Dickinson College
Greenhouse Gas Inventory
2008 - 2019

March 25, 2020

Dickinson

Dickinson College Greenhouse Gas Inventory, 2008 – 2019.

Prepared by the Center for Sustainability Education, Dickinson College
March 25, 2019

Acknowledgements

Numerous people assisted with data collection, data analysis and preparation of the Greenhouse Gas Inventory report and are thanked for their help. They include Ken Ball, Kristine Barrick, Kristen Chirillo, Jeff Forester, Amanda George, Tina Gutshall, Mary Hair, Angie Harris, Stephanie Hostetler, Michael Kiner, Neil Leary, Lindsey Lyons, Cheryl Lusk, Cody Rosenbarker, Ken Shultes, Leslie Shwartz, Lori Sinkovitz, Margaret Stafford, Chuck Steel, Matt Steiman, Michelle Spicer, and Sean Witte.

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1 Introduction and Summary

Dickinson College joined with 19 other institutions in 2007 to take action on climate change as Charter Signatories of the American College and University Presidents' Climate Commitment. The Carbon Commitment, as it is now called, has been signed by over 600 colleges and universities. Signatories commit to integrate teaching about climate change and sustainability into their educational programs; measure and report their emissions of greenhouse gases (GHGs); adopt and implement a plan to reduce emissions; and become carbon neutral by cutting net emissions to zero by a date of their choosing.

Dickinson produced its first GHG inventory in 2008 and adopted its Climate Action Plan in 2009. The plan set ambitious targets for emission reductions and carbon neutrality for 2020, 2025 and 2030 (Table 1). This report presents an inventory of Dickinson's greenhouse gas emissions for the period 2008 through 2019 and documents progress toward the college's Carbon Commitment targets.[1]

Table 1. Climate Action Plan Targets

	2008 Baseline	*2019*	*2020 Target*	*2025 Target*	*2030 Target*
Gross Emissions ($MTCO_2E$)	18,847	15,241	14,136	9,424	4,712
Percentage change from 2008	-	-19.1%	-25%	-50%	-75%
Renewable Energy Credits & Carbon Offsets ($MTCO_2E$)	-3,965	-5,792	-14,136	-9,424	-4,712
Net Emissions ($MTCO_2E$)	14,893	9,408	0	0	0

Greenhouse gases are pollutants that change the Earth's climate by accumulating in the atmosphere where they absorb thermal radiation and warm the planet. Greenhouse gases emitted by Dickinson include carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4) and a variety of fluorinated gases. The gases are emitted through activities that include heating, cooling, lighting and powering the campus with fossil fuels and purchased electricity; students and employees traveling by air, train, bus, taxi and personal vehicles; refrigerants leaking from Dickinson owned cooling equipment; applying fertilizers on campus grounds and the Dickinson Farm; raising livestock at the Dickinson Farm; landfilling Dickinson's solid waste; and treating Dickinson's wastewater.

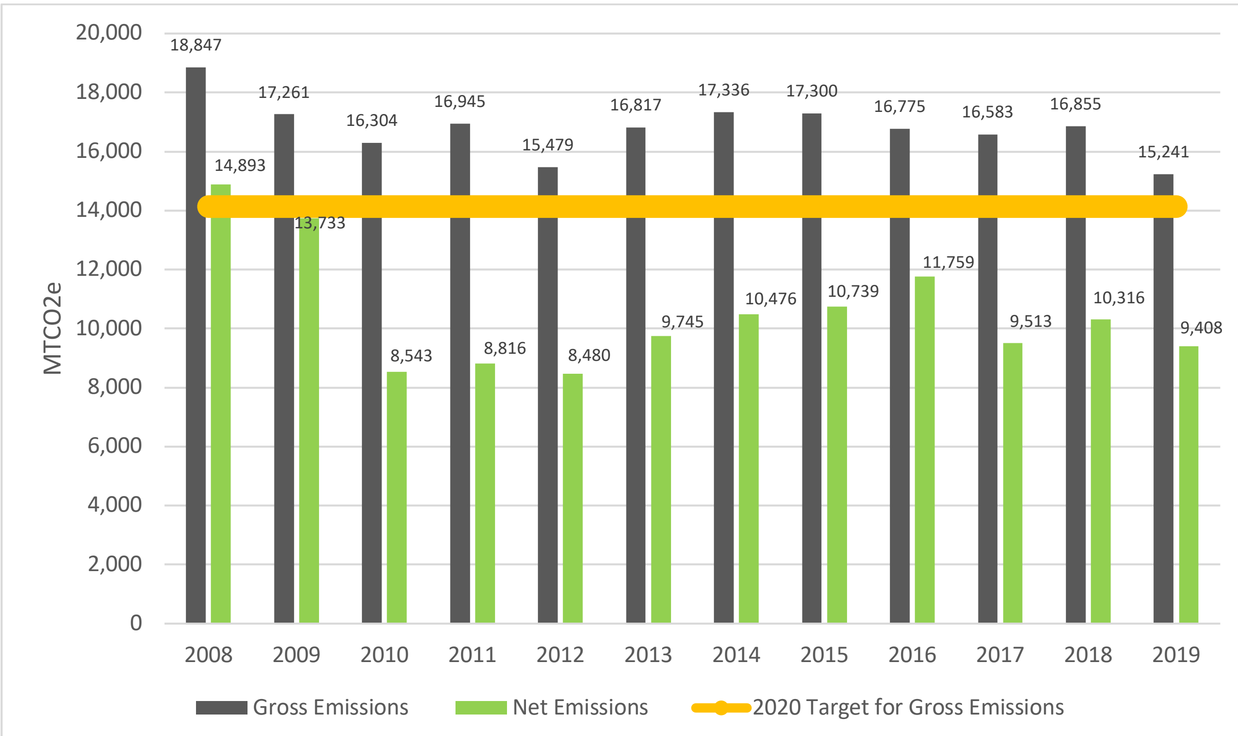
Gross GHG emissions declined from the 2008 baseline level of 18,847 $MTCO_2E$ to 15,241 $MTCO_2E$ in 2019, a reduction of 3,606 $MTCO_2E$ or 19.1 percent (Figure 1).[2] Purchases of Renewable Energy Credits and composting of food waste at the Dickinson Farm offset a portion of the college's gross emissions and reduce net emissions of GHGs. Net emissions (gross emissions minus renewable energy credits and offsets) decreased from 14,893 $MTCO_2E$ in 2008 to 9,408 $MTCO_2E$ in 2019, a decline of 36.8 percent. Meeting the 2020 target will require further reductions in gross emissions of roughly 1,100 $MTCO_2E$ and purchases of slightly more than 14,000 $MTCO_2E$ of carbon offsets.

[1] Years refer to Dickinson's fiscal years; the 2019 fiscal year began July 1, 2018 and ended June 30, 2019

[2] Emissions of greenhouse gases are reported in units of metric tons of carbon dioxide equivalent, or $MTCO_2E$. The method for converting quantities of different gases into an equivalent amount of carbon dioxide is described in section 2 of this report.

The decrease in emissions occurred despite a 16.2 percent increase in Dickinson's gross square feet of building space and a 6.3 percent increase in Dickinson's population of students and employees over the 2008 – 2019 period. Countervailing the effects of these factors on GHG emissions are Climate Action Plan projects that increased energy efficiency, as reflected in a 10.5 percent decrease in energy use per square foot of building space; shifts in electricity generation in Dickinson's market region that reduced carbon dioxide emissions per kilowatt hour (kWh) of electricity by over 30 percent; and improved efficiencies in commercial air travel that reduced emissions per passenger mile by 23.4 percent.

Figure 1. Greenhouse Gas Emissions, Gross, Net and 2020 Target, 2008 - 2019



Section 2 of the report describes the methodology for measuring Dickinson's GHG emissions. Section 3 provides information about the sources of emissions disaggregated by category and by activity. Section 4 of the report presents detailed information about the emission-generating activities and Section 5 describes Dickinson's Renewable Energy Credits and carbon offsets. Section 6 examines the drivers or factors that have contributed to changes in Dickinson's emissions over the period 2008 through 2019. Section 7 concludes the report with descriptions of recent Climate Action Plan projects that are expected to close the gap and get Dickinson to carbon neutrality by 2020.

2 Measuring Greenhouse Gases

Greenhouse gases (GHGs) are gases that absorb infrared radiation, trap heat in the atmosphere, and warm the climate. Carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) are GHGs that occur naturally but are also generated as byproducts of human activities such as burning fossil energy, clearing forests, cultivating crops, and raising livestock. The atmospheric concentrations of these three GHGs have increased as a result of human activities to levels significantly above the concentrations that existed in the pre-industrial era and for at least the past 800,000 years. Synthetic fluorinated gases such as hydrofluorocarbons (HFCs), hydrochlorofluorocarbons (HCFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6) are also GHGs. They have no natural sources, are used as refrigerants, solvents and in other applications, and escape into the atmosphere where they accumulate. The rising concentrations of carbon dioxide, methane, nitrous oxide and fluorinated gases are amplifying the greenhouse effect, warming the planet, and changing the Earth's climate in other ways.[3]

Dickinson College contributes to the emissions of greenhouse gases that drive global climate change. The college does this by using fossil and electric energy to heat, cool, light and power the campus; traveling for college business, commuting, and studying abroad; using refrigerants in our cooling equipment; using nitrogen fertilizers on campus grounds and at the Dickinson Farm; raising livestock; generating solid and human wastes; and purchasing and consuming goods and services, the production and distribution of which generate emissions.

Beginning in 2008, Dickinson has measured its emissions of greenhouse gases to produce an annual GHG emissions inventory, also called a carbon footprint. The process begins with the collection of data from multiple sources on Dickinson activities that generate GHGs either directly or indirectly. The activity data are input to the Sustainability Indicator Management and Analysis Platform (SIMAP), an online tool managed by the University of New Hampshire Sustainability Institute that is used by many colleges and universities to calculate their carbon and nitrogen footprints. SIMAP processes the activity data, applying standardized emission factors to calculate estimates of emissions of GHGs following methods established by the Greenhouse Gas Protocol.[4]

Emission factors used in the calculations updated in SIMAP in 2019 are presented in Table A-1. They are used, for example, to calculate the kg weights of carbon dioxide, methane, and nitrous oxide that are emitted per gallon of distillate fuel oil, gasoline, and diesel fuel burned; per million BTUs of natural gas burned; per kWh of electricity consumed; per passenger mile traveled by air, train and taxi; and per head of livestock raised on the farm.

Greenhouse gases differ in their capacities to absorb infrared radiation and their average residence times in the atmosphere after being emitted. Consequently, emission of one kilogram of one greenhouse gas has a different effect on the climate than does emission of one kilogram of a different greenhouse gas. In order to compare and add up the combined effects of GHGs on the climate, the weight of emissions of each gas are converted to an amount of carbon dioxide that would have an equivalent effect on radiative forcing in the atmosphere. The Global Warming Potential (GWP) of each gas, a measure of the effect of a gas on radiative forcing of the atmosphere relative to carbon dioxide, is used to convert a quantity of a gas to an equivalent quantity of carbon dioxide. The GWP for carbon dioxide is 1.0. Other gases are more powerful warming agents. For example, methane is 25 times more powerful per unit weight than carbon dioxide over a 100-year time horizon and has a 100-year GWP value of 25. Nitrous oxide is 298 times more powerful and has a 100-year GWP of 298. Fluorinated gases can be several thousand times more powerful than carbon dioxide. SIMAP applies estimates of 100-year GWPs from the Intergovernmental Panel on Climate Change to convert the quantity of emissions of each gas into metric tons of carbon dioxide equivalent ($MTCO_2E$) so that they can be compared and added up in a common unit (see Table A-2).

