on campus grounds and on the golf course for FY 2018.
Data Source: Mike Jasper, Director of Grounds and Environmental Services and Jon McConville, Golf Course Superintendent.
Calculations: The total pounds of fertilizer is multiplied by the percentage of nitrogen content to get the total pounds of nitrogen used.

SCOPE 2 EMISSIONS

Scope 2 emissions are the indirect emissions from sources that are neither owned nor operated by Colgate University, but whose products are directly linked to on-campus energy consumption. Scope 2 emissions include all emissions generated in the production of electricity consumed by the institution.

Purchased Electricity

In order to calculate Colgate's emissions associated with the purchase and usage of electricity, we have to determine how our electricity is produced and calculate the rate of greenhouse gas emissions associated with each source. Colgate purchases electricity from the Village of Hamilton, which operates as a municipal electric, water, natural gas, and sewer utility. The vast majority (84 percent) of the Village's electricity is purchased directly from large-scale hydroelectric power mainly from Niagara Falls. The remaining electricity (12 percent) is purchased from the New York State grid and comes from a mix of sources, including nuclear, wind, coal, and other fossil fuels. Colgate's emissions factor of 0.00001356 $MTeCO_2$/kWh is significantly lower than the Upstate New York average of 0.000373082 $MTeCO_2$/kWh. The lower factor is based on the large amount of hydroelectric, nuclear, and wind power that makes up the Village's electricity mix. The result of this low emissions factor is that Colgate's overall emissions associated with electricity use is also relatively low, making up about 3.1 percent of the university's total emitted greenhouse gasses (before factoring in forest sequestration numbers (Table 11).

Table 11. *Greenhouse gas emissions from purchased electricity, FY 2008-2018*

Fiscal Year	Total	Emissions Factor	GHG Emissions
	(kWh)	(MTeCO/kWh)	(MTeCO)
2008	30,783,478	0.0000596931	1,838
2009	31,571,030	0.0000596931	1,885
2010	30,264,128	0.0000596931	1,807
2011	30,883,211	0.0000596931	1,844
2012	30,390,822	0.0000596931	1,814
2013	30,252,750	0.0000596931	1,806
2014	29,983,490	0.0000596931	1,790
2015	30,199,884	0.0000596931	1,803
2016	28,730,067	0.0000102	293
2017	28,808,072	0.0000183	527
2018	30,013,716	0.0000163	489

Total Purchased Electricity

Data Requested: Total purchased electricity in FY 2018, in kWh.
Data Source: John Pumilio, Director of Sustainability.

SCOPE 3 EMISSIONS

Scope 3 emissions are all other indirect emissions attributed to our institution–those that are a consequence of the activities of the institution, but occur from sources not owned or controlled by the institution. Colgate's Scope 3 emissions include faculty and staff commuting, bus commuting, employee business ground travel, air travel paid by or through the university, solid waste, and paper use. As explained earlier, emissions from student commuting are considered de minimus emissions and are not included in Colgate's GHG inventory.

Faculty and Staff Commuting

Most Colgate faculty and staff commute to work by driving. In order to calculate the emissions associated with this behavior, we need to determine the amount of gasoline consumed by each employee over the course of the year for commuting. We estimate this by conducting an annual survey (established in FY 2010) using Qualtrics survey software and distributing the survey to the campus community via campus distribution email (See Appendix A). The survey captures how many days per week and weeks per year each individual drive themselves to campus, the distance traveled, and the average miles per gallon of their vehicle.

Table 12. *Greenhouse gas emissions from faculty and staff commuting, FY 2010-2018*

Fiscal Year	Total Gasoline	Emission Factor	GHG Emissions
	(gallons)	(MTeCO/gallon)	(MTeCO)
2010	157,740	0.008924124	1,408
2011	153,057	0.008928806	1,367
2012	154,872	0.00909726474	1,409
2013	145,866	0.008648022	1,261
2014	81,904	0.008648022	708
2015	93,202	0.008648022	806
2016	150,027	0.008823814	1,324
2017	167,915	0.009099034	1,528
2018	130,227	0.008782	1,144

Faculty and Staff Commuting
Data Source: The survey is created by the Sustainability Director and Environmental Studies and Sustainability Program Coordinator and Office of Sustainability interns work with the Program Coordinator to perform the analysis. The survey is circulated via a Campus Distributions sent by Jasmine Kellogg, Internal Communications.

Calculations: Based on the responses, the average employee utilized 122 gallons of gasoline to get to and from campus in FY 2018. Multiply 122 gallons by 1,069 employees to get 130,227 gallons consumed.
Comments: The survey is distributed to the campus community via campus distributions during the first week of October and is live for three weeks to collect responses. This year, the Green Raider interns were utilized to complete the analysis.

Directly Financed Outsourced Bus Travel

Up until August of 2016, Colgate University contracted with Birnie Bus Services, Inc. to provide free transportation service around campus and to select locations off-campus with shuttle buses known the Colgate Cruisers. Birnie Bus also provided service to Colgate's athletic teams for competition away from campus.

