Greenhouse Gas Inventory

Prepared by:

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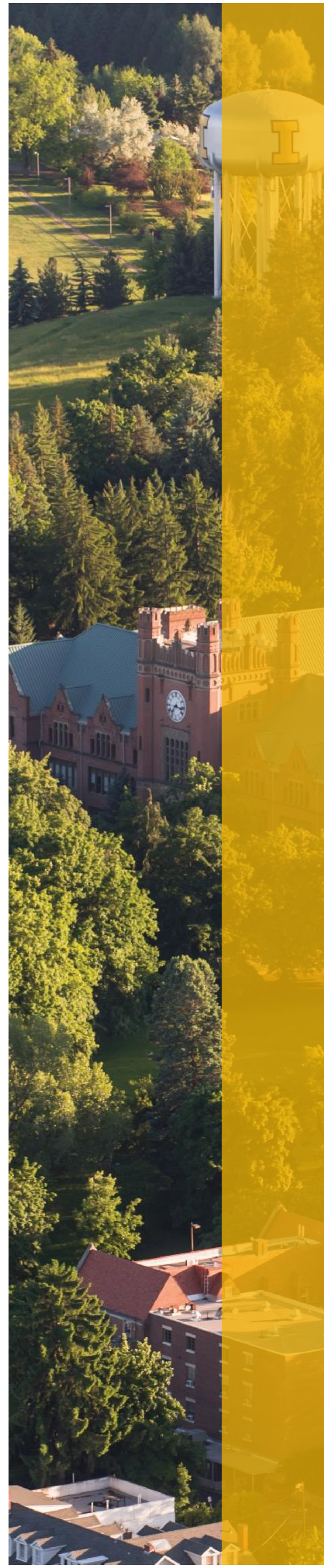
2019



University of Idaho

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List of Nomenclature

AASHE	Association for the Advancement of Sustainability in Higher Education
ACUPCC	American College and University Presidents Climate Commitment
CACP	Clean Air-Cool Planet
CCC	Campus Carbon Calculator
CH_4	Methane
CO_2	Carbon dioxide
eCO_2	Carbon dioxide equivalent
eGRID	Emissions and Generation Resource Integrated Database
EPA	U.S. Environmental Protection Agency
GHG	Greenhouse Gas
GWP	Global warming potential
HFC	Hydrofluorocarbons
LSI	Latah Sanitation Inc.
MRF	Materials recovery facility
MSW	Municipal solid waste
N_2O	Nitrous oxide
NWPP	Northwest Power Pool
PFC	Perfluorocarbons
REC	Renewable energy certificate
SF_6	Sulfur hexafluoride
Scope 1	Direct emissions
Scope 2	Indirect emissions
Scope 3	Other emissions
SIMAP	Sustainability Indicator Management and Analysis Platform
STARS	Sustainability Tracking, Assessment, and Rating System
WRI	World Resources Institute

HIGHLIGHTS

Total Emissions (Metric tons eCO_2)

FY2019 Net emissions: 27,438

Scope 1: 6,953

Scope 2: 14,115

Scope 3: 6,370

Emissions per student: 2.91

Emissions per sq. ft: 6.15 kg

FY2018 Net emissions: 27,304

Scope 1: 6,338

Scope 2: 14,249

Scope 3: 6,717

Emissions per student: 2.93

Emissions per sq. ft: 6.12 kg

2005 Baseline emissions: 39,234

Scope 1: 7,859

Scope 2: 26,952

Scope 3: 4,423

Emissions per student: 3.36

Emissions per sq. ft: 10.57 kg

FY2019 Change in total emissions:

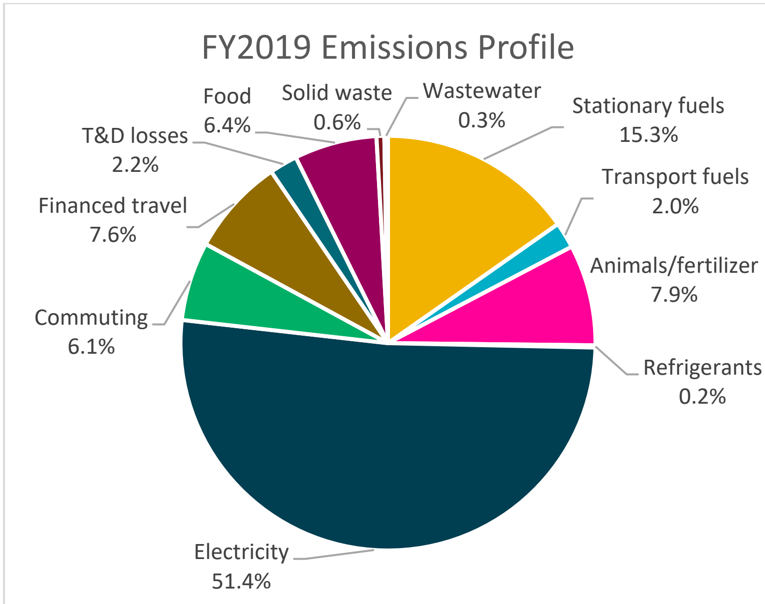
From Previous Year: + 0.49 %

From 2011 GHG Report: - 16.42 %

From 2005 Baseline: - 30.07 %

Executive Summary

Total emissions for the University of Idaho in FY2019 are 27,438 metric tons of eCO_2. Emissions are down 30% since the first GHG inventory in 2005, but up 0.5% since FY2018. The largest sources of emissions on campus are electricity consumption (51.4%), stationary fuel use such as natural gas (15.3%), animals/fertilizer (7.9%), and directly financed travel (7.6%). The inventory includes the main campus, neighboring farms, and city locations in Moscow, Idaho.



Reductions are attributed to energy efficiency improvements on campus and efforts by Avista Utilities to move away from fossil fuels. Minor improvements are seen in financed air travel, fuel use, and others, but these may be due to budgetary constraints more than improvements in efficiency or behavior. Some emissions sources, such as beef and dairy cows, are increasing.

Improvements are possible in every category. To meet the 2030 goal of carbon neutrality, U of I needs to accelerate its reductions in energy consumption by expanding the biomass-fueled district energy network and invest in renewables such as photovoltaics. The largest impacts, besides energy improvements, will come from addressing commuting behavior and reducing the livestock population on campus. Electricity generation or the purchase of RECs will be required to offset emissions from Scope 1 and 3 sources.

University of Idaho Greenhouse Gas Emissions Inventory

Introduction

Purpose of this Report

As a signatory of the Talloires Declaration and American College and University Presidents Climate Commitment (ACUPCC), the University of Idaho (U of I) recognizes the environmental, economic, and social risks created by climate change and is committed to reducing its carbon footprint. The U of I 2010 Climate Action Plan outlined steps needed to become carbon neutral by 2030 [1]. This report has been prepared as a means of quantifying and tracking U of I carbon emissions, which plays a critical role in reaching that goal.

In the past, U of I has released Greenhouse Gas (GHG) Inventory Reports intermittently, with the first being released in 2008 [2] and again in 2013 [3]. It is the intent here to create reports that can be updated more frequently for dissemination both internally and to the public. By doing so, internal accounting and reporting can be streamlined, and progress made towards carbon reductions is more apparent. As GHG accounting methods change and improve over time, so will future reports.

Organizational Boundaries

A well-defined boundary is necessary to accurately collect data and measure carbon emissions. A control approach is taken here, where emissions are measured for operations over which U of I has practical control at facilities it owns. In this GHG Inventory, the organizational boundary includes the Moscow, Idaho campus and facilities within the surrounding region under its control. This includes the main university campus, West Farm, North Farm, Parker Farm, and locations within the city.

Some facilities in Moscow, such as U of I owned family housing units and the Greek system are billed by the local utility, Avista Utilities, directly and are therefore excluded from this report. Furthermore, U of I owns and operates facilities in nearly every county of the State of Idaho. These facilities are not included here since they have their own billing accounts and data collection is difficult, thus it would be more appropriate for them to conduct independent GHG inventories.

The university's GHG emissions are categorized under Scopes 1, 2, and 3. Scope 1 accounts for direct emissions caused by on-site activities: stationary combustion (e.g. natural gas), vehicle emissions, fugitive emissions (escaped GHG's from refrigeration systems), etc. Scope 2 accounts for emissions caused indirectly by the combustion of fossil fuels from purchased electrical power. Scope 3 accounts for any GHG emissions not captured by Scope 1 and 2, such as university-funded travel, solid waste disposal, and emissions generated from commuting.

Methodology

Overview of Assessment Methods

U of I Reporting Methods

Greenhouse gas reporting methods have changed over the years as data collection and modeling techniques improve. The Greenhouse Gas Protocol developed by the World Resources Institute (WRI) provides standards, guidance, and a selection of tools to measure GHG emissions [4]. GHG Protocol standards are the most commonly used standards worldwide and most tools and calculators available are based on them. Previous U of I GHG inventories used the Campus Carbon Calculator (CCC) developed by Clean Air Cool Planet (CACP), which provided calculation tools specific to institutions of higher education as a supplement to the GHG Protocol. The CCC program was discontinued in January 2018 and is no longer supported.

The Sustainability Indicator Management and Analysis Platform (SIMAP) was launched in 2018 to replace CCC. SIMAP uses methodologies codified by the GHG Protocol Initiative in an effort to standardize and simplify the reporting process [5]. The user enters raw data into the online SIMAP tool and calculated emissions are returned after applying the appropriate emissions factor. Except when newer EPA information is available, the default SIMAP emissions factors are used in this report.

As each GHG inventory is completed, the university learns more about which data is missing and how to better account for emissions sources. While all of the major emissions sources are consistently accounted for, such as natural gas, electricity, and commuting, many smaller sources are only just now being inventoried. Additions to the GHG inventory are listed below in Table 1. While each of them is small compared to the total, it is important to have the most complete inventory possible to better understand where improvements should be made. Emissions are reported by source to allow readers to make comparisons between years by neglecting the additional emissions sources.

Table 1. Changes in accounting.

	CY2005	CY2011	FY2019
Scope 1: Direct emissions			
Sheep	N	N	Y
Fertilizer	N	N	Y
Scope 3: Other emissions			
Distribution losses from purchased electricity	N	N	Y
Food	N	N	Y
Wastewater	N	N	Y

Established Baseline Year

The established baseline year for GHG emissions is calendar year 2005. This year was chosen because it was the first year that complete data was available for all major emissions sources on campus. In addition, reporting methods were significantly different in years prior to 2005.

