GREENHOUSE GAS EMISSIONS AND REACTIVE NITROGEN INVENTORY

FOR

THE UNIVERSITY OF WYOMING

Fiscal Year 2019

By

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For

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Laramie, Wyoming

November 2022

Acknowledgements

The completion of this report would not have been possible without the efforts and contributions of all that assisted in providing. This report was the result of many hours of data collection and refining, which was only feasible due to the combined efforts of all involved. We would like to take this opportunity to express our gratitude to all departments that assisted in the project, as well as a special thank you to our supervisors, Michael Ziemann of Utilities Management and Forrest Selmer, Deputy Director of Utilities Management.

Abstract

The University of Wyoming (UW) began conducting a Greenhouse Gas (GHG) Inventory as part of its commitment to the American College and University Presidents Climate Commitment (ACUPCC), signed by UW President Tom Buchanan in Fall 2007. As of June 2018, UW is no longer a signatory of the ACUPCC, now Second Nature, but continues to complete an annual emissions inventory.

This report compiles data gathered for the GHG Emissions Inventory of the University of Wyoming for the Fiscal Year (FY) 2019. The inventory data is included in Appendix A and includes fiscal years 2002 through 2018. Sustainability Indicator Management and Analysis Platform (SIMAP), a GHG Emission calculator designed for College Campuses developed by the Sustainability Institute at the University of New Hampshire was used for all calculations included in this document.

UW emitted a net total of 96,982.58 metric tons of carbon dioxide equivalent (CO_2e) and 53.21 metric tons of Nitrogen during FY 2019. There was a 12.15% increase from FY 2018 (86,480.46 metric tons of CO_2e) to FY 2019. The possible reason behind this increase observed can be due to the new methodology adopted for calculating commuter data for FY 2019 than all years prior along with increase in directly financed air travel. These values were updated to a new eGrid (previously noted to be the US Average and instead switched to the RMPA region for years after 2007 and updated to ROCK for years prior to 2007). There was a 24.46% decrease from FY 2005 (128,396.90 metric tons of CO_2e) to FY 2019. This significant decrease over the years can be accounted to the usage of natural gas over coal for the on-campus heating and cooling activities.

Contents

Introduction

American College and University President's Climate Commitment (ACUPCC)

Institutions of higher education such as the University of Wyoming (UW) have a large part to play in the reduction and neutralization of greenhouse gas emissions. The American College and University President's Climate Commitment (ACUPCC), supported by the *Association for the Advancement of Sustainability in Higher Education* (AASHE), *ecoAmerica* and S*econd Nature*, began in 2006 with the intention to address global climate change at this level.

In August of 2007, President Buchanan committed the University of Wyoming to reducing its carbon emissions by signing onto this organization, along with 152 other institutions. The steps involved with this pledge included:

- Completion of an annual emissions inventory.
- Selection of immediate or short-term actions from a designated list to reduce GHG emissions.
- Completion of a Climate Action Plan within two years of signing on to achieve carbon neutrality.
- Integration of sustainability into the curriculum.

UW's Climate Action Plan (CAP), created in 2009, involves efforts from administrators, faculty, staff, as well as students, to play our part in lessening our impact on our environment and eventually going carbon neutral as a university. The CAP outlines UW's GHG reduction goals:

> "The Climate Action Plan is divided into three phases: (1) reducing greenhouse gas emissions to 15 percent below 2005 levels by 2015; (2) reducing greenhouse gas emissions to 25 percent below 2005 levels by 2020; and (3) achieving carbon neutrality by 2050."

UW officially withdrew from the ACUPCC (now Second Nature) in June 2018, but continues to complete an annual emissions inventory. Progress toward GHG reduction goals will be discussed in the results and discussion section.

Greenhouse Gas Emissions Inventories

The value of greenhouse gases emitted to or removed from the atmosphere over a period of time from a defined entity – in this case, the University of Wyoming - is accounted for using a GHG Emissions Inventory. In this way, institutions are able to monitor their particular emissions and track progress towards carbon neutrality.

Though there are various emissions inventory calculators used across the world by an assortment of institutions, governments, and businesses, the primary goal remains of providing a tangible value of the entity's contribution to climate change. This is done by converting emissions into carbon dioxide equivalents, or CO_2e, which calculated is based on its Global Warming Potential (GWP), or the ratio of warming that would result from 1 kg of any GHG to x kg of CO_2 over a period of time. The GWP ratio is the Radiative Forcing (RF) of a given substance being emitted in relation to the RF of CO_2 which, based on wavelength and lifetime, determines the degree to which the gas traps the sun's energy. For instance, the GWP of Methane (CH_4) is 25, so one

molecule of CH_4 warms the planet to a similar extent as 25 molecules of CO_2 meaning that emitting 1 kg of CH_4 is equivalent to emitting 25 kg of CO_2. This methodology allows for a standardized unit of comparison between various gases and facilitates meaningful comparisons both within and among measuring entities (IPCC 2007).