Table 13. *Greenhouse gas emissions from outsourced bus travel, FY 2009-2018*

Fiscal Year	Cruiser (gallons gas)	Emissions Factor (MTeCO/gal)	Cruiser (gallons diesel)	Emissions Factor (MTeCO/gal)	GHG Emissions (MTeCO)	Athletics Travel (gallons)	Emissions Factor (MTeCO/gal)	GHG Emissions (MTeCO)	Total Emissions (MTeCO)
2009	-	-	7,230	0.010347846	75	18,335	0.010347846	190	265
2010	-	-	7,144	0.010347846	74	18,683	0.010347846	193	267
2011	-	-	11,985	0.010347846	124	17,352	0.010347846	180	304
2012	-	-	10,931	0.010347846	113	19,804	0.010347846	205	318
2013	-	-	10,234	0.010347846	106	16,512	0.010347846	171	277
2014	-	-	9,128	0.010347846	94	14,873	0.010347846	154	248
2015	-	-	10,649	0.010347846	110	12,725	0.010347846	132	242
2016	13,089	.010348	-	0.010347846	134	17,847	0.010347846	183	317
2017	27,028	.009099	-	0.00032406	277	20,342	0.010347846	209	486
2018	34385	.008782	965	0.010211	312	18,805	0.010211	192	504

Bus Commuting (Colgate Cruiser)
Data Requested: Gallons of gasoline consumed by Colgate Cruiser fleet in FY 2018.
Data Source: Simon Fritz, Director of Purchasing.

Athletics Travel

Data Requested: Gallons of diesel consumed in FY 2018 for bus service for varsity athletic travel.
Data Source: Lori Godshalk, Athletics Administrative Assistant.
Comments: Club sports outings use the passenger vans owned by Colgate, and are therefore included within the "Colgate Vehicle Fleet" data as Scope 1 emissions.

Employee Business Ground Travel

Colgate faculty and staff sometimes drive their personal vehicles to conduct Colgate business. The emissions associated with this practice are Scope 3 emissions since they are shared with the university and the individual who partakes in the travel and the university neither owns nor controls the vehicle that the employee drives.

Utilizing the Concur expense management system we determined the amount of money spent on gasoline reimbursements for business-related travel, as well as the amount of money spent on mileage reimbursements through accounting code -387. The federal reimbursement rate is $0.54 per mile. However, $0.25 per mile is awarded for the depreciation of the vehicle. Therefore, we multiplied the total reimbursement cost for accounting code -387 by 54 percent to determine the amount of money spent exclusively on gasoline (and not on vehicle depreciation). We then divided the total reimbursement cost for gasoline, derived from both the Concur expense management system and accounting code -387, by $2.50 (the national average cost per gallon of gasoline) in order to determine the total gallons of gasoline consumed.

Table 14. *Greenhouse gas emissions from employee business ground travel, FY 2011-2018*

Fiscal Year	Reimb. Cost	Percent of reimb. for gasoline	Total Reimb. for Gasoline	Total Gas Station Purchases	Average Cost per Gallon of Gasoline	Total Gasoline	Emission Factor	GHG Emissions
	($)	(%)	($)	($)	($)	(gallons)	(MTeCO/gal.)	(MTeCO)
2011	$286,687	57%	$163,412	-	$3.05	53,578	0.008928806	478
2012	$339,941	60%	$203,965	-	$3.54	57,617	0.009097265	524
2013	$292,829	60%	$175,697	-	$3.49	50,343	0.008864802	446
2014	$254,722	60%	$152,833	-	$3.65	41,872	0.009099063	398
2015	$246,374	60%	$147,824	$67,756.58	$3.22	66,951	0.009099034	609
2016	$232,483	60%	$139,490	-	$2.32	56,959	0.008823814	503
2017	$154,254	54%	$83,943	$68,102.47	$2.22	68,343	0.009099034	622

[3] This information was retrieved from the IRS website in "Standard Mileage Rates." The weblink is https://www.irs.gov/tax-professionals/standard-mileage-rates. Averaged 2017 and 2018 rates to get an accurate rate for the FY.

[4] To find the national average cost per gallon, we used the U.S. Energy Information Administration (U.S. EIA) website: http://www.eia.gov/petroleum/gasdiesel/. Download the "Full History" spreadsheet for U.S. regular gasoline prices. Then, we averaged the weekly data for the FY 2018.

2018	$196,472.85	54%	$105,506	85,553.57	$2.50	76,424	0.008782	671

Ground Travel Mileage
Data Requested: Total expenditures on mileage reimbursement and total gas station purchases in FY 2018 via Concur.
Data Source: Tina Pudney, Accounting Assistant.

Air Travel

Air travel plays a vital role in many university functions, a role that is arguably exacerbated by Colgate's rural location and our commitment to certain institutional priorities. Faculty members travel by air to support research and facilitate conference participation and professional staff throughout the university require air travel to pursue their work. Colgate's commitment to off-campus study opportunities, as well as to Division I athletics, also underscores the centrality of air travel to the university's mission.