Units

The carbon footprint of an institution is a measure of the greenhouse gasses emitted. The Kyoto Protocol specifies six specific greenhouse gasses: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFC), perfluorocarbons (PFC), and sulfur hexafluoride (SF_6) [6]. These GHG emissions are often measured in carbon dioxide equivalent (eCO_2) by multiplying them by their global warming potential (GWP). This process accounts for the fact that many GHGs have a higher GWP than CO_2 and allows for equal comparisons between gasses. By conducting an inventory in terms of eCO_2, all GHGs are accounted for under each Scope, not just CO_2.

The standard unit for measuring and reporting GHG emissions is metric tons of eCO_2 (1,000 kg). For consistency and comparability with other institutions, the same is used in this report. Some measured data, such as solid waste generation, is measured in U.S. customary units like short tons (2,000 lb). Unless stated otherwise, tons in this report always refer to metric tons.

Results and Discussion

Scopes (Operational Boundaries)

Nearly every action taken and product used results in emissions to the environment. Measuring every emissions source is unrealistic and a boundary must be drawn somewhere. Operational boundaries define which emissions can be realistically measured, which are grouped together in “Scopes.” These Scopes define three levels of responsibility for the emissions and account for the vast majority of emissions sources.

Scope 1: Direct Emissions

Scope 1 emissions are direct emissions from sources that are owned and controlled by U of I. These include combustion of fossil fuels for facilities and vehicles, fugitive emissions from refrigeration equipment, and emissions from agriculture such as fertilizer and animal stock.

Stationary Fuels

Emissions for this category include the combustion of fuels for heating buildings, research, cooking, etc. The U of I Energy Plant produces steam to supply energy to 61 buildings in the core campus using wood chips and natural gas. Over 90% of the steam produced at the Energy Plant is derived from wood chip fuel, resulting is economic savings above $1 million annually. Wood chips are sourced from the local timber industry. Biomass is typically considered carbon neutral, as the biogenic carbon released during combustion equals the amount sequestered during its growth. Trees must be harvested sustainably however to minimize the overall environmental impact. Carbon emissions from burning biomass are not included in this report as they are inventoried separately from the university’s carbon footprint, but emissions from electricity and vehicle fuel consumption to transport and handle wood chips on campus are inventoried here.

Natural gas consumption for U of I is listed below in Table 2. Data was gathered directly from Avista billing statements and the Energy Plant. In FY2019, the Energy Plant consumed 312,158 therms of gas, making it the single largest user on campus. Buildings not connected to the steam distribution network, followed by the farms, are the next largest users. Natural gas consumption is largely dependent on ambient weather conditions and fluctuates year to year, but overall consumption has changed little over the years.

Table 2. Natural gas consumption (therms).

	FY2017	FY2018	FY2019
Energy Plant	277,708	183,436	312,158
Campus Buildings	264,882	291,545	269,079
West Farm	128,970	139,865	138,290
North Farm	20,152	25,981	21,222
Parker Farm	44,075	33,674	40,781
Moscow City	8,083	7,033	7,711
Total gas consumption	743,870	681,537	789,241

EPA estimates that 1 therm of natural gas releases 5.306 kg eCO_2 after consumption [7]. Figure 1 below shows emissions released from natural gas consumption at the university. In FY2019 4,188 tons of eCO_2 were released, an increase of 14% over the previous year, but a decrease of 4% since 2005. To reduce emissions, it is suggested that additional buildings be connected to the campus steam network and install more efficient equipment across campus.

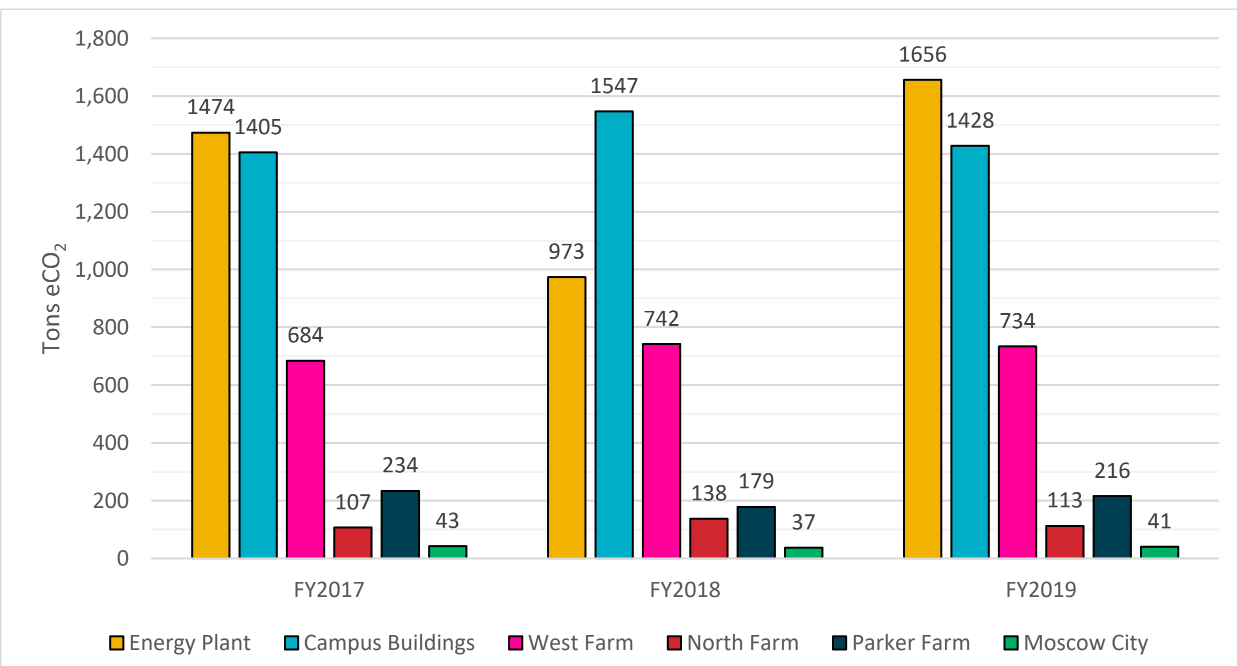


Figure 1. Emissions from natural gas consumption.

Transport Fuels

Besides the natural gas used on campus, another dominant source of direct emissions come from fuel use in vehicles, generators, etc. Fuel is purchased from Busch Distributors for the university owned fleet of vehicles and equipment. Data was available from their billing statements, shown below in Table 3.

Table 3. Fuel consumption of university vehicles (gallons).

	FY2017	FY2018	FY2019
Gasoline (E10)	39,075	38,176	34,319
Diesel #2	24,746	22,415	23,877

Emissions from transport fuels consist mostly of CO_2, CH_4, and N_2O. While CO_2 emissions are relatively straightforward to calculate from fuel consumption, CH_4 and N_2O are dependent on the vehicle emissions technology, operation, and weather conditions [8]. The U of I fleet is diverse in both age and usage, making estimates difficult. Due to the complexity of estimating eCO_2 from CO_2, CH_4, and N_2O emissions independently per GHG Protocol guidelines, the more conservative, built-in SIMAP eCO_2 calculation is used. An in-depth investigation on fleet emissions is suggested in the future for more accurate results. Campus emissions from direct transportation are shown below in Figure 2. Emissions in FY2019 are 545 tons eCO_2, a reduction of 3.4% from the previous year. Compared to the 2,617 tons of eCO_2 emissions in 2005, FY2019 emissions have been reduced by 79%, likely thanks to reductions in miles driven, changes in operations, and improvements in vehicle technology.

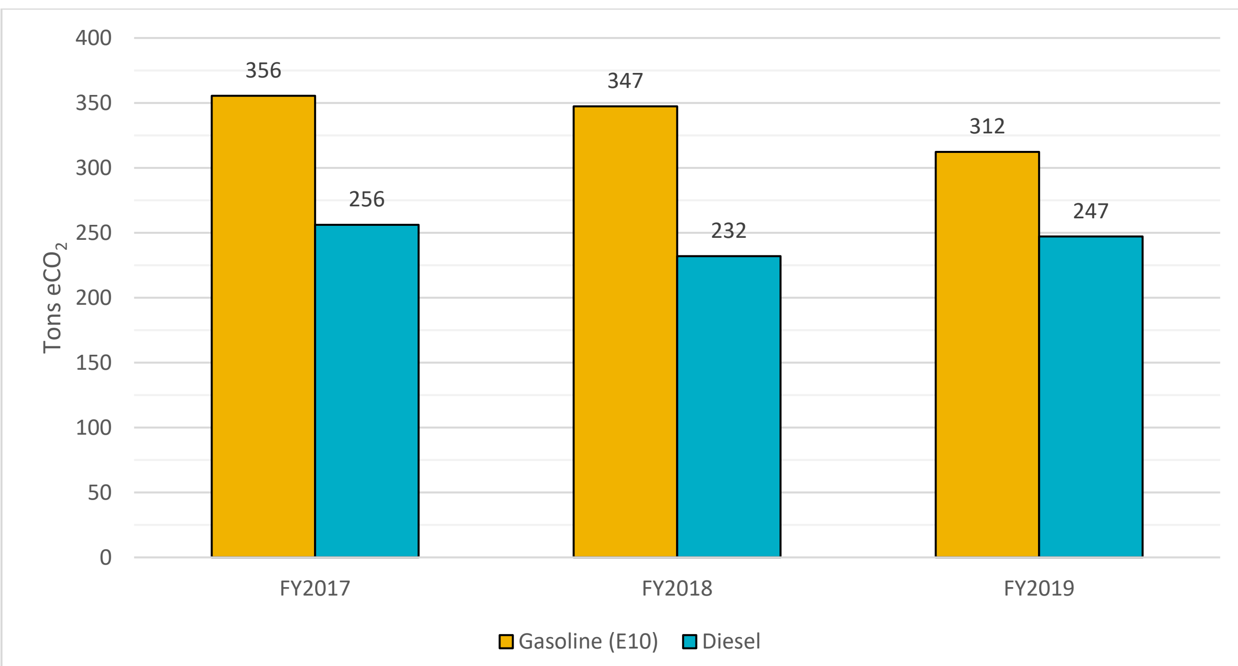


Figure 2. Emissions from direct transportation.