[3] Evidence of the accumulation of GHGs in the atmosphere, their sources and their effects on climate are thoroughly reviewed in IPCC, 2013, *Climate Change 2013: The Physical Science Basis* and in USGCRP, 2017, *Climate Science Special Report: Fourth National Climate Assessment, Volume I*.
[4] Information about SIMAP is available at https://sustainableunh.unh.edu/calculator; documentation for SIMAP is provided in the SIMAP users' guide, https://unhsimap.org/sites/default/files/user-uploads/SIMAP%20User%20Guide_DRAFT6.2_2.21.2018.pdf; and the Greenhouse Gas Protocol can be found at http://ghgprotocol.org/.

3 Sources of Greenhouse Gas Emissions

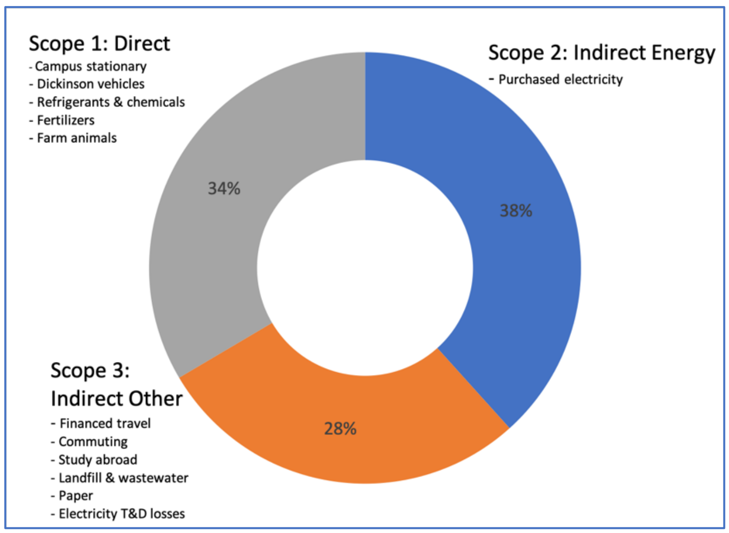
GHG emissions are reported in this document using two different ways of categorizing emissions: by scope and by activity.

3.1 Emissions by Scope

The Greenhouse Gas Protocol is the framework that is used by signatories of the Carbon Commitment to publicly report their emissions of greenhouse gases. The framework groups emissions into three categories, called scopes, that differ in the degree to which they are controlled by an entity. Some emissions, like emissions from burning natural gas in Dickinson's central energy plant boilers, are directly controlled by the college. Other emissions, like emissions produced by the electric utility from which Dickinson purchases electricity and emissions produced by commercial flights taken by students and employees, are indirect results of activities of the college and are not directly controlled by Dickinson. The

The three categories or scopes of emissions in the Greenhouse Gas Protocol as they are applied to Dickinson are described as follows:

Figure 2. Share of Greenhouse Gas Emissions by Scope, 2019



Scope 1: Emissions from sources that are directly owned and/or controlled by the college. This includes emissions from combusting fossil fuels in college-owned stationary facilities (e.g. boilers and furnaces), combusting fossil fuels in college owned vehicles, fugitive emissions from college-owned refrigeration equipment, emissions from the use of fertilizers on the main campus and the Dickinson Farm, and emissions from the management of livestock at the Dickinson Farm.

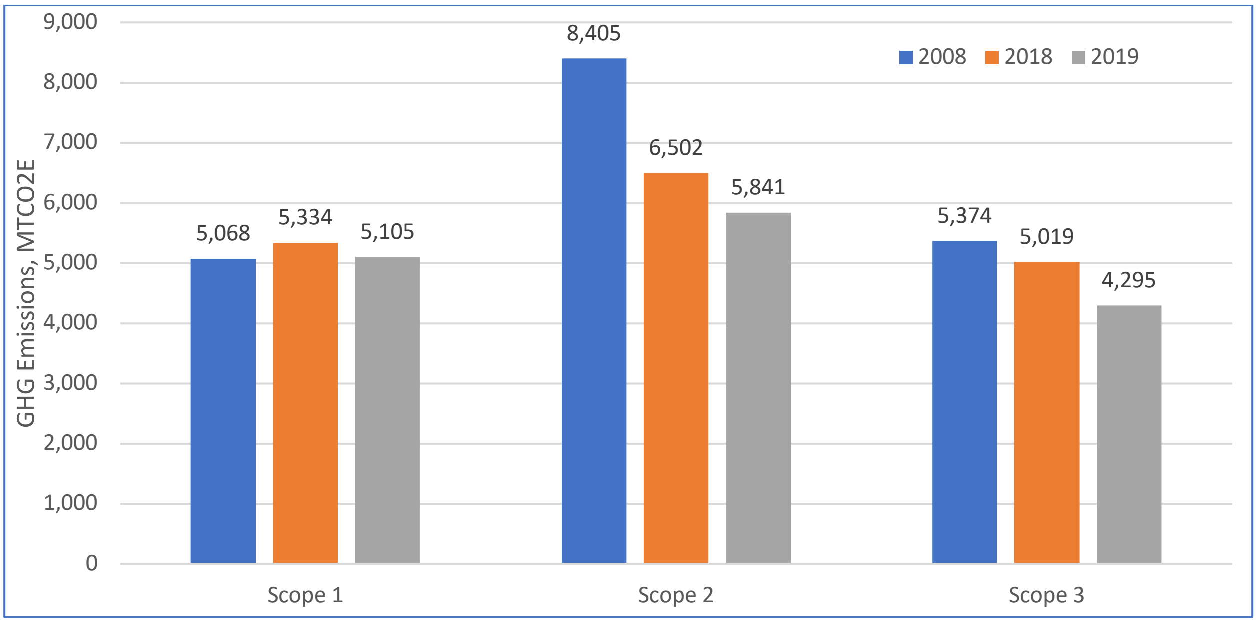
Scope 2: Emissions of electric utilities that result from generating electricity that is purchased by Dickinson. These sources are not directly controlled by the college. The electric utility from which Dickinson purchases electricity generates electricity by burning coal, oil, natural gas and other carbon-based forms of energy that emit GHGs, as well as from zero-carbon energy sources such as hydropower and nuclear power.

Scope 3: Emissions from sources not directly controlled by the college that are emitted as a result of providing goods and services other than electricity to the college, its students or its employees for college-related activities.

The Carbon Commitment requires Dickinson to report and include in its GHG inventory all Scope 1 and Scope 2 emissions, plus Scope 3 emissions for air travel paid for by the college and employee commuting.[5] Signatories of the Carbon Commitment can also voluntarily report and include in their GHG inventory additional Scope 3 emissions. Dickinson voluntarily reports emissions from students' study abroad travel, paper purchases, landfilled waste, wastewater treatment, and transmission and distribution (T&D) losses associated with purchases of electric power as part of its Scope 3 emissions. Dickinson's commitment to reduce its gross emissions by 25 percent applies to all Scope 1 and Scope 2 emissions plus the Scope 3 emissions noted in this paragraph.

Scope 2, indirect emissions from purchased electricity, accounts for the largest share of Dickinson's gross emissions, 38 percent in 2019, while Scopes 1 and 3 account for 34 and 28 percent respectively (see Figure 2). Quantities of gross emissions by scope for the years 2008, 2018 and 2019 are shown in Figure 3 and for all years in Table A-3 in the Appendix. Scope 1 emissions increased 0.7 percent from 2008 through 2019; Scope 2 emissions decreased 30.5 percent; and Scope 3 emissions decreased 20.1 percent.

Figure 3. Greenhouse Gas Emissions by Scope, 2008, 2018 and 2019



3.2 Emissions by Activity

In addition to reporting emissions by scope, emissions are also reported by activity. Reporting emissions by activity is helpful for communicating in a more intuitive way the actions that are responsible for Dickinson's GHG emissions. The shares of GHG emissions attributable to different activities of the college in 2019 are shown in Figure 4. Heating and powering the campus accounts for 70.1 percent of total gross emissions. Within this activity, purchased electricity accounts for 38.3 percent of gross emissions, on campus combustion of fossil energy to heat the campus and provide for other services produces 30.6 percent, and losses from the transmission and distribution of electricity (T&D) add another 2.1 percent.

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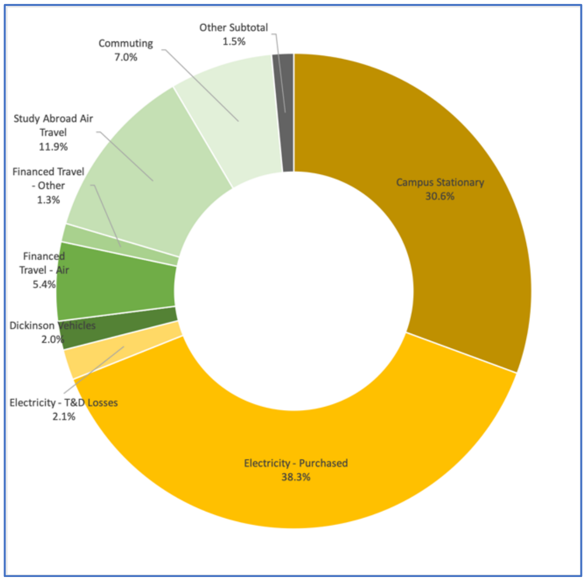
[5] Reporting of student commuting is also required. However, Dickinson College is a residential college and the overwhelming majority of Dickinson students live on campus. The small number of students who live off-campus are within walking distance of the college. The few students who might commute to campus in motor vehicles make a *de minimis* contribution to emissions and are not included in Dickinson's GHG inventory.

Travel by various modes and for various purposes accounts for 27.5 percent of total gross emissions. Students' study abroad travel accounts for 11.9 percent of total emissions; employee and student travel paid for by the college for 6.7 percent; employee commuting for 7.0 percent; and travel in Dickinson owned vehicles for 2.0 percent. Other activities account for 1.5 percent of gross emissions.

Figure 4. Share of Greenhouse Gas Emissions by Activity, 2019



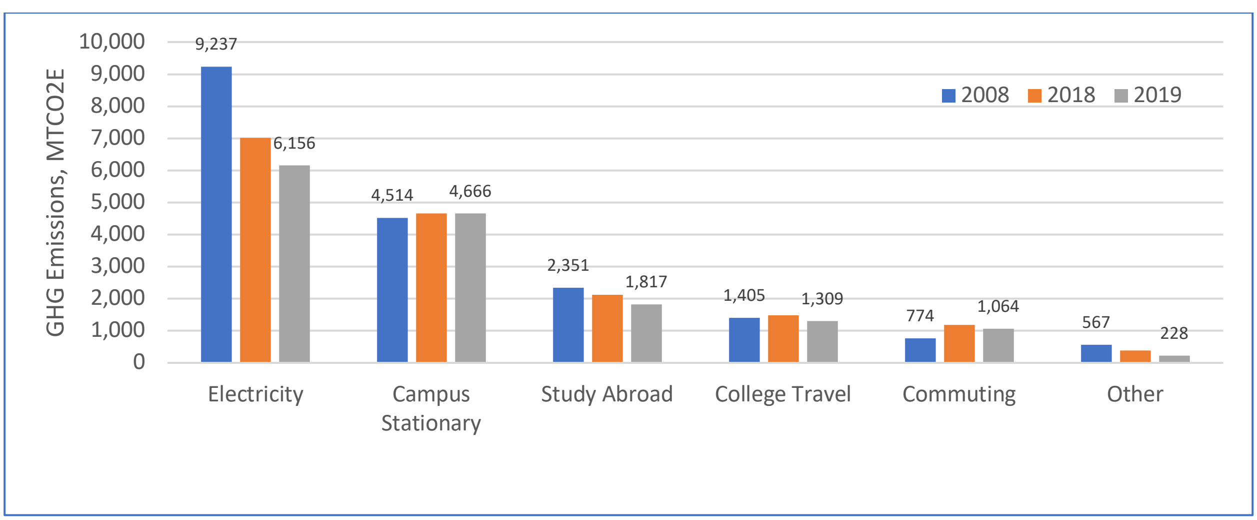
Heat & Power: 71.0%
- Campus Combustion
- Electricity – Purchased
- Electricity – T&D losses

Transportation: 27.5%
- Dickinson Vehicles
- College Travel – Air
- College Travel - Other
- Study Abroad Travel
- Employee Commuting

Other: 1.5%
- Refrigerants
- Farm Animals & Fertilizer
- Paper
- Solid Waste
- Wastewater

The quantities of emissions by activity for the baseline year 2008 and for 2018 and 2019 are shown in Figure 5 and for all years in Table A-4 in the Appendix. Emissions decreased since 2008 for activities that include purchases of electricity, study abroad travel, college financed travel and other. Emissions increased for campus combustion of fossil energy for heat and employee commuting. Further details about GHG emitting activities are provided in Section 4.