All air travel paid by the university is tracked through the Concur expense management system. FY 2018 was the first year that all air travel information came from Concur reports. Because we no longer had to account for miscellaneous expenses outside of the Concur system, we were able to pull mileage directly from the expense management system. This gives us a more accurate estimate of GHG emissions than using price like in previous years.

Table 15. Colgate's *greenhouse gas emissions from air travel, FY 2009-2018*

Fiscal Year	Business	Athletics	COVE	Total	Emission Factor	GHG Emissions
	(miles)	(miles)	(miles)	(miles)	(MTeCO/mile)	(MTeCO)
2009	5,960,140	19,461	5,966	5,985,567	0.000776336	4,647
2010	5,838,481	525,790	63,746	6,428,017	0.000776336	4,990
2011	6,328,300	-	246,393	6,574,693	0.000776369	5,104
2012	6,914,119	-	91,331	7,005,450	0.000546154	3,826
2013	6,118,940	-	-	6,118,940	0.000526717	3,223
2014	4,604,702	-	-	4,604,702	0.000508267	2,340
2015	8,908,112	-	-	8,908,112	0.000482417	4,297
2016	7,765,444	-	-	7,765,444	0.000482417	3,746
2017	6,314,755	-	-	6,314,755	0.000482417	3,046
2018	4,090,368	-	-	4,090,368	0.000482419	1,973

Air Travel Expenditures
Data Requested: Total expenses for air travel spent on corporate cards during, cost and miles FY 2018
Data Source: Tina Pudney, Accounting Assistant; Gift audits, Concur travel and expense administrator.

Calculations: Sum of miles in the concur report "Air Carbon Footprint" plus additional expenditures not proceed through Concur. Receive a dollar amount for additional expenditures. Calculate the cost per mile from the Air Carbon Footprint data. Apply that cost per mile to the dollar amount for additional expenditures to calculate miles. Total the calculated miles and the miles from the air carbon footprint report to determine total miles flown.

Landfill Waste

Colgate university owns two vehicles that transfer our solid waste to the Madison County Landfill and Recycling Center in the Town of Lincoln, approximately 20 miles from campus. One truck transports recyclables (paper products, metals, plastics, and glass) and the other transports landfill waste. For the purposes of Colgate's GHG inventory, we are only concerned with the amount of landfill waste (and not recycled waste) because landfill waste emits potent methane as it decomposes. However, different landfills utilize different techniques for how they handle methane and these techniques result in very different levels of GHG emissions.

In FY 2010, the Madison County Landfill installed a methane capture system and then in FY 2012 an electric generation facility resulting in fewer GHG emissions per ton:

- Prior to FY 2010 (no methane recovery): emissions factor = 1.0842857 $MTeCO_2$/short ton
- FY 2010-2011 (methane recovery with flaring): emissions factor = 0.1606349 $MTeCO_2$/short ton
- FY 2012 and beyond (methane recovery and electricity generation): emissions factor = -0.03 $MTeCO_2$/short ton

As a result, Colgate's overall emissions associated with our landfill waste were significantly reduced (Table 16).

Table 16. *Colgate's greenhouse gas emissions associated with landfill waste, FY 2008-2018*

Fiscal Year	Landfill Waste	Emission Factor	GHG Emissions	Full-time Equivalent Students	GHG Emissions per FTE
	(short tons)	(MTeCO/short ton)	(MTeCO)	(FTEs)	(MTeCO)
2008	928.82	1.0842857	1007	2,767	0.36
2009	812.61	1.0842857	881	2,784	0.32
2010	778.44	0.1606349	125	2,770	0.05
2011	793.81	0.1606349	128	2,876	0.04
2012	754.14	-0.03	-23	2,934	-0.01
2013	738.97	-0.03	-22	2,927	-0.01
2014	740.23	-0.03	-22	2,927	-0.01
2015	748.77	-0.03	-22	2,863	-0.01
2016	823.22	-0.03	-25	2,837	-0.01
2017	845.38	-0.03	-25	2,865	-0.01
2018	823.08	-0.02999708412	-25	2,865	-0.01

Data Requested: Total annual waste in short tons for FY 2018.
Data Source: Monthly statements from Madison County Landfill, accessed by John Pumilio, Director of Sustainability.

Paper Consumption

Colgate University's paper consumption is tracked through two main sources: 1) departmental purchasing and 2) the Print Shop. We track the amount of paper consumed by its recycled content because the greater the recycled content, the lower the rate of emissions (Table 17) and the more environmentally benign.