Animals and Fertilizer

Agricultural processes such as raising herds of animals and fertilizing fields/lawns are major sources of CH_4 and N_2O, both of which have a much higher GWP than CO_2. Animals release CH_4 from microbes found in their guts as well as through decomposing manure. Only 30% of the nitrogen content of fertilizer is retained by plants, while the rest is released to the environment [5]. This section addresses the emissions from animals and the fertilizer used across campus. Data was provided from Landscape Services, the College of Agriculture and Life Sciences, and Auxiliaries Services. Table 4 outlines the SIMAP emissions factors and quantity of each source. The breakdown by emission source is shown in Figure 3. FY2019 Emissions from animals and fertilizer increased 11% from the previous year and 175% since 2005 (144% if sheep are neglected). Since FY2019 was the first year that a head count for sheep was available, sheep population was assumed equal in FY2017 and FY2018.

Table 4. Emissions from each agricultural source.

	Emissions factor (kg eCO_2 / unit)	Unit	FY2017	FY2018	FY2019
Beef cows	1,543.9	Head	224	181	228
Dairy cows	5,572.6	Head	211	254	279
Horses	621.31	Head	4	7	4
Sheep	285.28	Head	859	859	859
Fertilizer (34-3-7)	0.00143	Pounds	708.75	3,496	2,649
Total Emissions		kg eCO_2	1,770,206	1,949,290	2,158,093
Total Emissions		**Tons eCO_2**	**1,770**	**1,949**	**2,158**

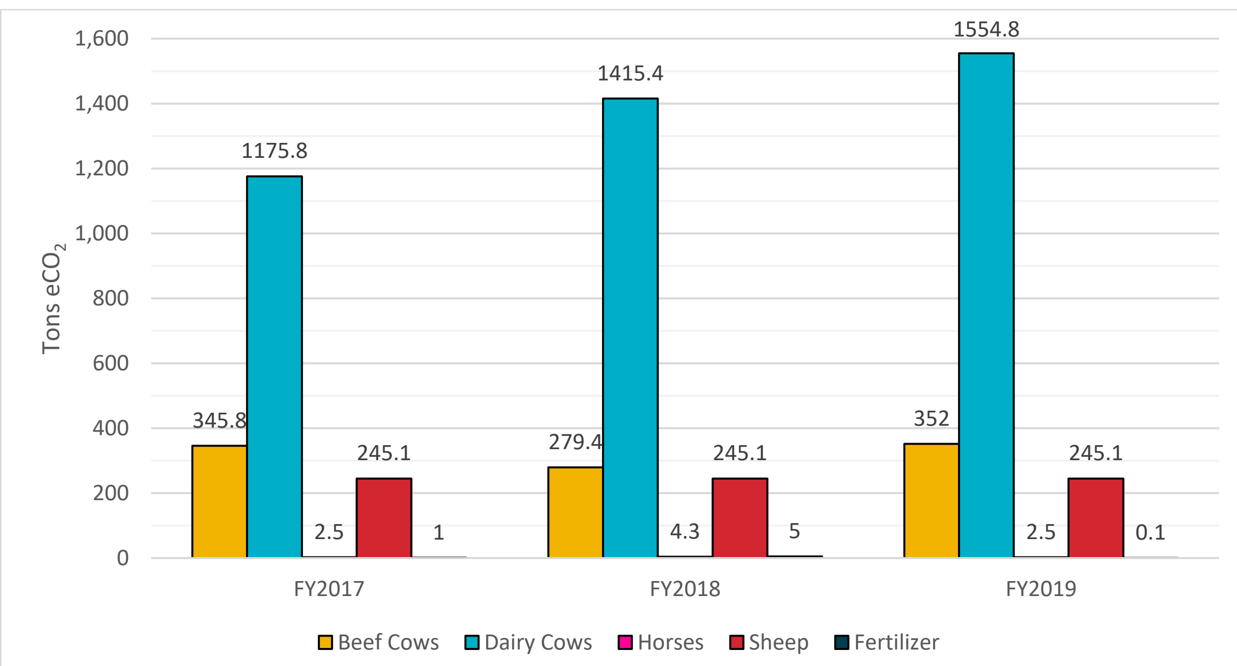


Figure 3. Campus emissions from animals and fertilizer.

Refrigerants and Chemicals

Fugitive emissions from refrigerants have high GWP values. The GWP of a GHG is defined as the ratio of the accumulated radiative forcing within a specific time horizon caused by emitting 1 kilogram of the gas, relative to that of the reference gas CO_2 [9]. Data was provided by the Facilities HVAC/Refrigeration team. Varieties of refrigerants are used across campus, outlined below in Table 5. Leaks from air conditioning units and refrigeration systems across campus are assumed to equal the amount recharged in those systems.

Table 5. Refrigerant usage (kg).

Common Name	100-year GWP	FY2017	FY2018	FY2019
R-22	1,760 [10]	3.63	80.74	0.91
R-134A	1,300 [10]	0.45	5.44	0
R-404A	3,922 [7]	17.24	9.98	11.79
R-410A	2,088 [7]	2.72	2.72	0

Multiplying the amount of refrigerant leaked by the 100-year GWP gives the amount of eCO_2 released to the atmosphere each year, shown below in Figure 4. Total eCO_2 emissions in FY2019 are 47.84 tons, a decrease of 75% from the previous year and 46% since 2005. The significant increase in R-22 emissions in FY2018 was due to failures of older equipment on campus, which are being decommissioned. As older refrigerants are phased out, emissions should decrease thanks to reduces GWPs.

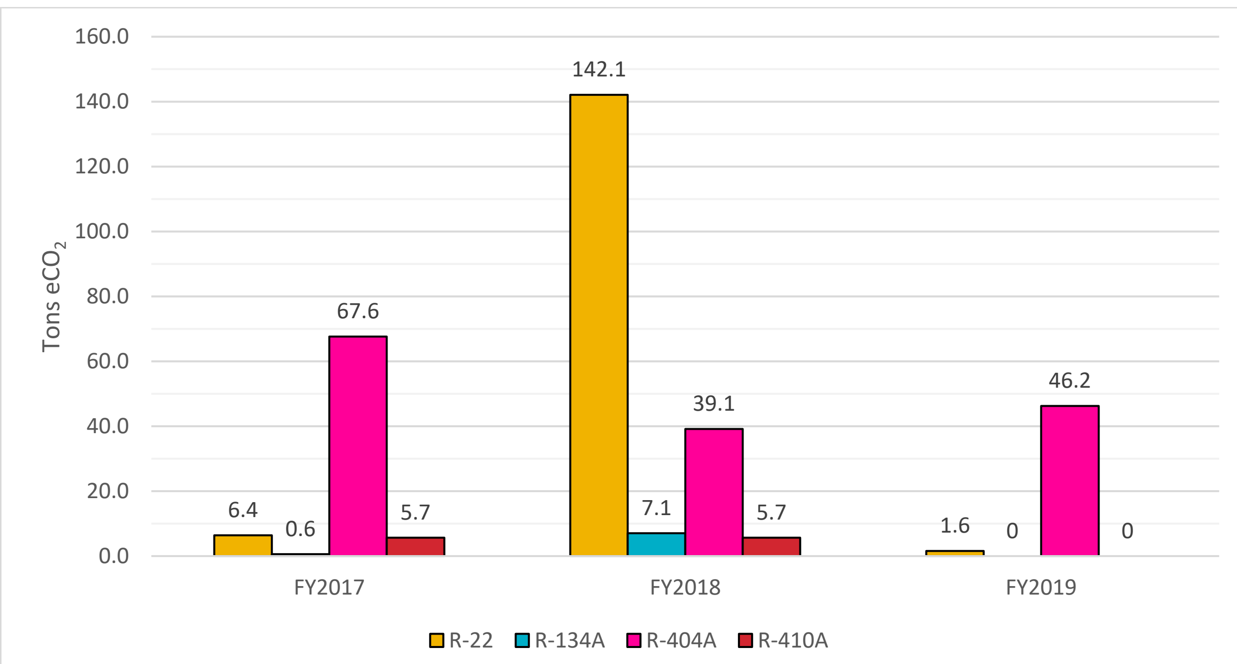


Figure 4. Emissions from refrigerant use.

Cumulative Scope 1 Emissions

Total Scope 1 emissions are shown below in Figure 5. Total FY2019 emissions are 6,953 tons, a reduction of 11.5% since 2005. If sheep are neglected, that reduction is 14.7%. Stationary fuels are the largest emissions source on campus, mostly due to heating requirements. The size of the beef and dairy herds result in significant emissions as well. Emissions from transport fuels are low in comparison.

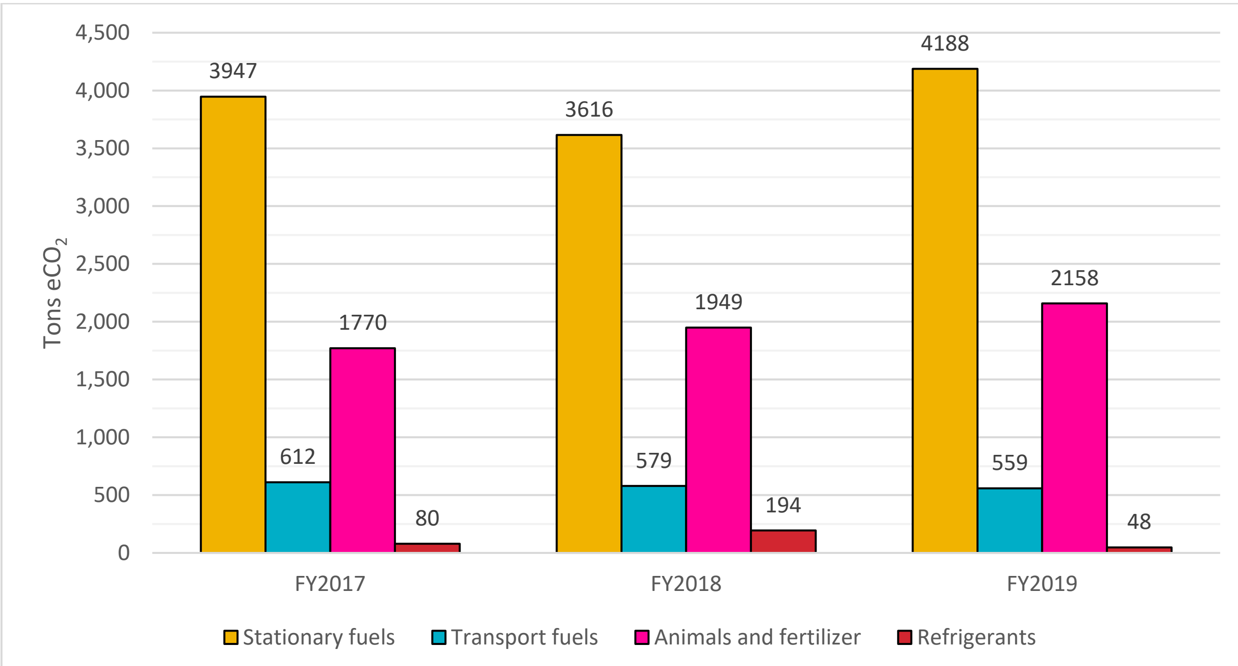


Figure 5. Cumulative Scope 1 emissions.