Figure 5. Greenhouse Gas Emissions by Activity, 2008, 2018 and 2019



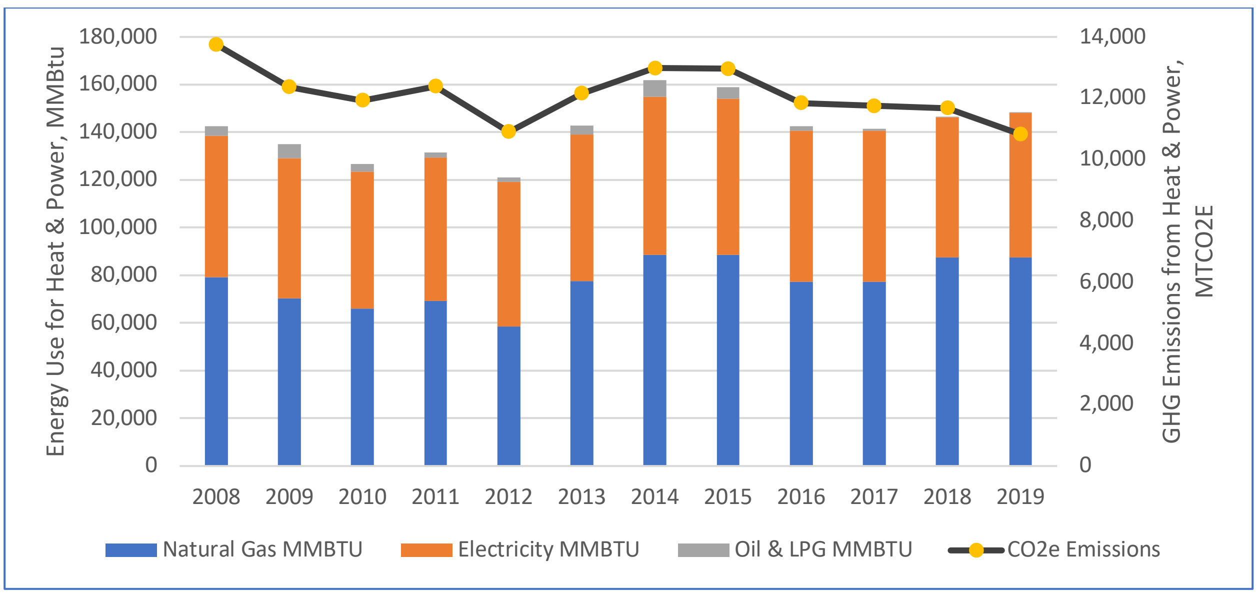
4 Analysis of Greenhouse Gas Emitting Activities

4.1 Heat and Power

Dickinson uses electricity, natural gas, distillate fuel oil, and liquid propane gas for heating, cooling, lighting and powering college owned and leased buildings. Two-thirds of Dickinson's buildings are heated and cooled by a central energy plant located in the northeast wing of Kaufman Hall. High-efficiency dual-fuel boilers in Dickinson's central energy plant can burn either natural gas or distillate fuel oil to produce low-pressure steam that is converted to hot water and distributed across campus through underground pipes for heat. Electric chillers in the central energy plant produce chilled water that is also distributed across campus to cool the same buildings.

Other buildings that are not connected to the central energy plant are heated and cooled with stand-alone gas and oil-fired boilers and furnaces, electric resistance heating systems, central air systems, and window air conditioners. These stand-alone systems generally are less efficient than heating and cooling by the central energy plant. Natural gas, in addition to being used for heating, is also used as a cooking fuel and for clothes dryers and water heaters. Electric power, in addition to being used for heating and cooling, is used for indoor and outdoor lighting and to power myriad college owned appliances that include water heaters, refrigerators, freezers, fans, pumps, washers, data servers, computers, televisions, and monitors. Electric power is also used by students and employees for a variety of personal electronic appliances.

Figure 6. Energy Use and Greenhouse Gas Emissions for Heat and Power, 2008 – 2019



Energy use for heat and power by energy type and the resulting GHG emissions are presented in Figure 6 and Table A-5. Dickinson consumed a total of 148.2 billion Btus for heat and power in 2019, nearly all of it in the form of natural gas and electricity. In 2019, natural gas represented nearly 60 percent of total energy used for heat and power and electricity 40 percent. Fuel oil and propane account for only 0.01 percent. Total energy use for heat and power increased and decreased from year-to-year. Starting at 142.6 billion BTUs in 2008, energy use fell to a low of 120.9 billion BTUs in 2012, rose to a peak of 161.9 billion in 2014 and has fallen since then. Energy use in 2019 stands at 3.9 percent above the 2008 baseline, despite an increase of 16.2 percent in building space and 6.3 percent increase in the campus population.

While energy use for heat and power is higher in 2019 than in 2008, GHG emissions associated with heating and cooling the campus is down 21.3 percent from the 2008 level, declining from 13,750 $MTCO_2E$ in 2008 to 10,822 $MTCO_2E$ in 2019. The decline in GHG emissions despite a slight increase in energy consumption from 2008 to 2019 is attributable to decreasing carbon emissions per kWh of electricity purchased (see Section 6.3 for further discussion).

4.2 Transportation

Dickinson employees and students travel by multiple modes for a variety of college-related purposes. This includes travel in college-owned vehicles, employee and student travel paid for by the college, commuting by employees, and travel by students to study abroad. Altogether, Dickinsonians traveled 10.1 million miles in 2019, which produced 4,190 $MTCO_2E$ of emissions (Figure 7). Details of miles and GHG emissions for each category and mode of travel are provided in Table A-6 of the Appendix.

Student air travel for study abroad is the largest contributor to travel-related emissions. Study abroad represents 43.4 percent of transportation emissions in 2019 and 11.9 percent of Dickinson's total carbon footprint. The number of students studying abroad each year has varied between 364 and 447, contributing an average of 4.5 to 4.9 $MTCO_2E$ per student traveler to the college's annual carbon footprint. Collectively, students traveled 4.1 million miles round trip by air in 2019 to their study abroad sites, less than 1 percent more than in 2008. While miles traveled was roughly unchanged, emissions from study abroad travel decreased, falling from 2,351 $MTCO_2E$ in 2008 to 1,817 in 2019, a reduction of 22.7 percent. The decline in emissions from study abroad results from declining carbon intensity of commercial air travel (see Section 6.3).

Employee commuting distances and modes of travel are estimated from a survey conducted in spring 2017. Survey responses indicate that 75 percent of all employees commute by driving single-occupant motor vehicles, 2 percent carpool, 4 percent bicycle and 19 percent walk.[6] But modes of travel look very different depending on the distance employees live from work. For example, of the 369 employees who lived within two miles of campus in 2017, representing 38 percent of all employees, 9 percent bicycle and 44 percent walk to work. The results from the 2017 survey are used to estimate commuting distances for each mode for all other years.

Employee commuting contributed 25.4 percent of transportation emissions and 7.0 percent of Dickinson's total carbon footprint in 2019. Dickinson employees commuted nearly 3.1 million miles in 2019, which produced GHG emissions of 1,064 $MTCO_2E$. Both miles and emissions increased substantially since 2008, 39.7 percent and 37.5 percent respectively. The rise in commuting miles is attributable to two factors. First, the number of full-time equivalent staff plus faculty increased from 780 in 2008 to 936 in 2019, a 20.1 percent increase. Second, the estimated miles commuted per employee rose from 2,803 miles per year in 2008 to 3,260 miles in 2019 as employees live farther from campus on average now than in the past.

Travel by employees and students paid for by the college includes travel by air, train, bus, taxi and personal vehicle.[7] College financed travel by all modes totaled 2.1 million miles in 2019 and produced

[6] Public transit options are very limited in Carlisle and southcentral Pennsylvania more generally. Consequently, very few Dickinson employees use public transit.

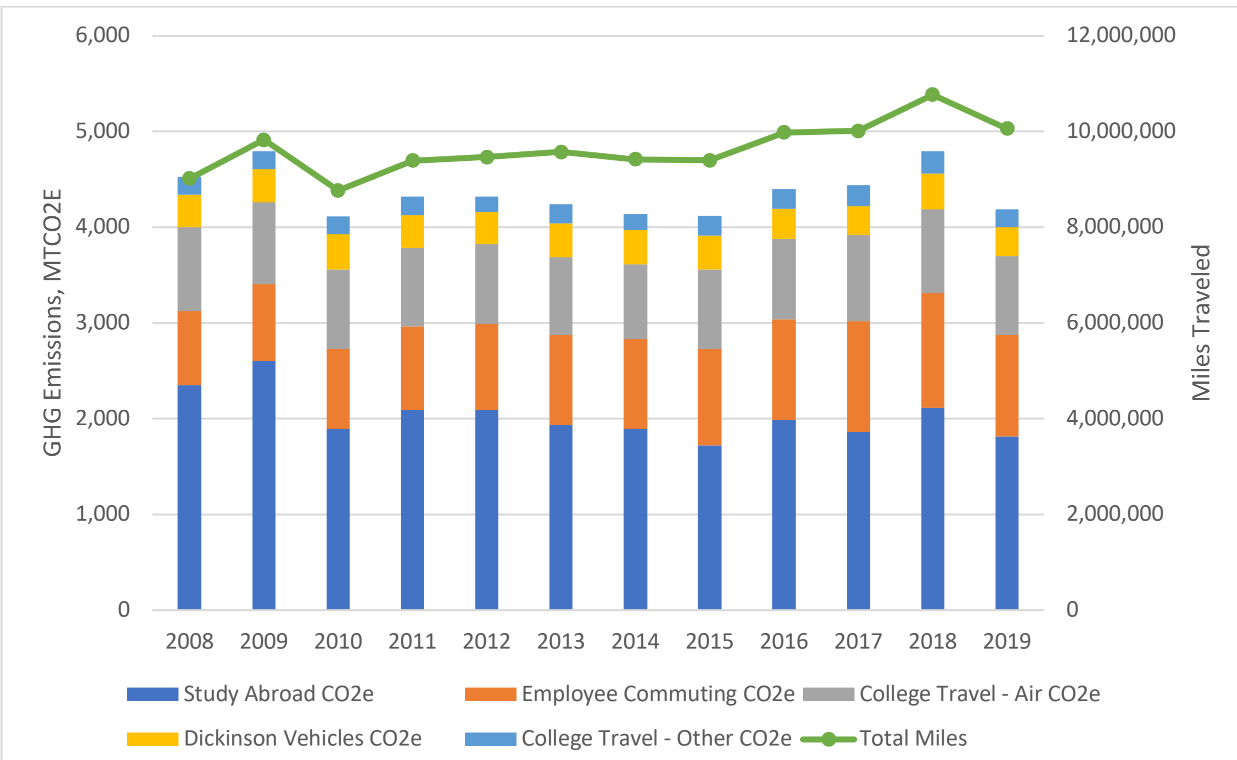
[7] College financed travel is calculated for 2016 through 2019 using financial records for those years. College financed travel for prior years is estimated by assuming that travel miles per employee for each mode of travel was the same as in 2016.