Table 17. *Colgate's greenhouse gas emissions associated with paper consumption, FY 2010-2018*

Fiscal Year	Paper Type	Departmental Consumption	Print Shop Consumption	Total Consumption	Emission Factor	GHG Emissions
	(% recycled)	(lbs)	(lbs)	(lbs)	(MTeCO/lb)	(MTeCO)
2010	0%	21,613	17,568	39,181	0.0012905	51
	10%	0	2,320	2,320	0.001365993	3
	30%	42,157	9,270	51,427	0.001147067	51
	50%	1,825	14,664	16,489	0.001051445	17
	100%	21,482	950	22,432	0.00081239	18
	TOTAL	87,077	44,772	131,849	-	140
2011	0%	15,616	15,652	31,268	0.0012905	45
	10%	0	3,865	3,865	0.001365993	5
	30%	44,961	3,399	48,360	0.001170973	57
	50%	7,929	15,381	23,310	0.001051445	25
	100%	21,329	1,481	22,810	0.00081239	19
	TOTAL	89,835	39,778	129,613	-	151
2012	tree-free	4,056	0	4,056	0	0
	0%	0	28,287	28,287	0.001365993	39
	10%	0	2,506	2,506	0.001365993	3
	30%	35,820	17,495	53,315	0.001216988	65
	50%	6,931	7,620	14,551	0.001067983	16
	100%	27,464	1,810	29,274	0.000769973	23
	TOTAL	74,271	57,718	131,989	-	146
2013	0%	0	25,589	25,589	0.001365993	35
	10%	0	6,691	6,691	0.001365993	9
	30%	37,690	4,616	42,306	0.001216988	51

	50%	110	6,808	6,918	0.001067983	7
	100%	40,795	1,319	42,114	0.000769973	32
	TOTAL	78,595	45,023	123,618	-	135
2014	0%	0	23,990	23,990	0.001365993	33
	10%	0	7,303	7303	0.001365993	10
	30%	10,422	9,428	19,850	0.001216988	24
	50%	600	3,334	3,934	0.001067983	4
	100%	26,559	1,123	27,682	0.000769973	21
	TOTAL	37,581	45,178	82,759	-	92
2015	0%	15,161	66,353	81,514	0.001365993	111
	10%	0	4,832	4,832	0.001365993	7
	30%	1,712	3,930	5,642	0.001216988	7
	50%	560	308	868	0.001067983	1
	100%	3,280	525	3,805	0.000769973	3
	TOTAL	20,713	75,948	96,661	-	129
2016	0%	14,622	26,966	41,588	0.001365993	57
	10%	0	1,443	1,443	0.001365993	2
	30%	9,854	6,335	16,189	0.001216988	20
	50%	4,950	0	4,950	0.001067983	5
	100%	38,110	100	38,210	0.000769973	29
	TOTAL	67,536	34,844	102,380	-	113
2017	0%	23,778	55,411	79,189	0.0013659934	108
	10%	0	477	477	0.0013659934	1
	30%	6,257	6,313	12,570	0.0012169883	15
	50%	2,050	0	2,050	0.0010679832	2
	100%	28,245	50	28,295	0.000769973	22
	TOTAL	60,330	62,251	122,581	-	147
2018	0%	23,077	26,051	49,128	0.001365993	67

	10%	0	484	484	0.00136595	1
	20%	0	74	74	0.0013659	0.1
	30%	5,504	4,976	10,480	0.0013658	14
	50%	2,319	0	2,319	0.0013657	3
	100%	30,243	107	30,350	0.0013654	41
	TOTAL	61,143	31,692	92,835	-	127

Departmental Purchasing

The various departments and office throughout campus individually order their paper through W.B. Mason in an exclusive contract. In previous years, some departments purchased tree-free paper from a student-owned LLC, but this company has stopped providing paper to departments. Since 2009, the amount of GHG emissions and overall purchase of paper from vendors and the amount of paper used per student has been significantly reduced (Tables 18 and 19). This was accomplished by adding print-release stations in public printing areas, setting double-sided printing as the default on campus machines in common areas, widening margins, and through increased awareness for more conscious printing. Unfortunately, despite past successes with preventing departments from purchasing virgin (0% recycled content) paper, this seems to have resumed in FY 2015 and continued over the last few years.

Table 18. *Colgate's departmental purchasing (sheets of paper consumed), FY 2009-2018*

Fiscal Year	Tree-free	0% recycled	30% recycled	50% recycled	100% recycled	TOTAL	Full-time equivalent students	TOTAL
	(sheets)	(sheets)	(sheets)	(sheets)	(sheets)	(sheets)	(FTEs)	(sheets/FTE)
2009	0	4,576,040	3,177,624	5,248	5,118,713	12,877,625	2,784	4,626
2010	0	2,139,901	4,173,960	180,693	2,126,931	8,621,485	2,770	3,112
2011	0	1,546,099	4,451,560	785,097	2,111,831	8,894,587	2,876	3,093
2012	401,584	0	3,546,535	686,238	2,719,280	7,353,637	2,934	2,506
2013	0	0	3,731,683	10,891	4,039,109	7,781,683	2,927	2,659
2014	0	0	1,031,881	59,406	2,629,604	3,720,891	2,927	1,271
2015	0	1,501,089	169,505	55,446	324,752	2,050,792	2,863	716
2016	0	1,447,722	975,644	490,099	3,773,267	6,686,733	2,837	2,357
2017	0	2,354,257	619,505	202,970	2,796,535	5,973,267	2,865	2,085

2018	0	2,284,897	544,936	229,574	2,994,327	6,053,734	2,865	2,113

Departmental Purchasing
Data Requested: The total amount of paper purchased in pound through departmental purchasing by recycled content for FY 2018.
Data Source: Simon Fritz, Director of Purchasing.
Calculations: To convert pounds of paper to sheets, divide poundage by 5.05 (average weight of one package) and multiply by 500 (sheets per package).