The Climate Leadership Network of Second Nature, a supporting organization of the ACUPCC, works to combine goals of carbon neutrality and climate resilience to provide climate solutions to higher education institutions (Second Nature). Second Nature also has a reporting platform allowing these higher institutions to track and report yearly emissions. The SIMAP calculator, managed by the University of New Hampshire Sustainability Institute (UNHSI), is recommended by the Second Nature Climate Commitment for GHG emissions calculations. Version 9.0 of this calculator was utilized for the University of Wyoming's FY 2019 inventory.

GHG Emissions Inventory Calculator

The Campus Carbon Calculator (CCC), used originally starting in with FY 2005, was discontinued and replaced by the Sustainability Indicator Management and Analysis Platform (SIMAP). This new system has been used for FY 2018 and 2019. SIMAP, like the CCC, is managed by the University of New Hampshire Sustainability Institute (UNHSI). SIMAP is accessed through an online platform. SIMAP maintains its recommendation from the Second Nature Climate Commitment for GHG emissions calculations. This most recent update includes changes in methodology and emissions factors which carries implications for the 2005 baseline and progress towards the GHG Emission Reduction Goals. One of the most drastic changes between CCC and SIMAP is that a new template (introduced in October 2019) varying from that of the previously used Excel sheets is used to import data to the calculator. This form includes a change in the calculation of the Commuter Data, listing it as a percentage as opposed to a solid number divided up between faculty and staff. The emission factor and methodology changes from the FY 2017 calculations to FY 2018 can be seen in the FY 2018 report under this section.

Physical and Temporal Boundaries

The physical boundaries in this inventory include main campus as well as off-campus property owned by the University of Wyoming, within Wyoming state. The ACUPCC requires that institutions report their calculated emissions on the basis of one-year periods, which can either be academic, calendar, or fiscal years. The GHG emissions and nitrogen emissions inventory for the University of Wyoming are conducted on a fiscal year basis, with this report concerning the 2019 fiscal year (July 1, 2018 through June 30, 2019).

Methodology for Collection of Data

The FY 2019 GHG emissions inventory for UW was completed with direction and oversight from the UW Campus Sustainability Committee and UW Operations. Data from the main campus and off-campus properties and activities were then entered into and then entered it into the SIMAP version of the University of New Hampshire Campus Carbon Calculator (CCC). All prior-year data was already input into this version of the CCC and looked over to ensure a consistent historical comparison. When collecting data, we verified campus source data by analyzing data thoroughly, and emailing those in charge of holding specific Scope Data with any

and all clarifying questions to avoid any double counting of emissions. The resulting data sets include on-campus and off-campus sources. Appendix B shows each corresponding emission data category and their source.

The ACUPCC identifies three scopes of emissions that the data categories of the CCC inventory calculator fall into (Figure 1):

- Scope 1 emissions are direct GHG emissions from sources either owned or controlled by the institution.
- Scope 2 emissions are indirect emissions that are generated in the production of electricity, steam, and chilled water.
- Scope 3 refers to all other indirect emissions that occur as a consequence of activities of the university from sources not owned or controlled by the university.