GHG emissions of 1,010 $MTCO_2E$. Air travel accounts for the majority of travel miles financed by Dickinson and was 1.9 million miles in 2019. College financed air travel miles rose 21.8 percent from 2008 to 2019 yet emissions from financed air travel decreased 6.7 percent. Travel financed by the college represents 24.1 percent of transportation emissions and 6.7 percent of Dickinson's total carbon footprint.

Dickinson owned vehicles are used to maintain campus facilities and grounds; provide student shuttle services; transport students for field trips and community service; attend conferences; recruit prospective students; and conduct other college business. Nearly 30,000 gallons of gasoline were purchased for travel in Dickinson vehicles in 2019 and almost 3,900 gallons of diesel and biodiesel fuel. Burning these fuels emitted 299 $MTCO_2E$ GHGs in 2019, a 12.4 percent decrease since 2008.

Total miles traveled for all categories and modes increased a bit more than 1 million miles, or 11.5 percent, from 2008 to 2019 (Figure 7). Most of the increase comes from an increase of nearly 900,000 miles for employee commuting. Despite the rise in miles traveled, emissions from travel declined 7.5 percent.

Figure 7. Travel Miles and Greenhouse Gas Emissions from Transportation, 2008 – 2019



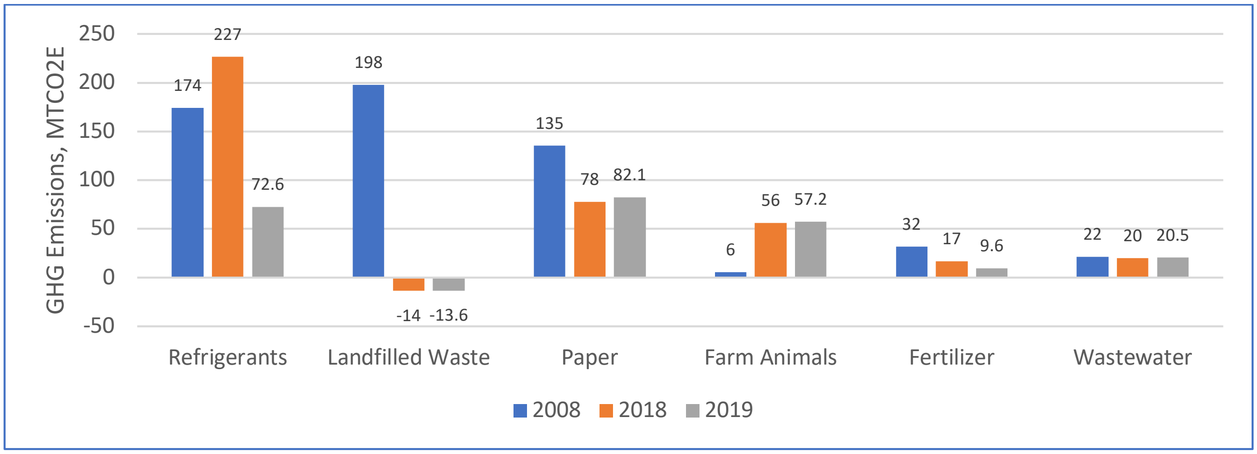
4.3 Other Activities

Other activities that contribute to Dickinson's GHG emissions include leaks of refrigerants, paper purchases, raising livestock at the Dickinson Farm, use of nitrogen fertilizers, solid waste disposal, and wastewater treatment. Together, these activities produced 229 $MTCO_2E$ of GHG emissions in 2019, which is 59.7 percent less than in 2008. They account for 1.5 percent of Dickinson's carbon footprint. Details of emissions from other activities are presented in Table A-7.

Dickinson purchases refrigerants composed of a variety of fluorinated gases each year to replace refrigerants that leak into the atmosphere from cooling equipment. Annual purchases are used as an estimate of the quantities that leak. Estimated leakages in 2019 are 77 $MTCO_2E$, down 58.4 percent from 2008.

Beef cattle, sheep and poultry raised at the Dickinson College Farm generated an estimated 57 $MTCO_2E$ emissions of methane and nitrous oxide in 2019, a nearly ten-fold increase from 2008. Much of the increase is the result of introducing beef cattle to the farm to provide meat for special meals in the campus dining hall and for families that are members of the farm's Campus Supported Agriculture program. Organic fertilizers applied at the farm in Boiling Springs, and organic and synthetic fertilizers applied on the grounds of the main campus in Carlisle, resulted in an estimated 9.6 $MTCO_2E$ emissions of nitrous oxide, which is 70 percent less than the 32 $MTCO_2E$ emissions from fertilizers in 2008.

Figure 8. Greenhouse Gas Emissions from Other Activities, 2008, 2018 and 2019



Dickinson purchased 99,000 pounds of paper in 2019. Production of the paper generated an estimated 82.1 $MTCO_2E$ of GHG emissions, 39 percent less than in 2008. 453 short tons of solid waste was sent to the landfill in 2019. Because the landfill captures methane, which is used to generate electricity, our landfilled waste generates credits that reduced our emissions in 2019 by 13.6 $MTCO_2E$. 42 million gallons of wastewater was sent from Dickinson to the local sewage treatment plant in 2019. The treatment process released an estimated 20.5 $MTCO_2E$ of nitrous oxide in 2019, about 5 percent less than in 2008.

5 Carbon Offsets

Dickinson currently offsets its emissions in two ways: by purchasing Renewable Energy Credits and by composting food waste at the Dickinson Farm.[8] These actions reduce Dickinson's net emissions.

Renewable Energy Credits (REC) are certificates that correspond to the environmental benefits of electricity that is produced from renewable energy sources such as wind and solar. Each megawatt-hour (MWh) of electricity produced from a renewable source results in the generator receiving a 1-MWh REC. The generator can sell the REC to another party, which provides the generator a financial incentive for

[8] Reporting conventions have changed such that purchases of renewable energy certificates count as a credit that reduces gross emissions, and not as an offset that reduces net emissions. Dickinson will switch to the new reporting conventions after 2020.

producing electricity using renewable sources. The buyer's purchase of a REC helps finance renewable energy development that reduces GHG emissions by displacing fossil fuel generated electricity. In exchange, the buyer receives a REC that can be used as an offset to reduce the buyer's carbon footprint.

Dickinson purchased 8,000 MWh of RECs in 2008, which offset of 3,865 $MTCO_2E$ of the college's emissions. Dickinson increased purchases of RECs in subsequent years. In 2019, the college purchased 18,000 MWh of RECs, which offset 5,792 $MTCO_2E$ of emissions, enough to reduce net emissions from Dickinson's electricity purchases to nearly zero. The RECs currently purchased by Dickinson are obtained from Renewable Choice Energy at a cost of roughly $17,000 per year. The RECs are certified by Green-E as meeting industry standards for clean, renewable energy.

Composting also provides an offset to Dickinson's emissions. Nearly all food waste from Dickinson's dining hall is collected, pulped to remove water, and transported to the Dickinson Farm where it is composted and used as a soil amendment. The compost adds carbon to the farm soils and is sequestered. This earns Dickinson a credit in the SIMAP GHG accounting system. In 2019, 137 tons of food waste was composted at the Dickinson Farm, which yielded a 40.4 $MTCO_2E$ offset to Dickinson's emissions.

6 Drivers of Emission Changes

A variety of factors have contributed to changes in Dickinson's emissions of greenhouse gases over the period 2008 to 2019. These include changes in the population of students and employees, the square footage of building space, and weather; changes in the carbon intensity of energy sources; changes in energy efficiencies; and changes in activity levels. Changes in activity levels were addressed in previous sections of the report. Changes in each of the other drivers are examined below.

6.1 Population, Building Space and Weather

The number of full-time equivalent (FTE) students has varied between 2,317 and 2,414 over the period 2008 to 2019. The period began with 2,345 FTE students in 2008 and ended with 2,414 FTE students in 2019, an increase of 2.9 percent. The number of FTE employees increased from 780 in 2008 to 936 in 2019, an increase of 20.8 percent. Dickinson students, nearly all of whom live in college owned or leased housing, use the campus very differently from employees. To account for the differences, the campus population is measured as a weighted sum of students and employees, giving greater weight to residents of college housing following the methodology of the Association for Advancement of Sustainability in Higher Education.[9] The number of weighted campus users at Dickinson increased from 2,878 in 2008 to 3,059 in 2019, an increase of 6.3 percent.

Dickinson has added to its building spaces since 2008. In 2008, Dickinson owned or leased 1.68 million gross square feet of building space. By 2019, construction of new buildings, additions to existing buildings, and divestment of other buildings resulted in a net increase of 270,000 square feet, raising the total area of building space to 1.96 million gross square feet, a 16.2 percent increase from 2008. In 2019 Dickinson opened its newest residence hall, the High Street Residence, which earned LEED Platinum

[9] The methodology counts each full-time equivalent student and employee living in campus housing as 1.0 weighted campus users and each full-time equivalent student and employee living off-campus as 0.75 weighted campus users. The several hundred participants in the summer Central Pennsylvania Youth Ballet, Johns Hopkins Center for Talented Youth, and sports camps who reside on and use the Dickinson campus are not included in the calculation of weighted campus users. This omission skews measures of Dickinson's energy use per person and emissions per person upward compared to a campus that does not have summer users and residents.