Scope 2: Indirect Emissions

Indirect emissions are from sources that are neither owned nor operated by U of I, but whose products are directly linked to campus energy consumption. These consist of resources purchased from a third party and consumed on campus such as electricity, steam, and chilled water. Since the university produces its own steam and chilled water for heating and cooling purposes, this Scope consists of electricity purchased from Avista Utilities. Currently no electricity is produced on campus; however, multiple projects are underway to begin producing electricity through steam turbines and solar panels.

Purchased Electricity

Electricity is delivered to campus through two main points, referred to as the East and West Feeds, which account for 99% of total electricity consumption in the past ten years. Electricity consumption is available through billing statements for the two feeds and auxiliary buildings, which are sent monthly to U of I Facilities, shown below in Table 6. Thanks to significant equipment upgrades and changes to operations, electricity consumption across campus has decreased 26% since 2005.

Table 6. Electricity consumption.

	East/West Feeds (kWh)	Auxiliary (kWh)	Total (kWh)
FY2017	48,290,921	394,054	48,684,975
FY2018	47,582,030	394,600	47,976,630
FY2019	47,194,789	390,341	47,585,130

GHG Protocol guidelines require institutions to use either location or market-based methods for Scope 2 reporting [11]. U of I is located in the Northwest Power Pool (NWPP), shown below in Figure 6. The NWPP is an electric power sub region as part of the Emissions and Generation Resource Integrated Database (eGRID) which is a comprehensive source of data on the environmental characteristics of most electricity generated in the United States. Institutions in areas that rely heavily on fossil fuels such as coal and natural gas will have higher Scope 2 emissions.

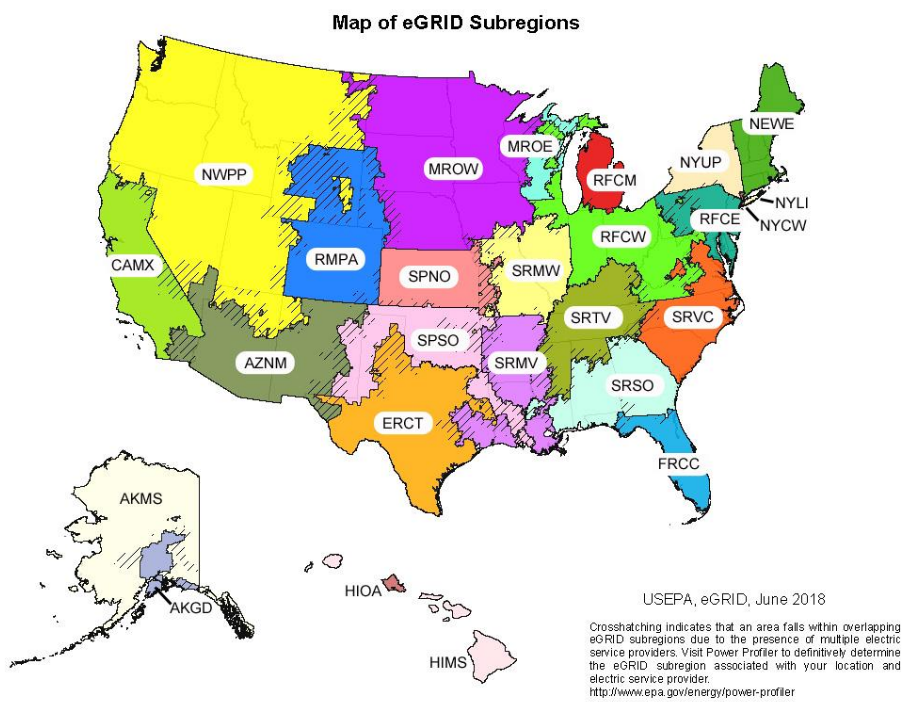


Figure 6. Map of eGRID sub regions [12].

The primary source of energy in the NWPP is hydropower, followed by coal and natural gas. The most recent 2018 energy mix estimate is shown below in Figure 7 [12]. Thanks to the extensive use of renewable energy sources, particularly hydro and wind, the NWPP has a lower emissions rate than the national average. The average emissions rate in the NWPP sub region is 0.297 kg/kWh, compared to the 0.455 kg/kWh national average.

The NWPP sub region spans across ten states and thus is a very broad estimate. Looking at the energy mix for Avista (see Figure 8) gives a better understanding of the power actually purchased by U of I [13]. While similar to the NWPP energy mix, with hydro being the dominant source of energy, less coal is used by Avista and thus actual emissions may be different. Entering the Avista energy mix into SIMAP shows an emissions factor of 0.294 kg/kWh, slightly lower than the 2018 NWPP average. Since there is only a 1% difference between the two, the eGRID data is used.

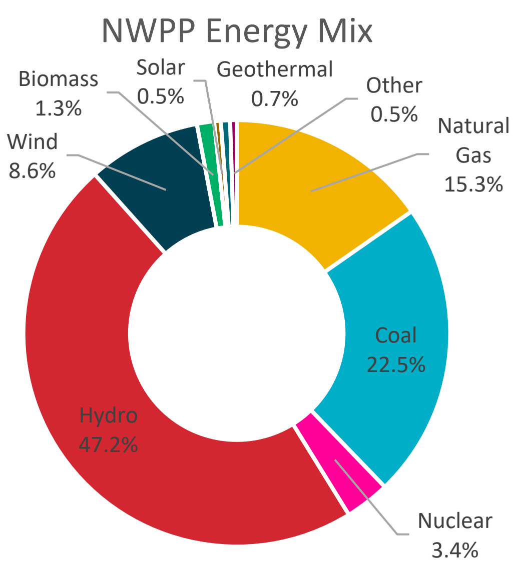


Figure 7. NWPP energy mix in 2018.

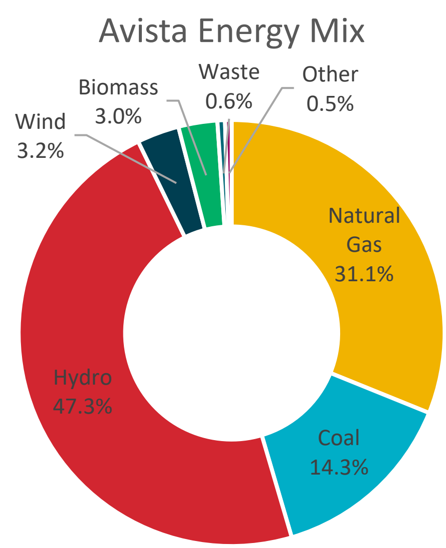


Figure 8. Avista Utilities energy mix in 2017.

Table 7. Scope 2 emissions.

	Unit	FY2017	FY2018	FY2019
Total electricity purchased	kWh	48,684,975	47,976,630	47,524,695
eGRID Emissions factor	(kg eCO_2/kWh)	0.414	0.297	0.297
Total emissions	kg eCO_2	20,155,580	14,249,059	14,114,834
Total emissions	**Tons eCO_2**	**20,156**	**14,249**	**14,115**

Total FY2019 Scope 2 emissions for the university are 14,115 tons eCO_2. This is a 1% reduction over the previous year, but a 48% reduction since 2005. Some of the decrease is due to efforts made by the university to reduce energy consumption, however the energy mix of the utility grid itself has also moved away from fossil fuels since 2005, indirectly reducing the university's Scope 2 emissions.

Scope 3: Other Emissions

Scope 3 emissions include other emissions from sources not accounted for in Scopes 1 and 2 that are neither owned or operated by U of I but are directly financed or linked to the campus. These include emissions from commuting to and from campus, U of I financed transportation, electrical distribution losses, food consumption, solid waste, and wastewater. Calculation methods are based on GHG Protocol guidelines for Scope 3 emissions [14].

Commuting

Traveling to and from campus for work and classes results in emissions based on the distance and mode of transportation. The U of I Sustainability Center (UISC) produced a campus sustainability survey in 2018 to gather commuter, environmental literacy, and cultural data on students and employees [15]. Moscow, Idaho is a relatively small town with a total area of 6.9 square miles. The typical commuting distance is less than four miles. Most of the population lives within city limits, making commute time short. Commuting behavior is outlined below in Table 8 for students, faculty, and staff in 2019. Student and faculty populations are available publicly, but data on the staff population was unavailable year to year.

Table 8. Primary means of transportation to and from campus by commuter type in FY2019 (percentage).

	Number of Commuters	Automobile	Bike	Carpool	Public Bus	Walk
Students	7,770	32	12	9	1	46
Faculty	715	57	18	7	1	17
Staff	1,686	64	9	13	1	13

GHG emissions from commuting to and from campus can be determined using the average data method outlined by the GHG Protocol (see Figure 9) [14]. Adjustments are made for each year for changes in the population. Total eCO_2 emissions are 1,687 tons annually. This is a reduction of 1.7% since the previous year and 18% since 2005. Students are much more likely to walk or bike to campus and many are only in town during the academic year (36 weeks per calendar year). University faculty and staff account for the majority of emissions since most drive a vehicle to work alone, commute throughout the year, and live further from campus on average. Emissions from commuting can be addressed by carpooling schemes, development of more extensive public transport infrastructure, and incentives for walking/biking.