Print Shop

The amount of greenhouse gas emissions and overall paper consumed through Colgate's print shop has also been reduced since we started tracking this data in FY 2010 (Table 19).

Table 19. *Colgate print shop (sheets of paper consumed), FY 2010-2018*

Fiscal Year	0% recycled	10% recycled	20% recycled	30% recycled	50% recycled	100% recycled	TOTAL	Full-time equivalent students	TOTAL
	(sheets)	(sheets)	(sheets)	(sheets)	(sheets)	(sheets)	(sheets)	(FTEs)	(sheets/ FTE)
2010	1,969,109	229,703	0	917,822	1,451,881	94,059	4,662,574	2,770	1,683
2011	1,932,376	382,673	0	336,535	1,522,871	146,634	4,321,089	2,876	1,502
2012	3,048,812	248,119	0	1,732,178	754,455	179,208	5,962,772	2,934	2,032
2013	2,533,564	662,475	0	457,030	674,059	130,594	4,457,723	2,927	1,523
2014	2,375,248	723,069	0	933,465	330,099	111,188	4,473,069	2,927	1,528
2015	6,569,604	478,416	0	389,109	30,495	51,980	7,519,604	2,863	2,626
2016	2,669,942	142,822	0	627,228	0	9,901	3,449,892	2,837	1,216
2017	5,486,238	47,228	0	625,049	0	4,950	6,163,465	2,865	2,151
2018	2,579,307	47,921	7,327	492,673	0	10,594	3,137,822	2,865	1,095

Data Requested: The total amount of paper purchased (in pounds) through the print shop by recycled content for FY 2018.
Data Source: Kip Manwarren, Manager of Document and Mail Services.
Calculations: To convert pounds of paper to sheets, divide poundage by 5.05 (average weight of one package) and multiply by 500 (sheets per package).

COLGATE'S GROSS GREENHOUSE GAS EMISSIONS

Colgate's gross GHG footprint in FY 2018 was 9,336 $MTeCO_2$ (3.26 tons/FTE). This includes all Scope 1 emissions (on-site stationary combustion of fossil fuels, vehicle fleet emissions, fugitive refrigerant chemicals, and emissions associated with grounds maintenance) and Scope 2 emissions (purchased electricity). Colgate calculated sources of Scope 3 emissions consistent with the Second Nature guidelines. Scope 3 emissions include faculty and staff commuting, bus travel, employee ground travel, air travel, landfill waste, and paper consumption. We also included forest sequestration in our gross emissions (see below). Since 2009, Colgate has reduced its overall emissions and emissions per student (FTE) by about 46 percent. This reduction is the result of a number of new practices, policies, and resource conservation and efficacy measures that have been put into place since 2009 that are further detailed in Colgate's 2011 Sustainability and Climate Action Plan and 2016 Bicentennial Plan.

Forest Preservation

In FY 2013, Colgate completed a detailed survey of its forested lands. As a result of that survey, it was determined that 1,578 tons of carbon are sequestered each year and Colgate's 1,069 acres of forest land contains 165,491 tons of stored carbon.

In 2014, we received an American Tree Farm System certification for long-term sustainable management of our forests.

In FY 2017, 200 trees were cleared from Colgate's campus resulting in the release of about 91 $MTeCO_2$.

In FY 2018, Colgate re-inventoried the forest determining that our trees sequester 3,776 tons of carbon annually and store 193,755 tons of carbon. Given this information, Colgate has begun to count the amount of carbon sequestered by its forests in our GHG Inventory.

We began including forest sequestration in our gross, as opposed to our net emissions, in FY 2017 and retroactively updated our gross emissions from 2014 (certification year) - 2016. Seeing that Colgate has control over its forested land, and should be penalized when trees are removed and carbon is released, we deemed it appropriate to include emissions and sequestration associated with forest carbon in our gross emissions.