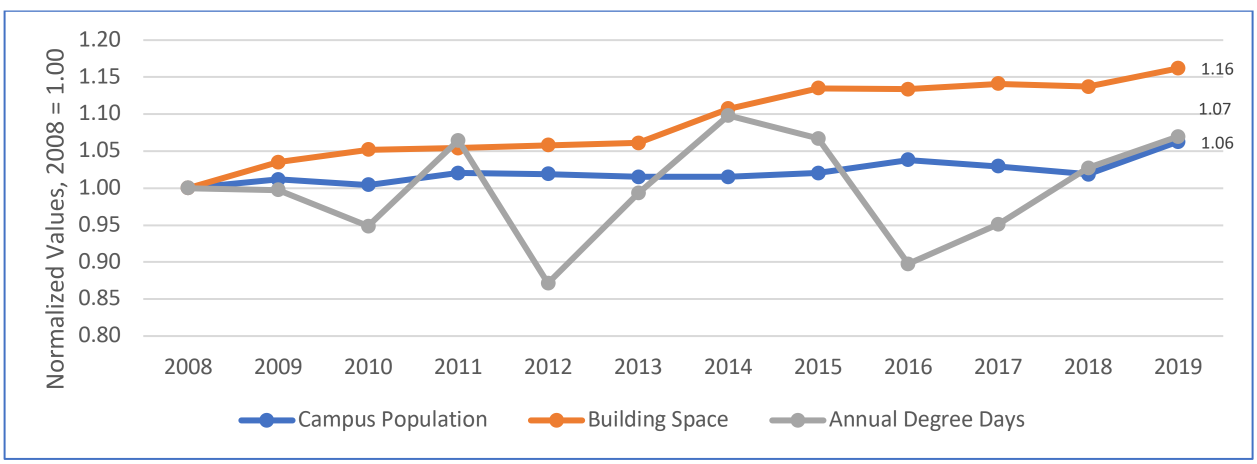
certification for its energy efficient and environmental design. While most of the additions received LEED Gold or Platinum certification, or were built to comparable standards, these new spaces added to energy demand for heating and powering Dickinson's campus.Additions to building space over the period 2008 to 2019 include:

- Althouse Renovation, LEED Gold: 29,100 square feet
- Waidner Admissions House addition, LEED Gold: 4,500 square feet
- Rector North Science Building: 23,000 square feet
- Dr Inge P Stafford Greenhouse for Teaching and Research: 2,500 square feet
- Durden Athletic Training Center, LEED Gold: 23,000 square feet
- Kline Fitness Center and Squash Courts, LEED Gold: 29,000 square feet
- High Street Residence Hall, LEED Platinum: 42,000 square feet

The weather also influences energy use and emissions of greenhouse gases. Heating degree days and cooling degree days are metrics that are used to represent the effects of weather variability on energy demand. Annual heating degree days are calculated from the number of hours over the year that the outside temperature is below 65° F. The greater the temperature differential from 65° F, and the greater the number of hours outside temperatures differ from 65° F, the greater is the demand for energy to heat or cool interior spaces. The sum of annual heating and cooling degree days, annual degree days, gives a measure of the effect of weather on annual demand for energy for heating and cooling. Annual degree days in our area have varied between 5000 and 6300 over the period 2008 through 2019, with no clear trend. Annual degree days in 2019 was 6.9 percent higher than in the 2008 baseline year.[10]

Figure 9 displays data for the number of weighted campus users, building square footage, and annual degree days. The data have been normalized so that the value in the 2008 baseline year is equal to 1.0 for each variable and values for other years are shown as ratios to the baseline year values. The changes in these drivers of GHG emissions indicate that, other things being equal, new building space added significantly to energy demand and emissions, the campus population added slightly to energy demand and emissions, and weather variations had sometimes positive and sometimes negative effects.

Figure 9. Campus Population, Building Space and Annual Degree Days



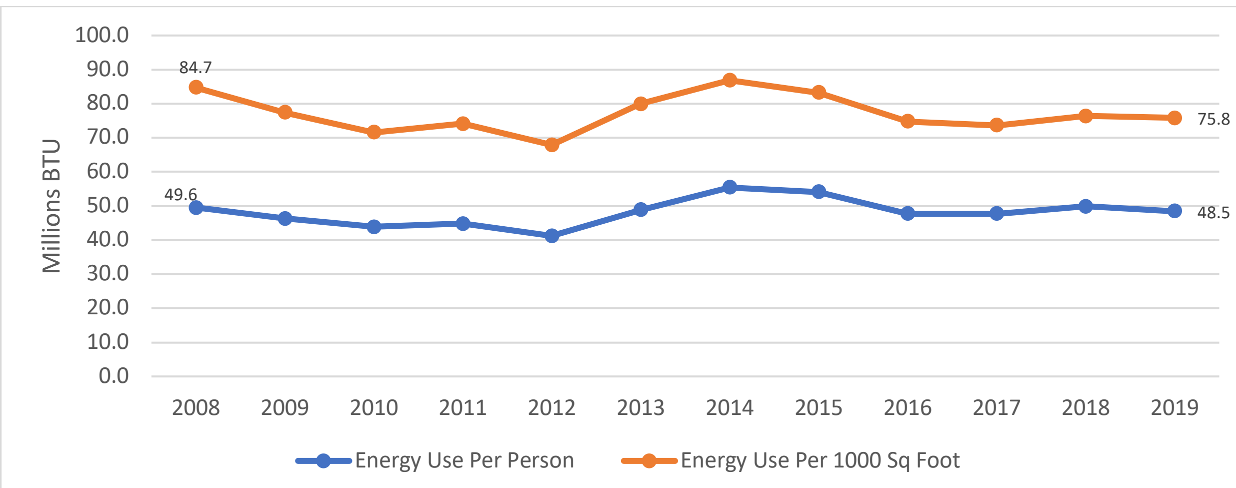
[10] Degree day calculations for a weather station in Harrisburg, PA are used for Dickinson's analysis and are available from http://www.weatherdatadepot.com/

6.2 Energy Efficiency

Dickinson has strived to improve energy efficiency through a variety of strategies. They include incorporating energy efficient design in new and renovated spaces; purchasing energy efficient equipment for new building spaces and for replacement existing equipment that have reached the end of their useful lifetimes; improving computer control systems for managing building systems; adjusting setback temperatures for heating and cooling buildings; switching to energy efficient lighting; and using high efficiency windows when replacing existing windows.

The effects of these efforts are reflected in the amount of energy consumed per square foot of building space and per person, or per weighted campus user. Energy use for heat and power per thousand square feet of building space fell from 84.7 million BTUs in 2008 to 75.8 million BTUs in 2019, a 10.5 percent decrease (see Figure 10). Energy use per weighted campus user changed only slightly from 49.6 million BTUs in 2008 to 48.5 million BTUs in 2019. The efficiency gains helped to counter the effects of growing building space and campus population on energy use and GHG emissions. Note that energy use per square foot and per person was relatively high in 2013, 2014 and 2015 and that these years coincide with relatively cold winters and high annual degree days.

Figure 10. Energy Intensity



6.3 Carbon Intensity

The carbon intensity of energy used by Dickinson, or the amount of carbon-equivalent GHG emissions per unit of energy use, decreased for electric and total energy for heat and power over the period 2008 through 2019 (Figure 11). The carbon intensity of the electricity purchased by Dickinson decreased 24.3 percent since 2008. The decline in carbon intensity of electricity reflects a shift away from coal for generating electricity in Dickinson's market region, which is relatively high in emissions of carbon per kWh of electricity generated, to greater use of natural gas, which emits less carbon per kWh.

The carbon intensity of total energy used for heat and power (electricity, natural gas, oil and liquid propane) also decreased. The largest contributor to the decrease is the decline in carbon intensity of purchased electricity noted above. Also contributing are an increased share of Dickinson's total energy coming from electricity and a decreased share of total energy coming from oil and liquid propane. The decline in carbon intensity for electricity and total energy contributed significantly to emission reductions achieved to date.

The carbon intensity of air travel also decreased from 2008 to 2019 (Figure 12). Carbon-equivalent emissions per passenger mile of air travel decreased 23.4 percent as commercial air travel has become more efficient through the use of more fuel-efficient aircraft and through increases in average numbers of passengers per flight. While total air miles traveled by students and employees increased 6.6 percent from 2008 to 2019, GHG emissions declined 18.4 percent because commercial air travel has become less carbon intensive. Other travel modes have increased slightly in carbon intensity, but the change for air travel dominates so that emissions per mile averaged across all modes of travel decreased 17 percent.

Figure 11. Carbon Intensity of Electricity and Total Energy

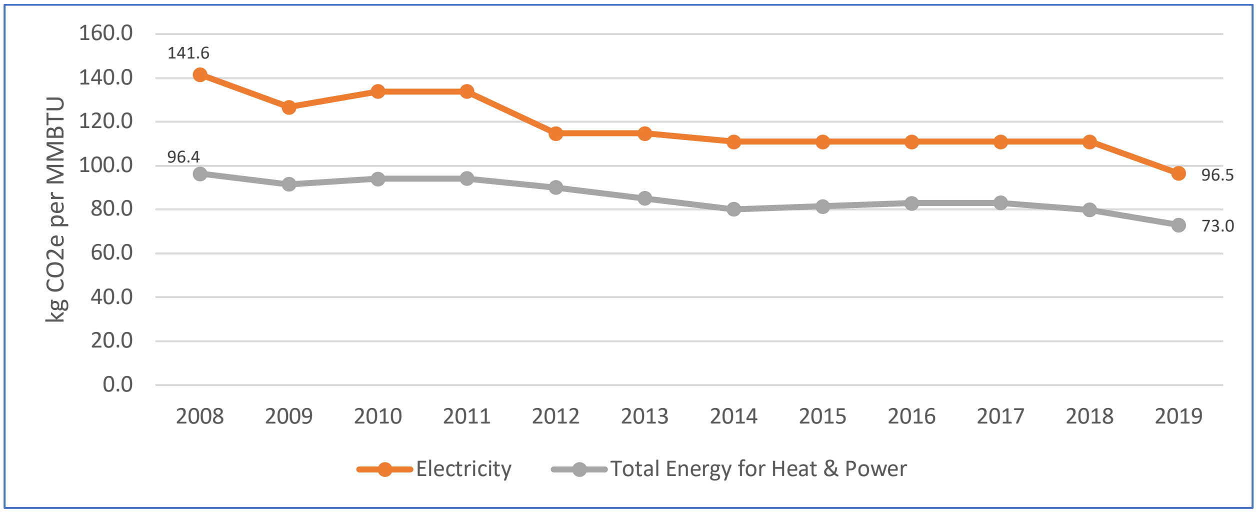
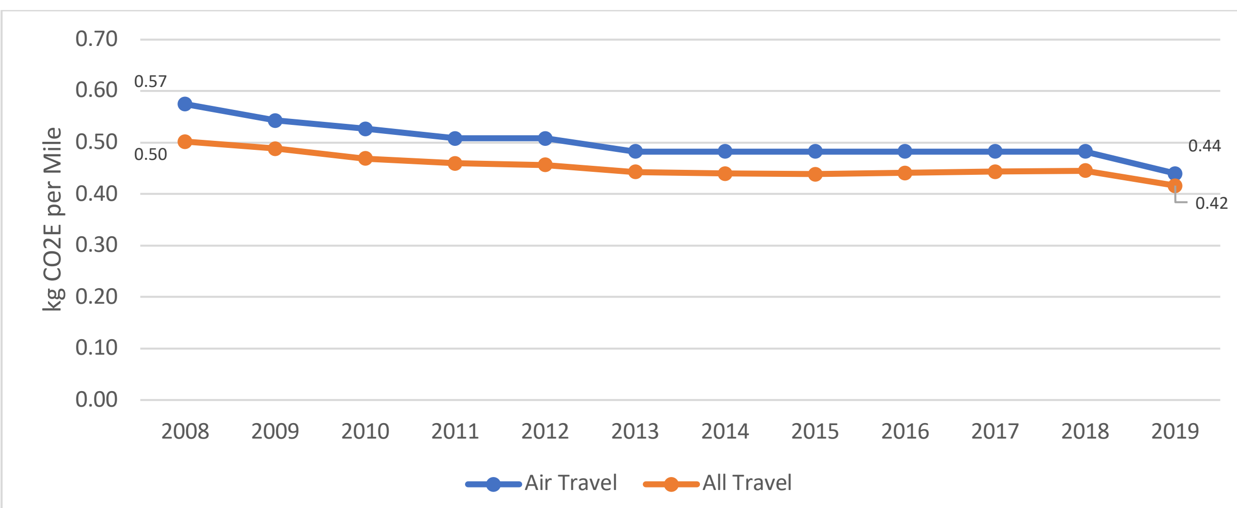


Figure 12. Carbon Intensity of Travel



7 Reaching Our 2020 Target

Dickinson has reduced its gross emissions of greenhouse gases by 3,600 $MTCO_2E$, or 19.1 percent, from its 2008 baseline, putting the college very near the 25 percent reduction target for 2020. Net emissions have been reduced by nearly 5,500 $MTCO_2E$. Further reductions in annual gross emissions of 1,100

$MTCO_2E$ are needed to reach the 2020 target. In addition, Dickinson will need to increase its purchases of carbon offsets, including RECs and other types of offsets, from the current level of roughly 5,800 $MTCO_2E$ to roughly 14,000 $MTCO_2E$ per year to achieve zero net emissions of greenhouse gases in 2020. Some of the recently completed Climate Action Plan projects that are contributing to emission reductions are described below.