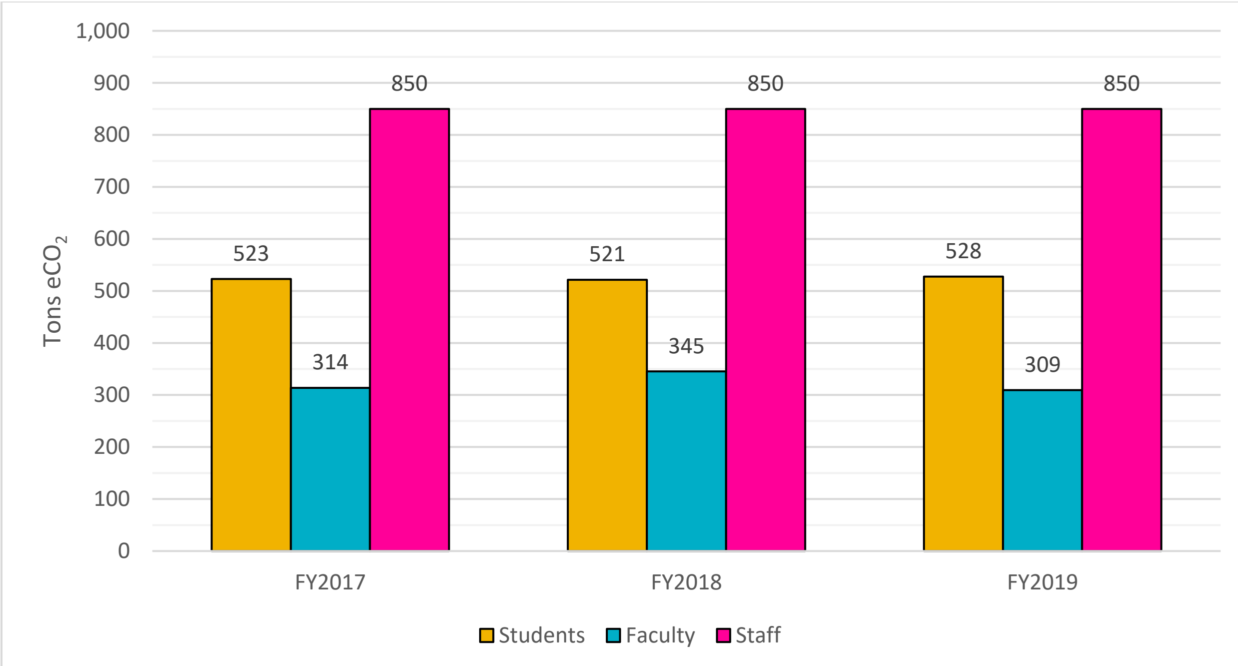


Figure 9. Emissions from commuting.

Directly Financed Outsourced Transportation

Directly financed transportation that does not involve university owned vehicles includes business trips on commercial aircraft and personal mileage reimbursements for faculty and staff. Air travel is a significant part of university operations, as faculty and staff must travel frequently for business, conferences, etc. Miles traveled have been estimated in the past by the university using the following conversions: 1 air mile = $0.25 and 1 vehicle mile = $0.535.

Emissions factors differ for airline travel based on distance, as the same amount of effort is needed for aircraft to take off and land regardless of the distance travelled. EPA estimates for 2018 are outlined below in Table 9 [7]. These factors change over time as airlines increase their operating efficiency.

Table 9. EPA emissions factors for business travel and commuting [7].

Travel type	Distance travelled (miles)	Emissions factor (kg eCO_2 / mile)
Short haul	< 300	0.225
Medium haul	< 2300	0.136
Long haul	> 2300	0.166
Passenger vehicles	any	0.343

U of I business travel information was provided by the Accounts Payable Office, which is measured in terms of in-state, out-of-state, and out-of-country. For ease of calculation, it is assumed that all in-state travel can be categorized as short haul, all out-of-state travel is medium haul, and out-of-country is long haul. These assumptions are made because the vast majority of in-state flights are between Lewiston, Idaho and Boise, Idaho, a flight distance of 198 miles, while the distance between Seattle, Washington and Miami, Florida (the longest flight distance from the northwest while staying within the continental U.S.) is less than 2700 miles. Miles traveled and emissions are summarized below in Table 10. Total eCO_2 emissions are 2,075 for FY2019, a reduction of 14% since the previous year (see Figure 10). The majority of all emissions from business travel are a result of commercial flights, not use of personal vehicles. It is recommended that travelers report estimated miles flown as well as costs to increase the accuracy of future GHG inventories.

Table 10. Summation of directly financed transportation miles and eCO_2 emissions.

	Unit	FY2017	FY2018	FY2019
Air travel				
Short haul	miles	2,226,932.3	2,330,227.8	1,781,623.9
Medium haul	miles	11,275,210.7	11,068,236.4	9,513,678.8
Long haul	miles	1,928,300.3	2,280,867.8	2,255,956.0
Subtotal	miles	15,430,443.4	15,679,332.0	13,551,258.7
Subtotal Emissions	kg eCO_2	2,354,586.3	2,408,205.5	2,069,214.4
Private automotive				
Personal Reimbursement	miles	15,892.5	16,914.2	16,314.11
Subtotal	miles	15,892.5	16,914.2	16,314.11
Subtotal Emissions	kg eCO_2	5,451.1	5,801.6	5,595.7
Total Emissions	kg eCO_2	2,360,037	2,414,007	2,074,810
Total Emissions	**Tons eCO_2**	**2,360**	**2,414**	**2,075**

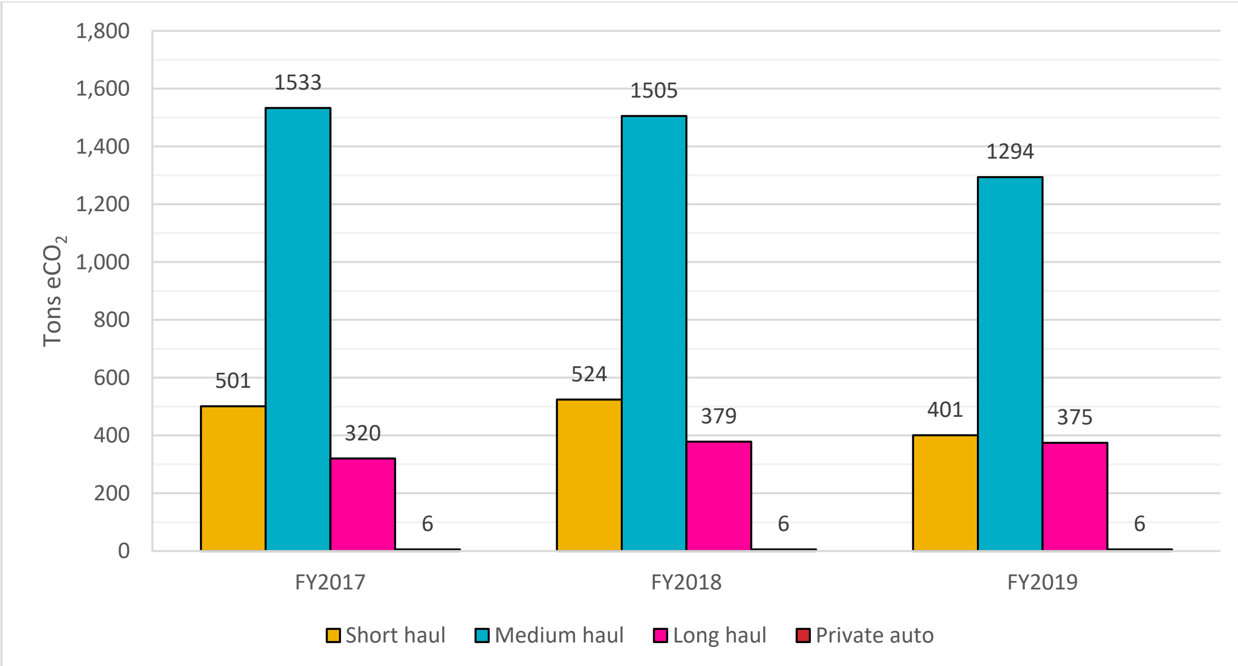


Figure 10. Emissions from directly financed transportation.

Transmission and Distribution losses from Purchased Electricity

Emissions from transmission and distribution (T&D) losses estimate the energy lost when supplying customers with electricity. These come from energy dissipated in transformers, conductors, and other equipment used to transmit, transform, and distribute electrical power. T&D losses are difficult to measure; however, estimates are available from the EPA eGRID program. The most recent estimates are 4.23% for the NWPP sub-region [12]. SIMAP estimates are 4.42%. Using the 4.23% values, emissions from T&D losses can be calculated using the same eGRID emissions factors used for Scope 2 emissions, shown below in Table 11. Total emissions from T&D losses are 597 tons in FY2019, a reduction of 1% from the previous year. Similar to Scope 2 emissions, the reductions over time are due to energy reduction efforts from the university and the Avista grid moving away from fossil fuels.

Table 11. T&D losses from purchased electricity.

	Unit	FY2017	FY2018	FY2019
T&D losses	kWh	2,059,374	2,029,411	2,010,295
Total emissions	kg eCO_2	852,581	602,735	597,057
Total emissions	**Tons eCO_2**	**853**	**603**	**597**

Food

Emissions from food production accounts for fertilizer application, cattle enteric fermentation, manure management, and losses [5]. For an accurate estimate, data on the total weight, type, organic status, and shipping distance of all food is needed. Data was collected and provided by Sodexo for September 2019 and used as a representative example of campus food consumption for the year. Only data for the Wallace dining facility (the HUB) was provided. Since SIMAP does not account for differences between months, these estimates are conservative. For example, food consumption in the summer is much less than September since there are fewer students on campus, but that is not reflected in the calculations. Due to the labor-intensive process of collecting data for every shipment of food to campus, it is unlikely that yearly data will be collected, but U of I and Sodexo are working to improve accuracy in future inventories.

Total food consumption by weight on campus is shown below in Figure 11. Consumption by weight is distributed evenly across most food types with milk, grains, and vegetables being the largest categories. Figure 12 shows the emissions from each food type. Beef alone accounts for over 39% of campus food emissions despite being 4% by weight, followed by cheese as the next largest source. Considering the very large carbon footprint of beef and dairy cows, this is expected. The consumption of meat in general accounts for most emissions at a total of 56%.

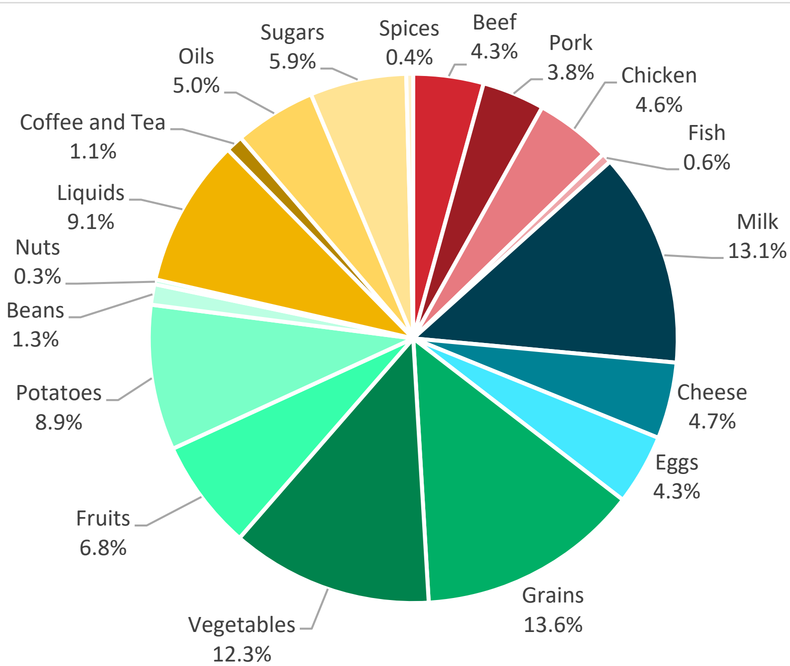


Figure 11. Food consumption by weight.