Table 20. *Colgate's gross greenhouse gas emissions by source and scope, FY 2009-2018*

Fiscal Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Source of Emissions	Tons of Emissions									
SCOPE 1										
Fuel Oil #6	4,368	3,339	3,451	2,435	2,991	-	-	-	-	-
Fuel Oil #2	1,864	1,752	1,909	1,729	1,879	7,318	2,536	1,524	947	771
Natural Gas	-	-	-	-	-	-	3,261	5,306	6,824	6,866
Kerosene	-	46	83	83	73	35	35	4	-	1

Propane	-	-	177	165	162	184	180	186	152	190
Vehicle Fleet	393	525	586	565	542	535	570	515	466	488
Refrigerants (HFC-134a and others)	1,247	84	592	449	232	113	111	110	146	75
Fertilizer	46	21	24	28	13	20	12	33	12	15
SCOPE 1 TOTAL	**7,917**	**5,767**	**6,822**	**5,454**	**5,891**	**8,205**	**6,705**	**7,667**	**8,548**	**8,404**
SCOPE 2										
Purchased Electricity	1,885	1,807	1,844	1,814	1,806	1,790	1,803	293	527	489
SCOPE 2 TOTAL	**1,885**	**1,807**	**1,844**	**1,814**	**1,806**	**1,790**	**1,803**	**293**	**527**	**489**
SCOPE 3										
Faculty/Staff Commuting	1,626	1,408	1,367	1,409	1,261	708	806	1,324	1,528	1,144
Bus Travel (Cruisers and Athletics)	258	260	296	318	279	250	242	317	486	504
Employee Business Ground Travel	-	-	478	524	446	398	609	503	622	671
Air Travel	4,647	4,990	5,104	3,826	3,223	2,340	4,297	3,746	3,046	1,973
Landfill Waste	881	125	128	-23	-22	-22	-22	-25	-25	-25
Paper Consumption	139	140	151	146	135	92	129	113	147	127
SCOPE 3 TOTAL	**7,323**	**7,297**	**7,891**	**8,041**	**5,052**	**3,637**	**6,054**	**5,976**	**5,804**	**4,394**
Forest Carbon	in net	in net	in net	in net	in net	-1,578	-1,578	-1,578	-1,487	-3,776
FTE	2,784	2,770	2,876	2,934	2,927	2,927	2,863	2,837	2,865	2,865
Tons/FTE	6	5	6	5	4	4	5	5	5	3
Gross Emissions	**17,353**	**14,505**	**16,194**	**13,817**	**13,841**	**11,984**	**12,984**	**12,261**	**13,392**	**9,464**

For each of the years we have completed Colgate's GHG footprint, the stationary combustion of fossil fuels for space heating and domestic hot water remains the largest single source of emissions (Figure 2). Colgate consumes natural gas, as the existing wood boiler does not have enough capacity to provide heat to all buildings connected on the steam line during the winter months. Colgate also burns fuel #2 in buildings not connected to the steam line. Air travel emissions are a close second. Combined, stationary combustion of fossil fuels on campus and air travel comprise three-quarters of Colgate's total greenhouse gas emissions (Figure 3). The drop in landfill waste emissions since 2009 can be attributed to both a reduction in overall landfill waste due to better recycling and composting and a switch to a methane capture and electricity generation system at the Madison County Landfill. This switch significantly reduced the rate of emissions associated with Colgate's waste production. Additionally, it should be noted that in some categories of the baseline year, some sources of emissions were not counted or utilized on campus (e.g., kerosene and propane).