Solar Field at Dickinson Park: Dickinson signed a 25-year power purchasing agreement in 2018 with Tesla for installation of a 3-megawatt solar photovoltaic system at Dickinson Park. The system started delivering power in January 2019 and is projected to produce an average of 4.8 million kWh per year of clean, carbon free electric power. The Solar Field will supply about 25 percent of Dickinson's annual electricity consumption and will reduce Dickinson's GHG emissions by approximately 2000 $MTCO_2E$ annually. The contracted cost per kWh of electricity is expected to be less than future prices of electricity from utility suppliers, resulting in net savings for the college.

LED Blitz: Dickinson converted nearly all indoor and outdoor lighting to LED in 2017 and 2018. The LED lights are estimated to reduce annual electricity use by 2 million kWh per year and reduce GHG emissions by 750 $MTCO_2E$. The full cost of the project, paid for from Dickinson's deferred maintenance budget, was $1.8 million. But the additional cost for LED lights in comparison to replacement with conventional lights was only $360,000. This investment will save an estimated $150,000 every year in reduced electric utility costs.

Water Chiller Improvements: Upgrades to the water chillers in Dickinson's central energy plant were needed to improve the flow of chilled water to supply the new High Street Residence Hall and other buildings on the south side of High Street. Dickinson used the opportunity to update the software used to control the chillers, water pumps, and flow valves to improve the efficiency of the system. The project also includes replacement of existing valves with variable flow valves for more efficient operation. The project, which cost $400,000, is estimated to reduce electricity use by 325,000 kWh per year, save $32,000 in electricity costs each year, and reduce annual emissions by 130 $MTCO_2E$.

Water Heater Replacements: 25 water heaters in residence halls and other buildings that had been identified as needing replacement in Dickinson's deferred maintenance plan were replaced in 2018 with high efficiency models. The total cost for the high efficiency water heaters was $120,000, which is about $18,000 more than replacement with less efficient models. The more efficient water heaters are estimated to use 15 percent less energy than conventional models, saving $15,000 per year and reducing annual emissions 40 $MTCO_2E$.

A number of other Climate Action Plan projects are in progress or are being considered. These include energy efficiency opportunities identified by a recent recommissioning analysis of the Rector Science Complex; modernization of Dickinson's small houses; replacement of steam traps in the network of pipes that distribute steam and hot water from the central energy plant; replacement of thermostats to enhance energy management in buildings heated with electricity; use of remote energy monitoring data to identify and correct problems in performance of building energy systems; and development and installation of additional solar photovoltaic systems on campus. These and other measures will be needed for Dickinson to continue to make progress and meet its targets for 2025 and 2030.

Acronyms

BTU	British Thermal Unit
CH_4	Methane
CO_2	Carbon dioxide
LED	Light emitting diode
FTE	Full-time equivalent
GHG	Greenhouse gas
GWP	Global Warming Potential
HCFC	Hydrochlorofluorocarbon
HFC	Hydrofluorocarbon
kWh	Kilowatt hour (1000-watt hours)
MMBTU	Million British Thermal Units
$MTCO_2E$	Metric tons carbon dioxide equivalent
MWh	Megawatt hour (one million-watt hours)
N_2O	Nitrous oxide
PFC	Perfluorocarbons
REC	Renewable Energy Credit or Renewable Energy Certificate
SF_6	Sulfur hexafluoride
SIMAP	Sustainability Indicator Management and Analysis Platform

Glossary

British Thermal Unit (BTU): The quantity of heat required to raise the temperature of one pound of water one degree Fahrenheit at or near 39.2 degrees Fahrenheit. MMBTU represents one million BTUs.

Carbon dioxide equivalent: A metric that is used to express a quantity of a greenhouse gas as an amount of carbon dioxide that would have an equivalent effect on radiative forcing in the atmosphere. It is calculated as the product of the weight of a greenhouse gas times its associated Global Warming Potential (GWP) and is often expressed in metric tons of carbon dioxide equivalent ($MTCO_2E$).

Carbon footprint: The amount of carbon dioxide and other greenhouse gases emitted by a person, institution, nation, or other entity.

Carbon intensity: The amount of greenhouse gas emitted per unit of energy use. It is often expressed as kg carbon dioxide equivalent emissions per million BTUs.

Carbon neutral: An entity is carbon neutral if its net emissions of carbon dioxide and other greenhouse gases is zero. Net emissions are equal to gross emissions minus carbon offsets.

Carbon offset: A reduction in emissions of carbon dioxide or other greenhouse gas that is external to an entity but that can count as a credit against that entity's emissions. It can result from an action taken by one entity that reduces other entities' emissions, including purchases of certificates that finance emission reductions and implementation of projects that reduce emissions.

Cooling degree day: A measure of how much and for how long the outside air temperature exceeds a selected temperature threshold. High values of cooling degree days are indicative of high demand for energy to cool indoor spaces.

Energy intensity: the amount of energy used per unit of activity or other benchmark. It can be expressed in a variety of ways, such as energy use per person, per square foot of building space, per mile traveled, or per dollar of economic activity. Low energy intensity values are associated with high energy efficiency.

Fluorinated gases: Human-made gases that can accumulate in the atmosphere and contribute to global warming. They include hydrofluorocarbons, hydrochlorofluorocarbons, perfluorocarbons, sulfur hexafluoride and nitrogen trifluoride. They are used as refrigerants, blowing agents, fire extinguishants, aerosol propellants and solvents.

Global warming potential (GWP): An index that measures the effectiveness relative to carbon dioxide of different greenhouse gases in causing radiative forcing over a period of time, usually 100 years. GWPs are calculated as the ratio of the radiative forcing that would result from the emissions of one kilogram of a greenhouse gas to that from emission of one kilogram of carbon dioxide over a period of time.

Greenhouse gas: Any gas that absorbs infrared radiation in the atmosphere. Greenhouse gases include water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases.

Gross emissions: Total emissions of greenhouse gases from all sources.

Heating degree day: A measure of how much and for how long the outside air temperature falls below a selected temperature threshold. High values of heating degree days are indicative of high demand for energy to heat indoor spaces.

Infrared radiation: The heat energy that is emitted from all solids, liquids, and gases. In the context of the greenhouse issue, the term refers to the heat energy emitted by the Earth's surface and its atmosphere. Greenhouse gases strongly absorb this radiation in the Earth's atmosphere, and radiate some back towards the surface, creating the greenhouse effect. See radiation, greenhouse effect, enhanced greenhouse effect, global warming.

Light emitting diode (LED): A high efficiency lighting technology that produces light by passing an electric current through a semiconductor.

Metric ton: A metric ton is equal to 2205 lbs or 1.1 short tons.

Net emissions: Gross emissions of greenhouse gases minus carbon offsets.

Radiative forcing: A change in the balance between incoming solar radiation and outgoing infrared radiation. Without any radiative forcing, solar radiation coming to the Earth would continue to be approximately equal to the infrared radiation emitted from the Earth. The addition of greenhouse gases traps an increased fraction of the infrared radiation, radiating it back toward the surface and creating a warming influence (i.e., positive radiative forcing because incoming solar radiation will exceed outgoing infrared radiation).

Renewable energy credit: A tradable certificate that corresponds to the environmental benefits of electricity that is produced from renewable energy sources such as wind and solar. When the renewable sources displace electricity that would have been generated using fossil fuels, an important benefit is a reduction in greenhouse gas emissions. The certificates, which are denominated in megawatt hours (MWh), represent a carbon offset that varies depending on the carbon that would have been emitted by the electricity that is displaced.

Scope 1 emissions: Emissions from sources that are directly owned and/or controlled by Dickinson. This includes emissions from combusting fossil fuels in college-owned stationary facilities (e.g. boilers and furnaces), combusting fossil fuels in college owned vehicles, fugitive emissions from Dickinson's refrigeration equipment, emissions from the use of fertilizers on the main campus and Dickinson Farm, and emissions from the management of livestock at the Dickinson Farm.

Scope 2 emissions: Emissions from sources that are not directly controlled by Dickinson that produce electricity purchased by Dickinson. The electric utility from which Dickinson purchases electricity generates electricity by burning coal, oil, natural gas and other carbon-based forms of energy that emit GHGs, as well as from zero-carbon energy sources such as hydropower and nuclear power.

Scope 3 emissions: Emissions from sources not directly controlled by Dickinson that produce goods and services other than electricity that are purchased or used for the benefit of Dickinson College. Dickinson's scope 3 emissions include emissions from air travel paid for by the college; employee commuting; students' study abroad air travel; paper purchases; landfilled waste; wastewater; and electricity transmission and distribution (T&D) losses.

Short ton: A short ton is equal to 2,000 lbs or 0.907 metric tons.

Weighted campus user: A metric that is used to measure the population of students and employees that use a college campus, taking into account differences in their use of energy and other resources of the college. Students and employees who reside in campus housing and who obtain a majority of their meals from campus food venues are weighted more than those who do not.

Data Appendix

Table A-1. Emission Factors, 2019

Source: SIMAP, https://unhsimap.org/home.

Emission Source	Units	Carbon Dioxide kg CO2/unit	Methane kg CH4/unit	Nitrous Oxide kg N2O/unit	Carbon Dioxide Equivalent kg CO2E/unit
Scope 1					
Distillate Fuel Oil	gals	10.163759	0.001450	0.000087	-
Natural Gas	MMBtu	53.020000	0.005275	0.000106	-
Propane	gals	5.166009	0.000883	0.000053	-
Gasoline	gals	8.586184	0.000463	0.000301	-
Diesel	gals	10.163759	0.000030	0.000031	-
Biodiesel 100	gals	9.450000	0.000030	0.000031	-
Fertilizer - Organic	lbs N	-	-	0.010157	-
Fertilizer - Synthetic	lbs N	-	-	0.009444	-
Animals - Beef Cows	Head	-	76.415253	0.449766	-
Animals - Poultry	Head	-	0.062106	0.002448	-
Animals - Sheep	Head	-	8.571429	0.190476	-
Scope 2					
Electricity	KWh	0.344031	0.000028	0.000004	-
Scope 3					
Employee Commuting - Auto	vehicle mi	0.356615	0.000019	0.000013	-
Employee Commuting - Carpool	vehicle mi	0.178307	0.000010	0.000006	-
Employee Commuting - Bus	passenger mi	0.328399	0.000001	0.000001	-
Financed Travel - Air	passenger mi	0.162429	0.000005	0.000005	-
Financed Travel - Charter Bus	vehicle mi	3.108722	0.004082	0.001966	-
Financed Travel - Personal Vehicle	vehicle mi	0.366432	0.000019	0.000013	-
Financed Travel - Public Bus	passenger mi	0.321218	0.000001	0.000001	-
Financed Travel - Taxi	passenger mi	0.356615	0.000019	0.000013	-
Financed Travel - Train	passenger mi	0.118883	0.0000003	0.0000004	-
Study Abroad Air Travel	passenger mi	0.162429	0.000005	0.000005	-
Landfill Waste - recovery & elec gen	short ton	-	-1.200000	-	-
Wastewater - Anaerobic digestion	gals	-	0.000001	0.000002	-
Paper - Uncoated Freesheet	lbs	-	-	-	0.001366
Compost - Dining	short tons	-	-	-	-0.294000

Table A-2. Global Warming Potentials

Source: SIMAP, https://unhsimap.org/home.