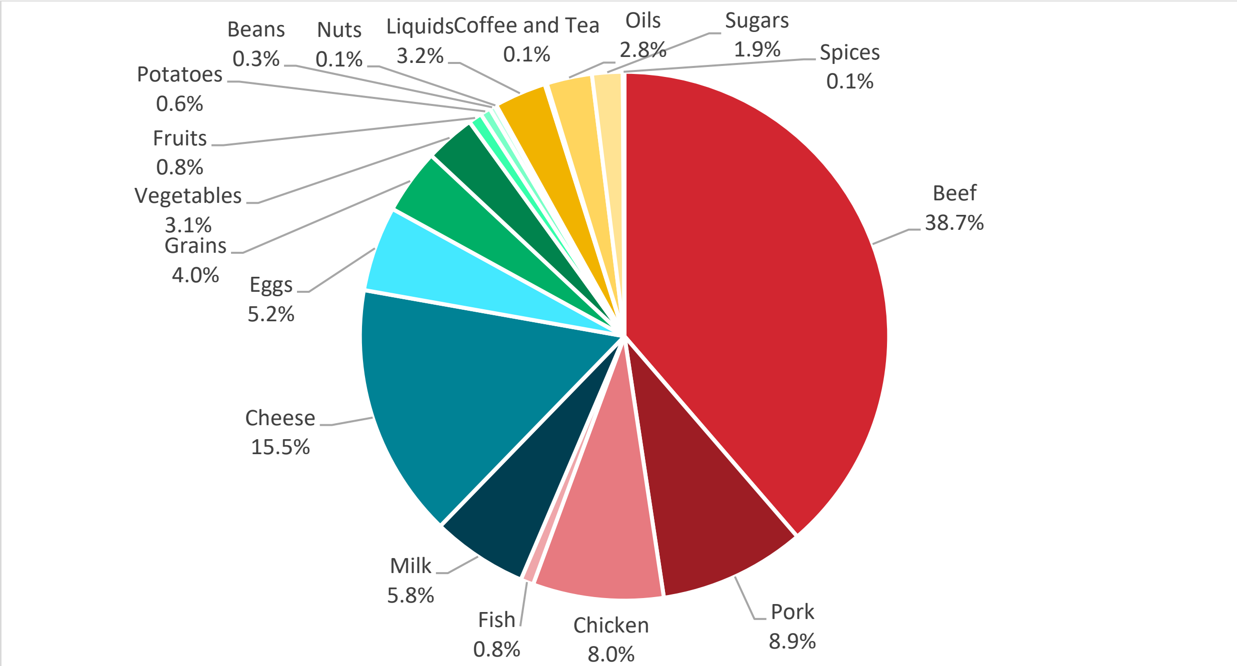


Figure 12. Emissions from food consumption by food type.

Since FY2019 is the first time food data has been available, emissions estimates for the previous years are made by using the on-campus student population for their respective years of attendance, shown below in Figure 13. Total emissions from food are 1,766 tons in FY2019. Unlike other sources of emissions, food emissions cannot realistically be addressed by reducing consumption. Instead, emphasis needs to be placed on what kinds of food are consumed, and food waste reduction strategies. It is suggested that local/regional (within 250 miles) food be purchased when possible and overall consumption of beef and cheese products be reduced. Providing more vegetarian meal options and substituting beef with other meats may also reduce emissions.

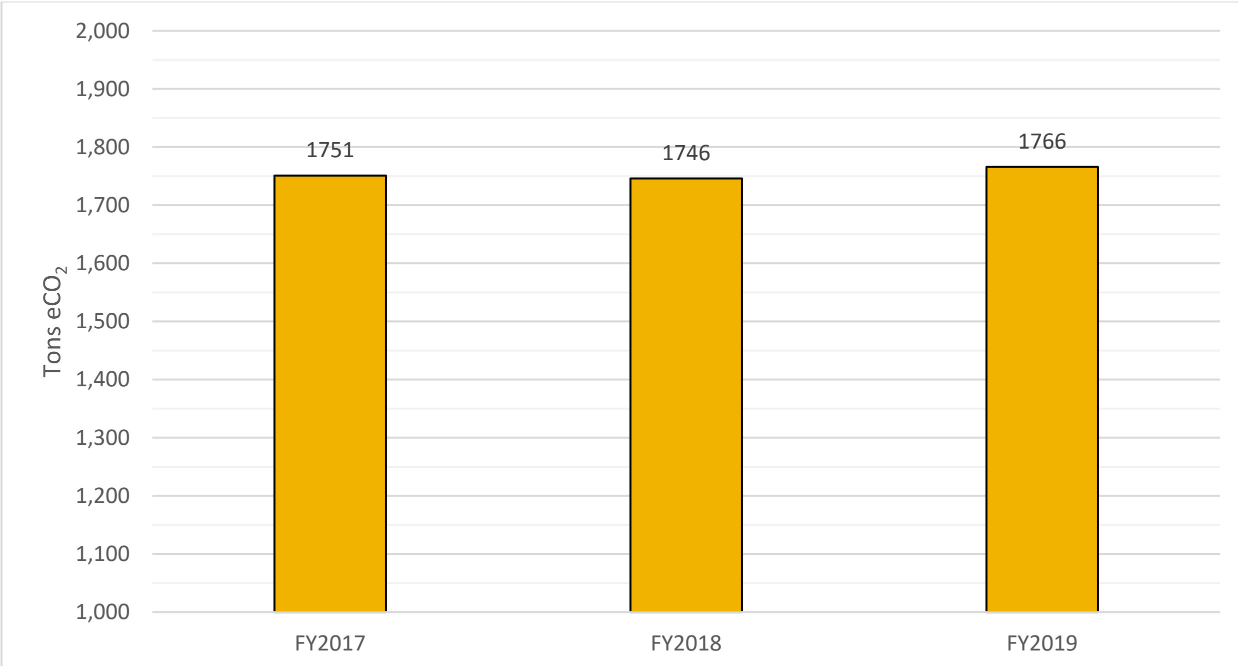


Figure 13. Total emissions from food consumption.

Solid Waste

This category includes waste generation and disposal methods for the university. Solid waste generation is typically measured in short tons, which is estimated here from the tipping fees charged by Latah Sanitation (LSI). Municipal solid waste (MSW) is collected by LSI and transferred 234 miles to the Columbia Ridge Recycling and Landfill located south of Arlington, Oregon. There it decomposes into methane, which is captured by the CH_4 recovery system at the landfill to generate electrical power [16].

Recycling is separated and collected on campus to reduce the need for virgin materials to create low quality goods and reduce the amount of material landfilled. Recycling is also collected by LSI, where it is shipped 295 miles to the Republic Services Materials Recovery Facility (MRF) in Seattle, Washington [17]. There it is sorted, processed, and sold to mills to produce new products. Most scrap metal is sent to Pacific Steel and Recycling in Lewiston, Idaho.

Solid waste generation on campus is outlined below in Table 12. Solid waste and recycling data was provided by the Recycling, Surplus, and Solid Waste (RSSW) division of Landscape and Exterior Services. Most waste generated is landfilled, with approximately one quarter of material being recycled or composted. As a university, U of I generates large amounts of paper and cardboard waste, which is easily recycled. Plastic recycling is limited in the area since LSI does not accept most types of plastic.

Calculating emissions from solid waste is difficult, as the exact composition is unknown, however the Waste Reduction Model (WARM) provided by the EPA allows organizations to estimate emissions from waste management practices such as landfilling, recycling, and combustion [18]. The amount of waste generated by material type and management practice, information on the landfill methane recovery process (if any), and transportation distances to processing facilities is needed from the user.

Table 12. Campus solid waste generation (short tons).

	FY2017	FY2018	FY2019
Solid waste landfilled			
Mixed MSW	767.14	812.28	841.22
Recycling			
Mixed paper (office)	49.42	46.06	43.27
Phone books	0	0.50	0
Cardboard	47.25	46.49	46.62
Metal	117.18	125.26	130.16
Electronic waste	20.70	26.28	19.36
Wood	15.18	3.08	0.7
Aluminum cans	0.16	0.24	0.16
Plastic bottles (#1 and #2 plastic)	0.35	0.30	0.16
Total recycled	200.79	248.21	240.43
Composting			
Leaves/trimmings	26.94	21.35	20.47
Dining waste/Agriculture	n/a	n/a	13.16
Total waste generated (short tons)	1,044.3	1,060.5	1,125.3

Entering these values into the WARM calculator results in the tons of eCO_2 generated from that material, shown below in Table 13. Total emissions from solid waste generation are 167.4 tons eCO_2 in FY2019, an increase of 2.4% over the previous year. For negative values, it means that emissions have been avoided thanks to the reduced raw material extracted from the environment and reduced energy requirements to create new products. Mixed MSW that is landfilled still releases eCO_2 to the environment despite using a methane recovery system because some methane still escapes to the atmosphere, a portion is flared, and emissions are still generated from transportation. Emissions from landfilled material are low thanks to the methane recovery system in place.

SIMAP and GHG Protocol documentation states that recycling should not be counted as a carbon offset in GHG inventories. This is because unlike composting, carbon is not sequestered after material is recycled. Emissions reductions from recycling are due to two factors [14]:

1) The difference between extracting and processing virgin material versus preparing recycled material for reuse
2) Reductions in emissions that would otherwise have occurred if the waste had been sent to the landfill

Put another way, the emissions reduced from recycling shown in Table 13 are what would have been emitted if that waste was landfilled instead. Therefore, the eCO_2 emissions reductions from recycling are presented here in the report but will not be counted in U of I's total emissions. Composting efforts however can be counted as carbon offsets and are accounted for in the total emissions from solid waste.

Table 13. Emissions from solid waste generation.