Figure 2. *Total Emissions by source, FY 2009-2018*

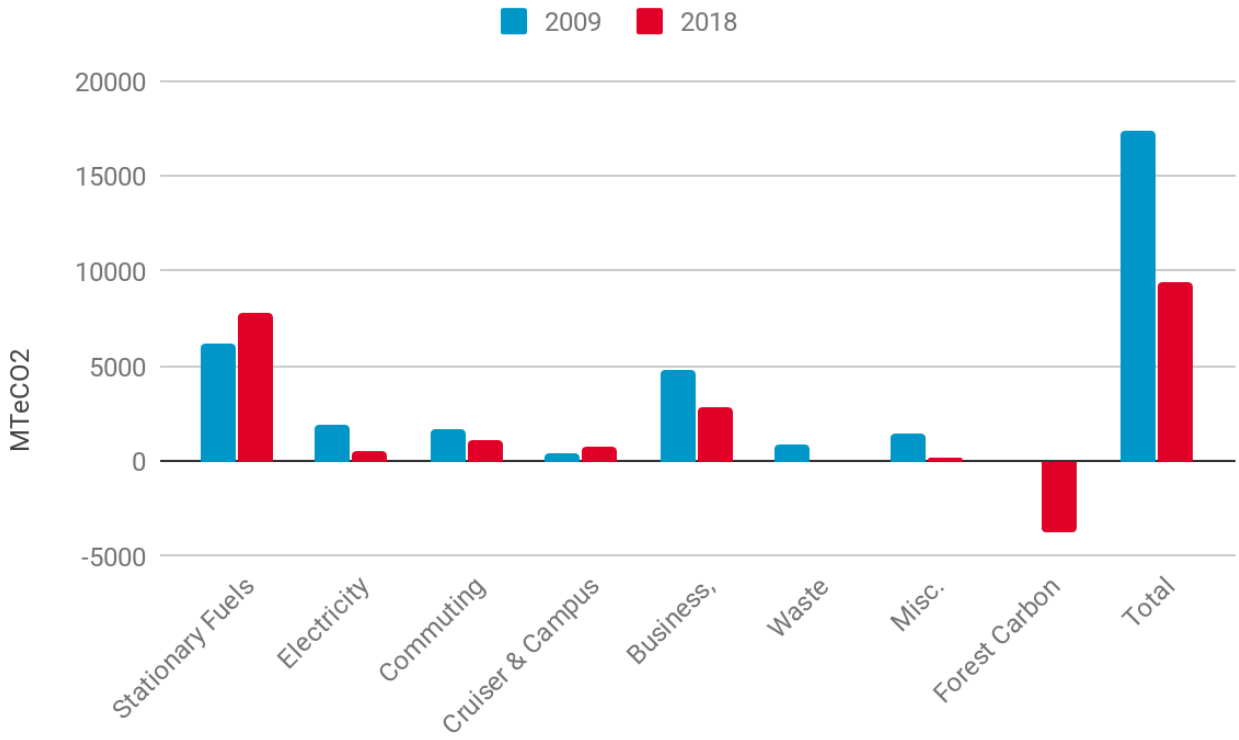
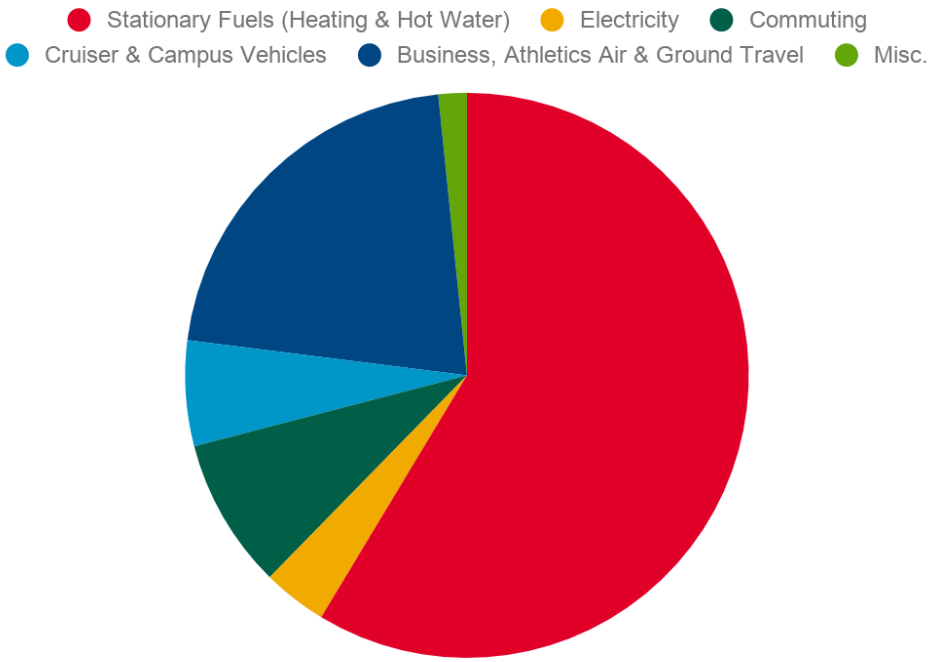


Figure 3. *FY 2018 percentage of gross emissions by source (excludes FOREST CARBON)*



CARBON OFFSETS AND NET GREENHOUSE GAS EMISSIONS

Thus far we have examined Colgate's activities that add greenhouse gases into the atmosphere. However, we also need to consider activities that sequester and/or prevent emitting greenhouse gases in order to determine our net carbon budget. In FY 2018, Colgate's source of offsets included our purchased offsets in Patagonia Sur, as well as Renewable Energy Credits (RECs) described below. As a result, Colgate's net greenhouse gas emissions in FY 2018 are 4,290 $MTeCO_2$ (Table 21).

Patagonia Sur

FY 2012 was the first year that Colgate purchased offsets from Patagonia Sur. Patagonia Sur is a Verified Carbon Standard (VCS) credited carbon offset vendor in Patagonia, Chile. Patagonia Sur is a for-profit conservation venture, which reforests and educates people about the Chilean environment. Patagonia Sur will plant the equivalent number of trees to absorb 5,000 tons of carbon from the atmosphere annually. The contract is set to last for 15 years.