Greenhouse Gas	Lifetime (years)	Global Warming Potential, 100 - Year
Carbon Dioxide		1
Methane	12.4	25
Nitrous Oxide	121	298
HCFC-22	12	1810
HFC-32	4.9	675
HFC-125	29	3500
HFC-134a	9.6	1430
R-410a	16.95	2088
CF4	50,000	7390

Table A-3. Greenhouse Gas Emissions by Scope, 2008 – 2019

	Fiscal Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Change 2018 - 2019	Change 2008 - 2019
	Units	MTCO2E	MTCO2E	MTCO2E	MTCO2E	MTCO2E	MTCO2E	MTCO2E	MTCO2E	MTCO2E	MTCO2E	MTCO2E	MTCO2E	%	%
Scope 1	Campus Stationary	4,514.3	4,167.8	3,760.8	3,853.2	3,241.2	4,410.9	5,227.9	5,082.7	4,255.5	4,164.4	4,661.1	4,666.2	0.1%	3.4%
	Dickinson Vehicles	341.5	348.0	364.4	337.9	335.7	351.1	361.4	357.3	308.7	295.9	373.6	299.2	-19.9%	-12.4%
	Refrigerants & Chemicals	174.4		153.5	130.5	116.2	264.5	72.8	63.9	372.0	228.9	226.8	72.6	-68.0%	-58.3%
	Fertilizer & Animals	37.9	19.6	22.8	32.8	42.5	38.9	55.2	58.7	62.3	52.3	72.8	66.9	-8.2%	76.3%
	Scope 1 Subtotal	5,068.1	4,535.3	4,301.5	4,354.5	3,735.6	5,065.3	5,717.3	5,562.5	4,998.4	4,741.4	5,334.3	5,104.8	-4.3%	0.7%
Scope 2	Purchased Electricity	8,405.3	7,455.7	7,689.7	8,034.6	6,957.5	7,032.4	7,365.7	7,251.5	7,031.3	7,033.1	6,501.7	5,841.2	-10.2%	-30.5%
	Scope 2 Subtotal	8,405.3	7,455.7	7,689.7	8,034.6	6,957.5	7,032.4	7,365.7	7,251.5	7,031.3	7,033.1	6,501.7	5,841.2	-10.2%	-30.5%
Scope 3	Commuting	773.8	803.6	834.2	873.9	902.2	942.9	935.5	1,008.1	1,050.0	1,155.4	1,192.8	1,063.7	-10.8%	37.5%
	Financed Travel - Air	877.1	857.4	831.2	822.5	830.9	806.2	783.0	826.0	842.5	906.0	874.3	817.9	-6.4%	-6.7%
	Financed Travel - Other	185.9	188.4	191.3	195.9	164.6	202.1	163.4	206.9	211.1	225.4	236.9	192.0	-18.9%	3.3%
	Study Abroad Air Travel	2,350.9	2,601.0	1,893.5	2,089.6	2,090.5	1,937.3	1,896.6	1,722.6	1,990.6	1,861.2	2,118.4	1,817.1	-14.2%	-22.7%
	Landfilled Waste	197.9	-14.8	-17.0	-17.0	-14.6	-14.6	-15.2	-18.4	-21.8	-16.2	-13.7	-13.6	-0.7%	-106.9%
	Wastewater	21.6	17.3	15.0	16.3	16.4	17.3	18.4	18.0	20.0	19.7	20.1	20.5	1.8%	-5.0%
	Paper	135.3	79.5	89.2	77.8	93.1	118.5	86.4	95.9	100.6	102.2	77.5	82.1	5.9%	-39.3%
	Electricity T&D Losses	831.3	737.4	475.3	496.6	702.4	710.0	385.2	626.5	552.6	554.4	512.5	315.0	-38.5%	-62.1%
	Scope 3 Subtotal	5,373.8	5,269.8	4,312.8	4,555.6	4,785.6	4,719.4	4,253.2	4,485.6	4,745.7	4,808.2	5,018.7	4,294.7	-14.4%	-20.1%
Gross	Gross Emissions	18,847.3	17,260.8	16,304.0	16,944.6	15,478.6	16,817.2	17,336.2	17,299.6	16,775.4	16,582.7	16,854.7	15,240.7	-9.6%	-19.1%
Offsets	Renewable Energy Credits	-3,864.9	-3,456.6	-7,689.7	-8,034.6	-6,957.5	-7,032.4	-6,814.5	-6,529.6	-4,991.5	-7,033.1	-6,501.7	-5,792.4	-10.9%	49.9%
	Compost	-89.7	-71.4	-71.5	-94.1	-41.2	-39.5	-46.2	-31.2	-25.3	-37.0	-37.4	-40.4	8.1%	-55.0%
	Offsets Subtotal	-3,954.6	-3,528.0	-7,761.3	-8,128.7	-6,998.6	-7,071.9	-6,860.7	-6,560.8	-5,016.8	-7,070.1	-6,539.1	-5,832.8	-10.8%	47.5%
Net	Net Emissions	14,892.7	13,732.8	8,542.8	8,816.0	8,480.0	9,745.3	10,475.5	10,738.8	11,758.6	9,512.5	10,315.7	9,407.9	-8.8%	-36.8%

Table A-4. Greenhouse Gas Emissions by Activity, 2008 – 2019

	Fiscal Year	2008 Baseline	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Change 2018 - 2019	Change 2008 - 2019
	Units	MTCO2E	MTCO2E	MTCO2E	MTCO2E	MTCO2E	MTCO2E	MTCO2E	MTCO2E	MTCO2E	MTCO2E	MTCO2E	MTCO2E	%	%
Heat & Power	Campus Stationary	4,514.3	4,167.8	3,760.8	3,853.2	3,241.2	4,410.9	5,227.9	5,082.7	4,255.5	4,164.4	4,661.1	4,666.2	0.1%	3.4%
	Electricity - Purchased	8,405.3	7,455.7	7,689.7	8,034.6	6,957.5	7,032.4	7,365.7	7,251.5	7,031.3	7,033.1	6,501.7	5,841.2	-10.2%	-30.5%
	Electricity - T&D Losses	831.3	737.4	475.3	496.6	702.4	710.0	385.2	626.5	552.6	554.4	512.5	315.0	-38.5%	-62.1%
	Heat & Power Subtotal	13,750.9	12,360.9	11,925.8	12,384.5	10,901.1	12,153.3	12,978.7	12,960.7	11,839.4	11,751.8	11,675.2	10,822.3	-7.3%	-21.3%
Transportation	Dickinson Vehicles	341.5	348.0	364.4	337.9	335.7	351.1	361.4	357.3	308.7	295.9	373.6	299.2	-19.9%	-12.4%
	Financed Travel - Air	877.1	857.4	831.2	822.5	830.9	806.2	783.0	826.0	842.5	906.0	874.3	817.9	-6.4%	-6.7%
	Financed Travel - Other	185.9	188.4	191.3	195.9	164.6	202.1	163.4	206.9	211.1	225.4	236.9	192.0	-18.9%	3.3%
	Study Abroad Air Travel	2,350.9	2,601.0	1,893.5	2,089.6	2,090.5	1,937.3	1,896.6	1,722.6	1,990.6	1,861.2	2,118.4	1,817.1	-14.2%	-22.7%
	Commuting	773.8	803.6	834.2	873.9	902.2	942.9	935.5	1,008.1	1,050.0	1,155.4	1,192.8	1,063.7	-10.8%	37.5%
	Transportation Subtotal	4,529.2	4,798.3	4,114.6	4,319.8	4,323.9	4,239.4	4,139.9	4,120.9	4,403.0	4,443.9	4,795.9	4,189.9	-12.6%	-7.5%
Other	Refrigerants & Chemicals	174.4	0.0	153.5	130.5	116.2	264.5	72.8	63.9	372.0	228.9	226.8	72.6	-68.0%	-58.3%
	Fertilizer & Animals	37.9	19.6	22.8	32.8	42.5	38.9	55.2	58.7	62.3	52.3	72.8	66.9	-8.2%	76.3%
	Landfilled Waste	197.9	-14.8	-17.0	-17.0	-14.6	-14.6	-15.2	-18.4	-21.8	-16.2	-13.7	-13.6	-0.7%	-106.9%
	Wastewater	21.6	17.3	15.0	16.3	16.4	17.3	18.4	18.0	20.0	19.7	20.1	20.5	1.8%	-5.0%
	Paper	135.3	79.5	89.2	77.8	93.1	118.5	86.4	95.9	100.6	102.2	77.5	82.1	5.9%	-39.3%
	Other Subtotal	567.1	101.6	263.6	240.3	253.7	424.5	217.6	218.0	533.0	387.0	383.6	228.5	-40.4%	-59.7%
Gross	Gross Emissions	18,847.3	17,260.8	16,304.0	16,944.6	15,478.6	16,817.2	17,336.2	17,299.6	16,775.4	16,582.7	16,854.7	15,240.7	-9.6%	-19.1%
Offsets	Renewable Energy Credits	-3,864.9	-3,456.6	-7,689.7	-8,034.6	-6,957.5	-7,032.4	-6,814.5	-6,529.6	-4,991.5	-7,033.1	-6,501.7	-5,792.4	-10.9%	49.9%
	Compost	-89.7	-71.4	-71.5	-94.1	-41.2	-39.5	-46.2	-31.2	-25.3	-37.0	-37.4	-40.4	8.1%	-55.0%
	Offsets Subtotal	-3,954.6	-3,528.0	-7,761.3	-8,128.7	-6,998.6	-7,071.9	-6,860.7	-6,560.8	-5,016.8	-7,070.1	-6,539.1	-5,832.8	-10.8%	47.5%
Net	Net Emissions	14,892.7	13,732.8	8,542.8	8,816.0	8,480.0	9,745.3	10,475.5	10,738.8	11,758.6	9,512.5	10,315.7	9,407.9	-8.8%	-36.8%