	FY2017	FY2018	FY2019
Solid waste landfilled			
Mixed MSW	157.3	166.6	172.5
Recycling			
Mixed paper (office)	-174.7	-162.8	-152.9
Phone books	0.0	-1.3	0.0
Cardboard	-146.0	-143.7	-144.1
Metal	-509.3	-544.4	-565.7
Electronic waste	-15.4	-19.6	-14.4
Wood	-36.8	-7.5	-1.7
Aluminum cans	-1.5	-2.2	-1.5
Plastic bottles (#1 and #2 plastic)	-0.4	-0.3	-0.2
Total emissions offset by recycling	-883.9	-881.6	-880.4
Composting			
Dining/yard trimmings/agriculture	-4.0	-3.2	-5.2
Total emissions (tons eCO_2)	**153.3**	**163.4**	**167.4**

Wastewater

Wastewater treatment typically releases nitrogen into the atmosphere instead of carbon and emissions depend on the level of wastewater treatment. The Moscow wastewater treatment plant uses an anaerobic digestion process, which releases CH_4 and N_2O. The SIMAP emissions factor for wastewater is estimated to be 0.52 g eCO_2/gallon. Table 14 below outlines U of I emissions due to wastewater. Emissions from wastewater treatment increased 5.2% from the previous year. Wastewater was not included in the previous GHG reports, but historical data shows domestic water usage of 247,708,636 gallons in 2005, equal to 128.8 tons eCO_2. Using this value, FY2019 emissions from wastewater treatment have decreased 40%.

Table 14. Emissions from wastewater.

	Unit	FY2017	FY2018	FY2019
Wastewater	gallons	146,029,846	141,187,215	148,908,882
Total emissions	kg eCO_2	75,935.5	73,417.4	77,432.6
Total emissions	**Tons eCO_2**	**75.9**	**73.4**	**77.4**

Cumulative Scope 3 Emissions

Total Scope 3 emissions are shown below in Figure 14. Total FY2019 emissions are 6,370 tons. Since food and T&D losses were not addressed in earlier inventories, a comparison can be made by neglecting them for FY2019. After accounting for the differences, Scope 3 emissions are down 9.4% since 2005. Directly financed air travel is the largest source of emissions in this category, followed by food consumption and commuting. T&D losses cannot be addressed directly as they are tied to the amount of electricity consumed.

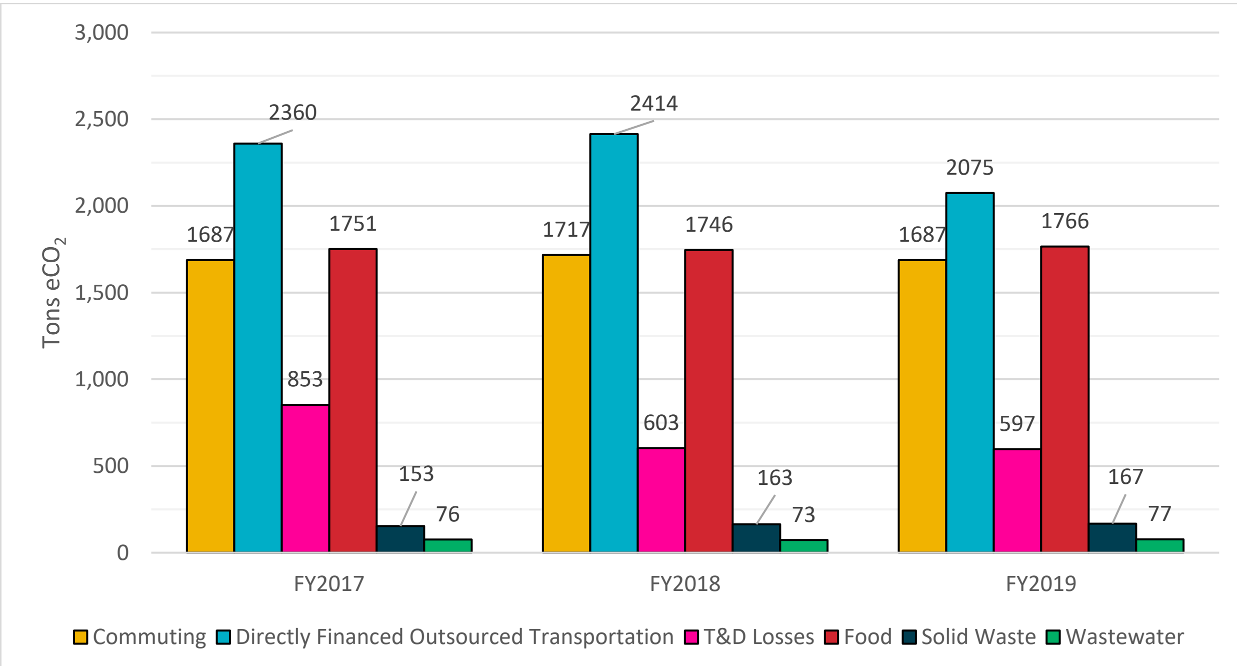


Figure 14. Cumulative Scope 3 emissions.

Total University Emissions Profile

Compiling the emission from all three Scopes illustrates the total university carbon footprint for each year, shown below in Figure 15. Emissions from the two earlier GHG inventories as well as the previous two years are shown for comparison. Some emissions have moved between Scopes in the past due to changes in reporting methods, such as animal emissions, so numbers are not identical to the previous reports. They have been moved into the current Scope methodologies in this report so comparisons can be made in reductions over time. Wastewater has also been included here, since that information is known. Total campus emissions in FY2019 are 27,438 tons, a reduction of 30% since 2005 and an increase of 0.5% since the previous year. Scope 1, 2, and 3 emissions account for 25.3%, 51.4%, and 23.2% of the total profile, respectively. Overall, the magnitude of emissions reductions has been dropping despite additional emissions sources being inventoried, though progress has slowed in recent years. Emissions can only be reduced so much before electricity generation from renewables and extensive composting efforts will be needed to reach carbon neutrality.

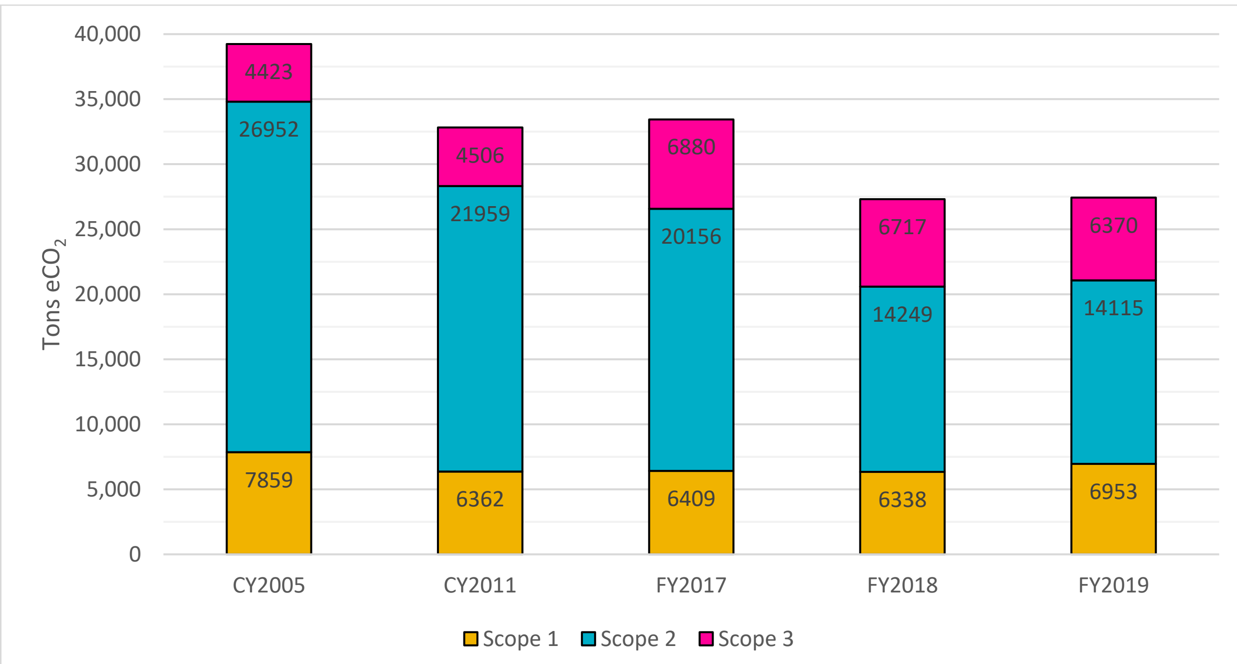


Figure 15. Total university emissions.

The total breakdown of GHG emissions in FY2019 are shown below in Figure 16. The largest sources of emissions on campus are electricity consumption (51.4%), stationary fuel use such as natural gas (15.3%), animals/fertilizer (7.9%), and directly financed travel (7.6%).

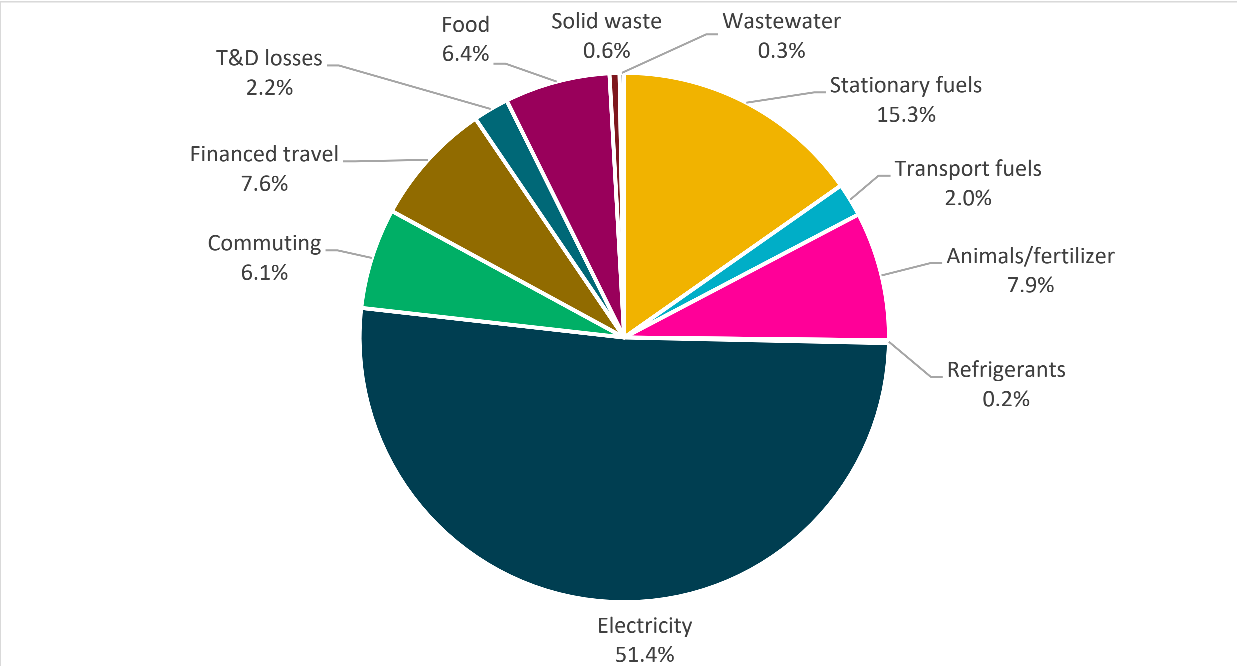


Figure 16. FY2019 emissions profile.