Power Purchase Agreement

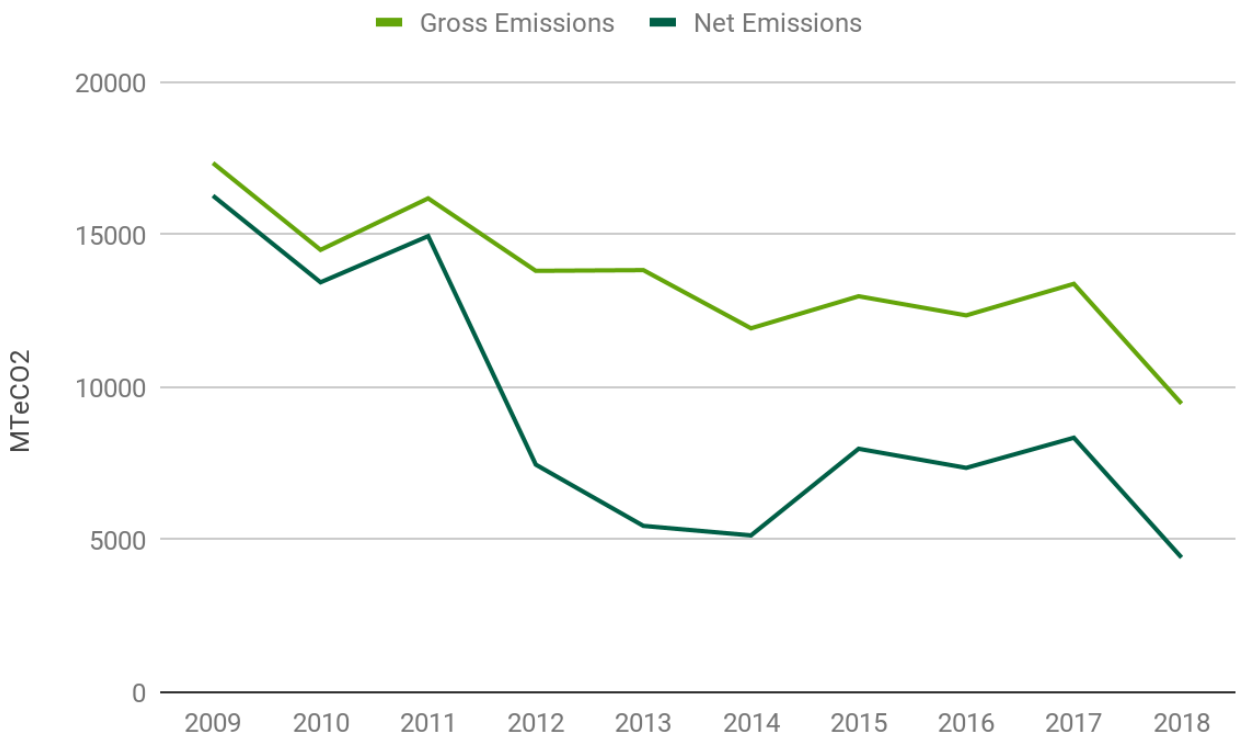
In FY 2018, as a part of the Class of '65 Arena LEED Certification process, Colgate purchased 3,400,000 kWh of green power offsetting 46 $MTeCO_2$.

Forest Carbon

Table 21. *Colgate's offsets and net greenhouse gas emissions, FY 2009-2018*

Fiscal Year	Total Emissions (MTeCO)	Total Carbon Offsets (MTeCO)					Total Net Carbon Emissions (MTeCO)
		Renewable Energy Credits	Carbon Offset Purchases	Patagonia Sur Offsets	Forest Carbon	Total Carbon Offsets	
2009	17,353	-	9	-	1063	1072	16,281
2010	14,505	-	-	-	1063	1063	13,442
2011	16,194	-	-	-	1239	1239	14,955
2012	13,817	-	114	5,000	1239	6353	7,464
2013	13,841	1,807	-	5,000	1578	8,385	5,456
2014	11,934	1,790	-	5,000	in gross	6,790	5,144
2015	12,984	-	-	5,000	in gross	5000	7,984
2016	12,358	-	-	5,000	in gross	5000	7,358
2017	13,392	46	-	5,000	in gross	5046	8,346
2018	9,464	46	-	5,000	in gross	5046	4,418

Figure 4. *Net and Gross greenhouse gas emissions, FY 2009-2018*



APPENDIX A: 2018 COMMUTER SURVEY

Commuter Survey was distributed digitally to all colgate employees. PDF version here.

APPENDIX B: RETROACTIVE GHG EMISSION UPDATES

Guidance on retroactively upgrading GHG emissions can be found here.

APPENDIX C: BUILDINGS INCLUDED IN INVENTORY AND SQUARE FOOTAGE

Colate utilizes operating lease and operational control arrangements. More information from the GHG protocol can be found here and below.

	Type of Leasing Arrangement	
	Finance/Capital Lease	**Operating Lease**
Equity Share or Financial Control Approach Used	Lessee does have ownership and financial control, therefore emissions associated with fuel combustion are scope 1 and with use of purchased electricity are scope 2.	Lessee does not have ownership or financial control, therefore emissions associated with fuel combustion are scope 3 and with use of purchased electricity are scope 3.
Operational Control Approach Used	Lessee does have operational control, therefore emissions associated with fuel combustion are scope 1 and with use of purchased electricity are scope 2.	Lessee does have operational control, therefore emissions associated with fuel combustion are scope 1 and with use of purchased electricity are scope 2.[a]