Table A-5. Heat and Power Activity and Greenhouse Gas Emissions, 2008 – 2019

		Units	2008 Baseline	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	% Change 2018 to 2019	% Change 2008 to 2019
Campus Stationary Combustion of Fossil Energy	Distillate Oil	gal	29,661	41,867	24,506	16,711	12,197	26,999	50,727	35,588	13,604	5,003	0.0	1,274.2	-	-95.7%
		MMBtu	4,082	5,763	3,371	2,263	1,616	3,712	6,973	4,892	1,870	694	0.0	176.7	-	-95.7%
		Emissions MTCO2E	303.7	428.8	250.9	171.0	124.8	276.2	518.8	364.0	139.1	51.6	0.0	13.0	-	-95.7%
	Natural Gas	1000 cubic ft	76,272.7	67,794.8	63,820.7	66,826.4	56,344.4	74,120.5	84,421.4	84,687.5	74,320.1	74,251.8	84,493.1	87,487.2	3.5%	14.7%
		MMBtu	79,171	70,303	65,991	69,232	58,598	77,678	88,474	88,668	77,367	77,296	87,619.3	87,487.2	-0.2%	10.5%
		Emissions MTCO2E	4,210.6	3,739.0	3,509.6	3,682.0	3,116.4	4,131.2	4,705.3	4,715.6	4,114.6	4,110.9	4,659.9	4,652.9	-0.2%	10.5%
	Propane	gal	0	0	71.2	48.6	0	667.6	709.8	589.1	323.9	354.6	222.7	50.1	-77.5%	-
		MMBtu	0	0	7	4	0	61	65	54	29.7	32.5	18.8	4.2	-77.4%	-
		Emissions MTCO2E	0.0	0.0	0.4	0.3	0.0	3.5	3.7	3.1	1.7	1.9	1.2	0.3	-77.6%	-
	Subtotal	MMBtu	83,253	76,066	69,368	71,500	60,214	81,451	95,511	93,613	79,267	78,022	87,638	87,668	0.0%	5.3%
		Emissions MTCO2E	4,514.3	4,167.8	3,760.8	3,853.2	3,241.2	4,410.9	5,227.9	5,082.7	4,255.5	4,164.4	4,661.1	4,666.2	0.1%	3.4%
Electricity	Electricity - Purchased	MWh	17,398.3	17,255.8	16,835.7	17,590.7	17,780.9	17,972.4	19,455.8	19,154.2	18,572.6	18,577.3	17,173.6	17,747.4	3.3%	2.0%
		MMBtu	59,366	58,879	57,446	60,022	60,671	61,324	66,386	65,357	63,372	63,388	58,598.9	60,556.7	3.3%	2.0%
		Emissions MTCO2E	8,405.3	7,455.7	7,689.7	8,034.6	6,957.5	7,032.4	7,365.7	7,251.5	7,031.3	7,033.1	6,501.7	5,841.2	-10.2%	-30.5%
	Electricity - T&D Losses	Emissions MTCO2E	831.3	737.4	475.3	496.6	702.4	710.0	385.2	379.2	367.7	367.8	512.5	315.0	-38.5%	-62.1%
	Subtotal	MMBtu	59,365.5	58,879.2	57,445.7	60,022.1	60,670.9	61,324.5	66,385.9	65,356.9	63,372.3	63,388.3	58,598.9	60,556.7	3.3%	2.0%
		Emissions MTCO2E	9,236.6	8,193.1	8,165.0	8,531.2	7,659.9	7,742.4	7,750.9	7,630.7	7,399.0	7,400.9	7,014.2	6,156.2	-12.2%	-33.3%
Total	Energy for Heat & Power	MMBtu	142,618	134,945	126,814	131,522	120,885	142,776	161,897	158,970	142,639	141,411	146,237	148,225	1.4%	3.9%
	Emissions from Heat & Power	MTCO2E	13,750.9	12,360.9	11,925.8	12,384.5	10,901.1	12,153.3	12,978.7	12,713.4	11,654.5	11,565.3	11,675.3	10,822.4	-7.3%	-21.3%

Table A-6. Transportation Activity and Greenhouse Gas Emissions, 2008 – 2019

	Mode or Fuel	Units	2008 Basline	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	% Change 2018 to 2019	% Change 2008 to 2019
Dickinson Vehicles	Biodiesel	gal	2900	1,055	845	840	333	109	201	550	100	100	100	0.0	-100.0%	-100.0%
		Emissions MTCO2E	0.3	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-100.0%	-100.0%
	Diesel	gal	2,012.0	5,002.2	4,474.0	1,803.7	4,688.4	4,343.8	5,728.5	6,002.5	7,207.6	4,568.1	6,782.6	3,891.0	-42.6%	93.4%
		Emissions MTCO2E	20.7	51.4	45.9	18.5	48.1	44.6	58.8	61.6	73.9	47.3	70.2	39.6	-43.6%	91.7%
	Gasoline	gal	35,859.0	33,319.2	35,936.5	36,110.0	32,550.1	34,700.9	34,282.2	33,508.2	26,611.1	27,318.7	33,347.0	29,877.2	-10.4%	-16.7%
		Emissions MTCO2E	320.6	296.5	318.4	319.3	287.5	306.5	302.7	295.7	234.8	248.6	303.4	259.6	-14.5%	-19.0%
	Subtotal	Vehicle miles	889,821.4	854,318.1	888,034.5	830,400.3	809,061.3	847,081.6	860,648.9	880,506.2	747,515.6	712,484.7	896,089.6	752,164.7	-16.1%	-15.5%
		Emissions MTCO2E	341.5	348.0	364.4	337.9	335.7	351.1	361.4	357.3	308.7	295.9	373.6	299.2	-19.9%	-12.4%
College Travel	Air	Passenger miles	1,526,184.1	1,578,700.0	1,578,068.5	1,618,205.5	1,634,847.6	1,671,068.8	1,623,100.2	1,712,184.7	1,746,448.0	1,878,105.0	1,812,276.5	1,858,248.1	2.5%	21.8%
		Emissions MTCO2E	877.1	857.4	831.2	822.5	830.9	806.2	783.0	826.0	842.5	906.0	874.3	817.9	-6.4%	-6.7%
	Train	Passenger miles	27,658.2	28,066.2	28,598.5	29,325.8	29,627.4	30,283.9	29,414.5	31,029.0	31,649.9	30,149.0	32,159.0	13,098.3	-59.3%	-52.6%
		Emissions MTCO2E	4.4	4.5	4.3	4.4	4.4	4.5	4.4	4.6	4.7	4.5	4.8	1.6	-67.6%	-64.9%
	Charter Bus	Passenger miles	20,529.2	20,832.0	21,227.1	21,767.0	13,190.5	22,478.1	13,095.8	23,031.1	23,492.0	26,060.0	29,190.8	28,820.8	-1.3%	40.4%
		Emissions MTCO2E	77.2	78.4	79.9	81.9	49.6	84.6	49.3	86.6	88.4	98.0	109.8	108.4	-1.3%	40.4%
	Taxi	Vehicle miles	266,922.6	270,860.5	275,996.9	283,016.7	285,927.3	292,262.3	283,872.8	299,453.2	305,446.0	295,886.0	300,665.8	190,918.1	-36.5%	-28.5%
		Emissions MTCO2E	98.4	99.7	101.2	103.5	104.4	106.7	103.6	109.2	111.4	111.3	113.1	68.9	-39.1%	-30.0%
	Personal Vehicle	Vehicle miles	15,743.4	15,975.6	16,278.6	16,692.6	16,864.3	17,237.9	16,743.1	17,662.1	18,015.5	30,708.7	24,362.0	36,360.3	49.3%	131.0%
		Emissions MTCO2E	5.8	5.9	6.0	6.1	6.2	6.3	6.1	6.4	6.6	11.5	9.2	13.1	43.0%	125.7%
	Subtotal	Vehicle miles	1,857,037.4	1,914,434.3	1,920,169.5	1,969,007.6	1,980,457.2	2,033,330.9	1,966,226.4	2,083,360.1	2,125,051.4	2,260,908.7	2,198,654.1	2,127,445.6	-3.2%	14.6%
		Emissions MTCO2E	1,063.0	1,045.8	1,022.5	1,018.4	995.5	1,008.2	946.4	1,032.9	1,053.6	1,131.4	1,111.1	1,009.9	-9.1%	-5.0%
Employee Commuting	Automobile	Vehicle miles	2,065,126.1	2,146,860.5	2,238,241.8	2,349,163.4	2,430,158.0	2,540,237.2	2,521,313.0	2,718,590.6	2,831,672.8	3,021,629.2	3,114,784.4	2,898,952.1	-6.9%	40.4%
		Emissions MTCO2E	761.2	790.2	820.4	859.4	887.2	927.2	920.0	991.4	1,032.6	1,136.3	1,171.3	1,046.0	-10.7%	37.4%
	Carpool	Vehicle miles	68,367.1	72,333.7	75,390.2	79,264.8	81,956.7	85,487.7	84,989.2	91,634.1	95,463.5	101,775.1	114,160.9	97,835.5	-14.3%	43.1%
		Emissions MTCO2E	12.6	13.3	13.8	14.5	15.0	15.6	15.5	16.7	17.4	19.1	21.5	17.7	-17.5%	40.5%
	Bike	Passenger miles	12,149.1	12,183.8	12,379.1	12,409.7	12,521.4	12,473.6	12,098.6	12,761.6	12,649.3	13,219.0	12,121.5	12,754.9	5.2%	5.0%
		Emissions MTCO2E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
	Walk	Passenger miles	39,453.3	39,754.5	39,855.1	40,992.1	41,300.0	41,838.4	40,409.6	42,280.6	42,960.7	44,476.3	42,173.5	42,172.3	0.0%	6.9%
		Emissions MTCO2E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
	Subtotal	Vehicle miles	2,185,095.5	2,271,132.5	2,365,866.2	2,481,830.1	2,565,936.0	2,680,036.9	2,658,810.4	2,865,266.9	2,982,746.4	3,181,099.6	3,283,240.3	3,051,714.8	-7.1%	39.7%
		Emissions MTCO2E	773.8	803.6	834.2	873.9	902.2	942.9	935.5	1,008.1	1,050.0	1,155.4	1,192.8	1,063.7	-10.8%	37.5%
Student Travel	Study Abroad Air	Passenger miles	4,090,586	4,789,351	3,594,930	4,111,280	4,112,918	4,015,730	3,931,435	3,570,830	4,126,330	3,858,104	4,391,110	4,128,505.0	-6.0%	0.9%
		Emissions MTCO2E	2,350.9	2,601.0	1,893.5	2,089.6	2,090.5	1,937.3	1,896.6	1,722.6	1,990.6	1,861.2	2,118.4	1,817.1	-14.2%	-22.7%
Total Transportation		Passenger miles	9,022,540	9,829,236	8,769,000	9,392,518	9,468,373	9,576,179	9,417,121	9,399,963	9,981,643	10,012,597	10,769,094	10,059,830.1	-6.6%	11.5%
		Emissions MTCO2E	4,529.2	4,798.3	4,114.6	4,319.8	4,323.9	4,239.4	4,139.9	4,120.9	4,403.0	4,443.9	4,795.9	4,189.8	-12.6%	-7.5%

Table A-7. Other Activities and Greenhouse Gas Emissions, 2008 – 2019

	Units	2008 Baseline	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	% Change 2018 - 2019	% Change 2008 - 2019
Farm Animals	head	55	43	120	93	123	191	81	100	120	113	113	110	-2.7%	100.0%
	Emissions MTCO2E	5.9	3.8	6.5	12.4	21.9	23.5	31.3	39.7	45.4	42.0	56.3	57.2	1.7%	874.8%
Fertilizer	lbs N	7,640	3755	3,895	488	4,912	3,664	5,720	4,550	4,051	2,477	3,986	3,275	-17.8%	-57.1%
	Emissions MTCO2E	32.0	15.7	16.3	20.5	20.6	15.4	23.9	19.0	16.9	10.3	16.6	9.6	-41.8%	-69.9%
Refrigerants	kg	95	0	85	73	65	143	36	35	205	125	119	34	-71.7%	-64.5%
	Emissions MTCO2E	174.4	0.0	153.5	130.5	116.2	264.5	72.8	63.9	372.0	228.9	226.8	72.6	-68.0%	-58.4%
Paper	lbs	103,606	60,864	68,312	59,555	112,281	110,914	104,117	115,564	121,261	123,209	93,469	99,017	5.9%	-4.4%
	Emissions MTCO2E	135.3	79.5	89.2	77.8	93.1	118.5	86.4	95.9	100.6	102.2	77.5	82.1	5.9%	-39.3%
Landfilled Waste	short tons	639	492	566	568	485	488	508	614	727	541	457	453	-0.9%	-29.1%
	Emissions MTCO2E	197.9	-14.8	-17.0	-17.0	-14.6	-14.6	-15.2	-18.4	-21.8	-16.2	-13.7	-13.6	-0.9%	-106.9%
Wastewater	millions gals	43.96	35.17	30.45	33.00	33.23	35.14	37.45	36.54	40.77	40.65	41.45	42.13	1.6%	-4.2%
	Emissions MTCO2E	21.6	17.3	15.0	16.3	16.4	17.3	18.4	18.0	20.0	19.7	20.1	20.5	1.6%	-5.1%
Total Other	Emissions MTCO2E	567.1	101.6	263.6	240.3	253.7	424.5	217.6	218.0	533.0	387.0	383.6	228.5	-40.4%	-59.7%