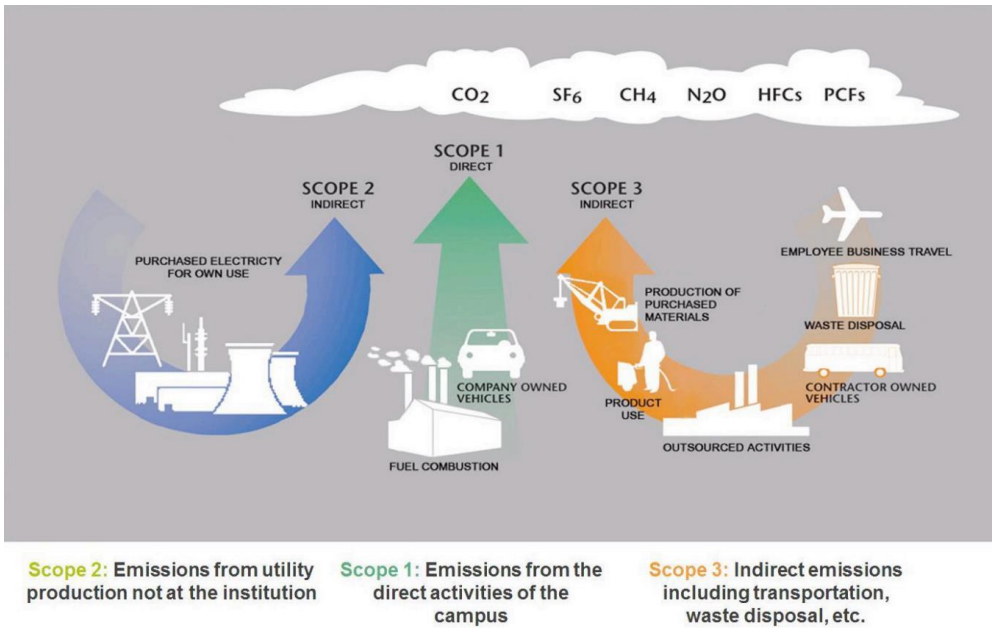

Figure 1: Scope 1, 2, and 3 emissions sources (Clean Air Cool Planet)

Budget

Data concerning the University budget is divided into three categories: Operational Budget, Research Dollars, and Energy Budget. It is to also be noted that each of these budget amounts were obtained from different departments throughout UW. All three budget categories include data from UW's satellite locations and properties.

The Operating Budget was based on the initial operating budget given from the Budget Office for the entirety of UW. It was therefore calculated from the publicly available Final, Board Approved Fiscal Year Operating Budget report found from the UW's Budget Office website. The summation was taken of the budget amounts for each fun class source. However, it should also be noted that this Operating Budget includes the entire Energy Budget; therefore, the Energy Budget was subtracted from the Operating Budget to prevent rerecording a budget amount. The Operating

Budget would also include any costs that are associated with new building or facility upgrades, including satellite buildings finance by UW.

When concerning the Energy Budget, it includes the combined budget for purchased electricity, chilled and steamed water, and any other purchases for on-campus stationary sources of energy (e.g., heating, cooling, etc.). However, SIMAP states this is to not include energy for transportation nor purchased water. Data for the energy budget was provided by Deputy Director of Utilities Management.

Research Dollars are separate monetary awards or grants to the University for specific research projects. The research budget was taken from the research expenditures given in the University of Wyoming Fact Books for 2019.

Building Space

The building space was obtained from University Operations. Research building space was obtained from Office of Research and Economic Development. In the event the data provided did not include UW property outside of the main campus, we contacted satellite properties for the remaining data, which was then aggregated with the main campus data before being entered into the SIMAP calculator.

The demolition of old buildings and addition of new buildings each year effectively alters the building space numbers. Research space was included in total building space. This is not considered double counting because the two numbers are graphed separately, and this inclusion follows the calculator guide.

Other On-Campus Stationary Sources

UW does not co-generate electricity, hence this energy usage data falls under the Other On-Campus Stationary sources category. When calculating and converting total emissions in metric tons (MT) of CO_2e from original units, the calculator automatically combines the components of on-campus stationary into one total figure of MT CO_2e .

Transportation

The University of Wyoming buys and provides gasoline and diesel for its own fleet and reimburses personal vehicles for their mileage driven. We were provided records of gallons of gas and diesel by UW Fleet Services. The mileage reimbursements amount was given in expense reports from Financial Affairs at UW, and we used a conversion rate of $0.575 per mile to find mileage.

Commuter Data

Commuter data was found by extrapolating data from the 2019 Walker Consultants Parking Needs Analysis and Operational Review Report, and using corresponding faculty, staff and student percentages for all commuting types. FY 2019 commuter data is more reliable than past years.

Refrigeration

The reported refrigerants used for FY 2019 included HFC-134a, R-404a, and R-407a. Data was only collected for properties on the main campus. The weight numbers were collected from

University Operations and are the amount of refrigerant used given in pounds. This does not include new refrigeration units installed, or refrigerants used by outside contractors.

Electricity

UW purchased 98% of its electricity from Rocky Mountain Power and 1.6053% from other sources during FY 2019. Data was provided by Mr. Forrest Selmer for UWYO Main Campus and other controlled properties. UW does not purchase any steam or chilled water.

Custom Fuel Mix

Fuel make-up of campus electricity usage needed fuel-makeup to be determined alongside associated emissions. This was determined using the Department of Energy's eGrid summary, which gave fuel percent makeup (percent of electricity provided by Coal, Natural Gas, Oil, Nuclear, Hydro-electric, and Other Renewables) for the UW campus. All electricity was assumed to have similar fuel make-up due to the fact that only 1.6053% was from other grid regions during FY 2019.