Normalization

Comparisons between institutions can be difficult, as the total carbon footprint is often an indicator of campus size rather than performance. To address this, results are normalized in two ways: per gross square foot and per full time equivalent student population. Reductions in emissions are compared with the 2005 baseline to determine how effective efforts have been and what steps need to be made.

Emissions per square foot

Campus square footage has changed little in the past few years. The newest major building on campus is the Integrated Research and Innovation Center, which was completed in 2016. As of 2019, the estimated occupied space on campus is 4,458,603 square feet, including the farms and Moscow locations. Total emissions per square foot are broken down below in Figure 17. Total emissions in FY2019 are 6.15 kg per square foot, a reduction of 41.8% since the 10.57 kg in 2005.

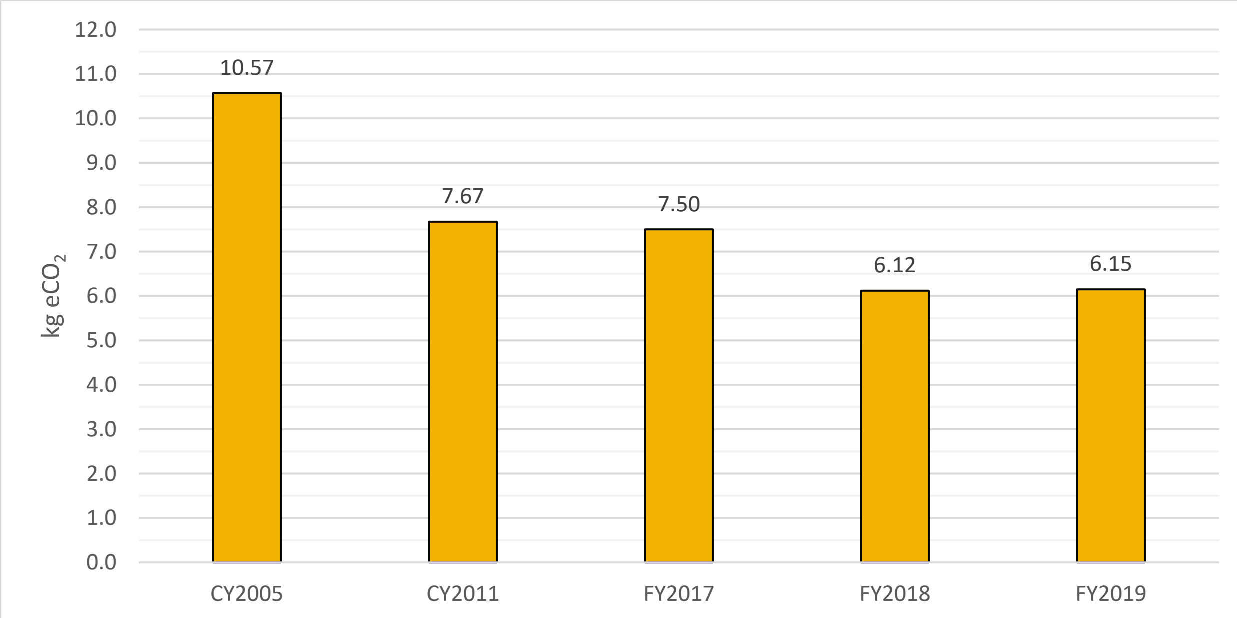


Figure 17. Emissions per square foot.

Emissions per full time equivalent student

The student population on campus changes year to year. The student populations for the Moscow campus were 9,349 in FY2017, 9,319 in FY2018, and 9,430 in FY2019. Figure 18 shows the estimated emissions per student on the Moscow campus. Total emissions in FY2019 are 2.91 tons per student, a reduction of 13.4% since the 3.36 tons in 2005. Unlike emissions per square foot, reductions per student have been less dramatic.

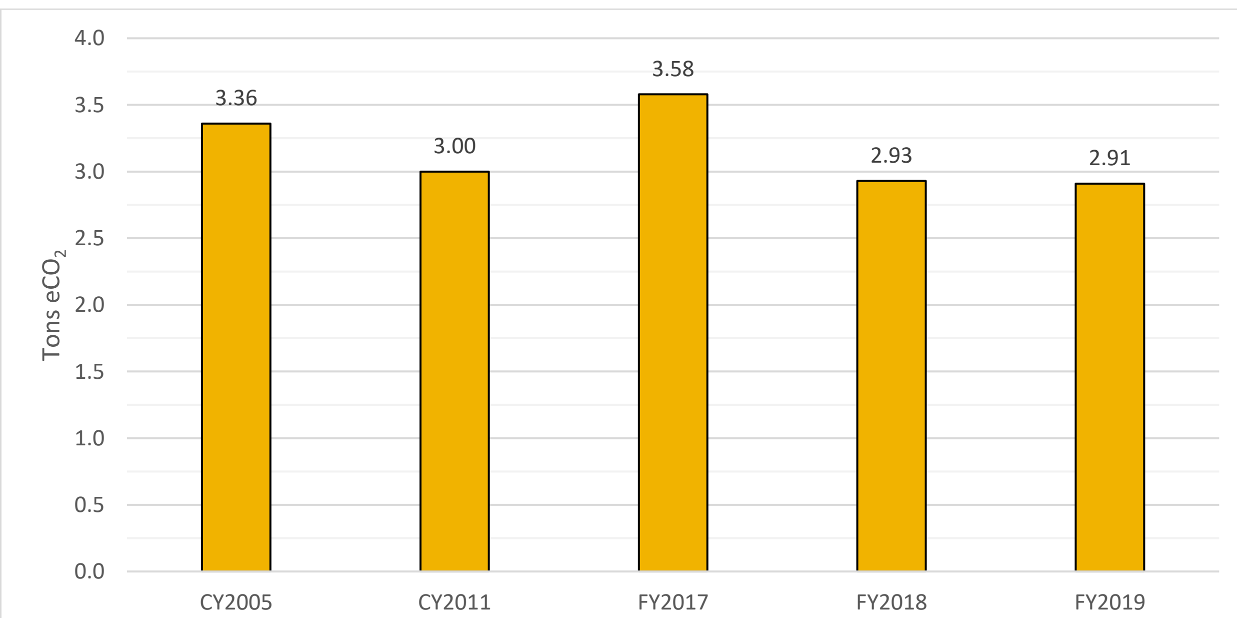


Figure 18. Emissions per student.

Conclusions and Recommendations

Total emissions in FY2019 are 27,438 tons of eCO_2. The total carbon footprint of the university has decreased 30% since reporting first began in 2005, but the rate of decline has slowed in recent years. Decreased electricity consumption accounts for most emissions reductions thanks to efforts on campus as well as the electric utility grid expanding the use of renewable energy sources in their portfolio. Successful efforts to reduce emissions on campus include HVAC setback schedules, VFDs on motors and pumps, lighting upgrades, the expansion of the district chilled water system, and improved operations of the vehicle fleet.

Changes in Scope 1 and 3 emissions are less noticeable, as beef and dairy operations have expanded at the university, buildings require heating and cooling, and commuting behavior is unchanged, among others. There are many possible ways to reduce emissions from these areas. Commuters should be encouraged to walk, bike, or carpool instead of driving alone. Less than 1% of the population using public transport indicates potential for commuting improvements. Emissions from the campus fleet of vehicles can be addressed through using biodiesel and electrification. Reducing the number of beef and dairy cows has an immediate impact as each dairy cow alone emits 5.6 tons of eCO_2 annually. Financed airline travel needs to be monitored via miles flown as well as dollars spent. Modifying the current business travel reporting process for faculty and staff to include estimated miles would increase the accuracy of future GHG inventories.

Some activities, such as business travel, natural gas usage, food consumption, and solid waste disposal will always exist and thus the university will always have Scope 1 and 3 emissions. To meet the goal of carbon neutrality by 2030, the university will need to commit to generating enough electricity on campus through renewables to offset those emissions. Investments such as the steam turbine project currently underway and PV arrays will have large impacts on the carbon footprint of campus. The turbine project alone has the potential to reduce total campus emissions by 7%. Reducing Scope 1 and 3 emissions on campus as much as possible reduces the size of the investment needed in electricity generation to meet the carbon neutrality goal. Renewable energy certificates (RECs) are an alternative way for the university to reach carbon neutrality without generating its own power. An updated Climate Action Plan is suggested to further assess the steps needed to achieve the university's goal.

For more information on this inventory, please contact Marc Compton at compton@uidaho.edu or Jeannie Matheison at jeanniem@uidaho.edu. Additional information on sustainability initiatives across campus and reports can be found at the University of Idaho Sustainability Center website here.

Acknowledgements

The author would like to thank the many people at the University of Idaho and the businesses who supported this effort.

University of Idaho

1) **Accounts Payable**
    a) Linda Keeney
2) **Auxiliaries Services**
    a) Golf Course
        i) Travis Ricard
    b) Housing
        i) Dee Dee Kanikkeberg
        ii) Lauren Smith
3) **College of Agriculture and Life Sciences**
    a) Joshua Peak
4) **Facilities Management**
    a) HVAC and Refrigeration
        i) Greg Dahmen
    b) Landscape and Exterior Services
        i) Charles Zillinger
        ii) Craig Carson
        iii) Gerard Martin
    c) Steam Plant
        i) Scott Smith
    d) Utilities and Engineering Services
        i) Gene Gussenhoven
        ii) Fred Pollard
        iii) Elmer Johnson
5) **Sustainability Center**
    a) Jeannie Matheison
    b) Kayla Bordelon

Businesses

1) **Avista Utilities**
    a) Kimberly Casey
2) **Busch Distributors**
    a) Gerri Nodine
3) **Sodexo**
    a) Lara Seng

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