Attribute Solar – Electric

There are currently three solar grids on campus: The Ford Array, which is by the football stadium; the Energy Innovation Center Array, at a size of 10kW and operational since 2015; and the Haub School Array. At the time of this report, the Haub School Array was not operational and has not been for the past few years. There are efforts to rebuild this array in Fall of 2021.

The College of Engineering and Applied Science (CEAS) Array was located on the engineering addition, at a size of 5kW. The CEAS array was overseen by Dr. Suresh Muknahallipatna, who stated that the generated electricity for this array has not been recorded for the past 10 years and the array was removed in 2019.

Attribute Solar – Thermal

The UW Visual Arts Facility was designed with a Solar Thermal Heat system. In the FY 2018 report, it was stated that the Solar Thermal would be operational during FY 2019, but it is currently inoperative and there were no numbers to collect.

Commercial Air Travel

Expense reports for travel cost reimbursements were provided by Financial Affairs at UW. These provided reports contained all travel reimbursements at UW, and therefore we eliminated much negligible information including reimbursements for ground transportation and any values under $100. Methodologies in previous years also seemed to be varied slightly from what would be feasible. Due to the vast extent of the data provided, only a set number of entries would be sampled. Values for both students and faculty/staff were impossible to differentiate between, as this data was not recorded on the expense reports. The starting location and end location of each sampled piece of data was programmed into an online flight calculator, as used in previous years, to find the total flight miles for that particular reimbursement. Total annual flight miles for each fiscal year were then found with a simple ratio.

Nitrogen

Nitrogen information was gathered from the four research farms: R&E Center Powell, Laramie R&E Center, Sheridan R&E, and SAREC. Nitrogen numbers were also found for main university campus, UW Athletics, UW Grounds, and UW Residence Life and Dining and UW Plant Sciences. Reports prior to FY 2018 had not included research farms. Information was collected from R&E Directors, Secretaries, and Associates.

Solid Waste

UW solid waste generated is taken to a landfill where there is no CH_4 recovery.

Results

In FY 2019 the University of Wyoming emitted a gross total of 96,982.58 Net MTCDE (metric tons of carbon dioxide equivalent). This is a 12.15% increase in emissions from FY 2018's net total of 86,480.46 MTCDE, and a 24.46% decrease from FY 2005's net total of 128,396.90 MTCDE (Figure 2).

Updating SIMAP to newer emission factors and global warming potential values lead to reduced emission totals throughout inventory history. It should be noted that beyond eGrid factors, no data was adjusted from previous inventories.

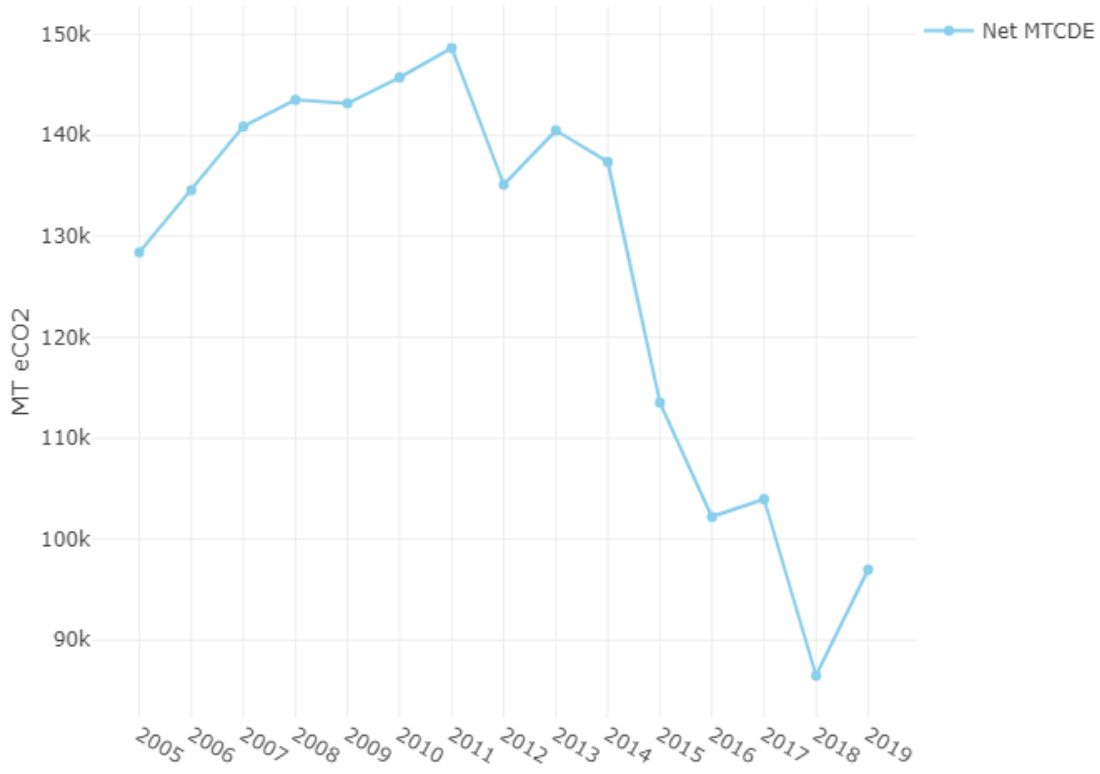

Figure 2: UW GHG emissions since FY 2005.

The major sources of CO_2e emission for UW are purchased electricity, on-campus stationary sources, solid waste and directly financed outsourced travel (Figure 3). The highest GHG contributor for FY 2019 was purchased electricity. Purchased electricity contributed 40.6% of overall emissions or 39,288 MTCDE. Other On-campus Stationary is the second highest source, contributing 36.5% which equaled 35,373 MTCDE. Directly Financed Air Travel is third, making up 8.44% of total emissions and contributing 8,168 MTCDE.

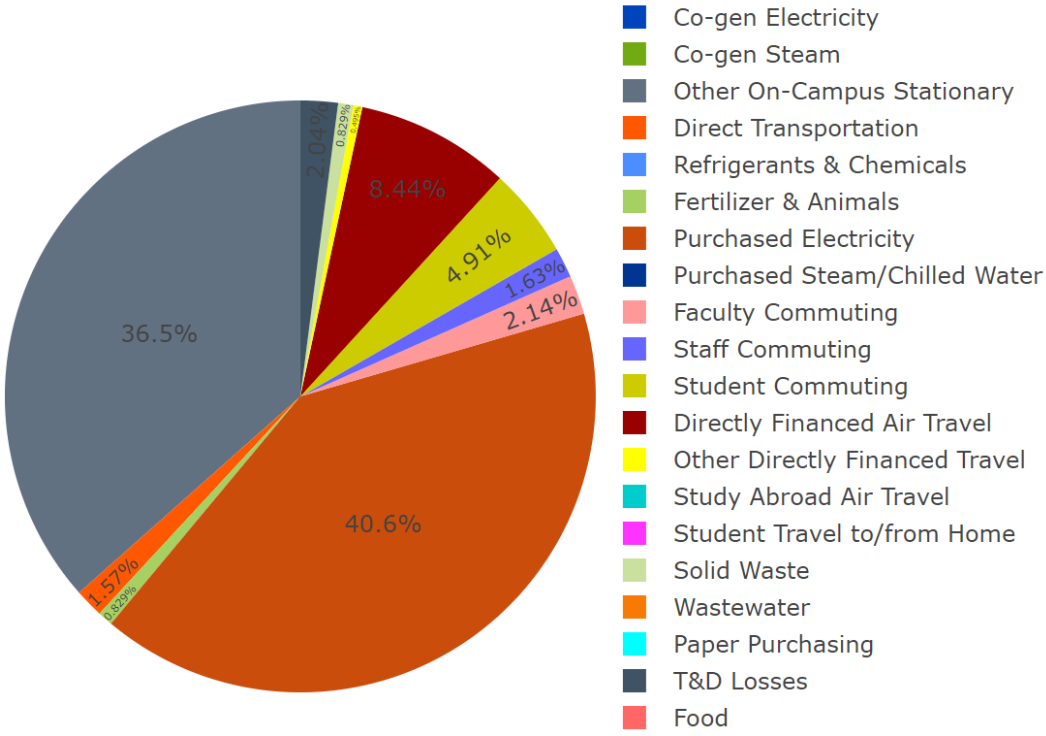

Figure 3: Breakdown of UW carbon emissions for FY2019

Several emission pattern changes led to the over-all increase in emissions seen in FY 2019. These trends are shown in Figure 4. This included a substantial increase in Directly Financed Air Travel which increased from 4.41% or 3,302 MTCDE in FY 2018 to 8.44% and 8,168 MTCDE in FY 2019. Other On-campus Stationary was observed to be 35,418.47 MTCDE which is nearly the same as FY 2018. Agriculture and Livestock were found to have increased in total emissions and percentage of total emissions. One of the largest changes in calculations between FY 2019 and all past years was that commuter data was collected differently from the Walker Consultants Report, generating a far larger number than all past years. This leads to the conclusion that all past years did not perform commuter data calculations as accurately as they could have.

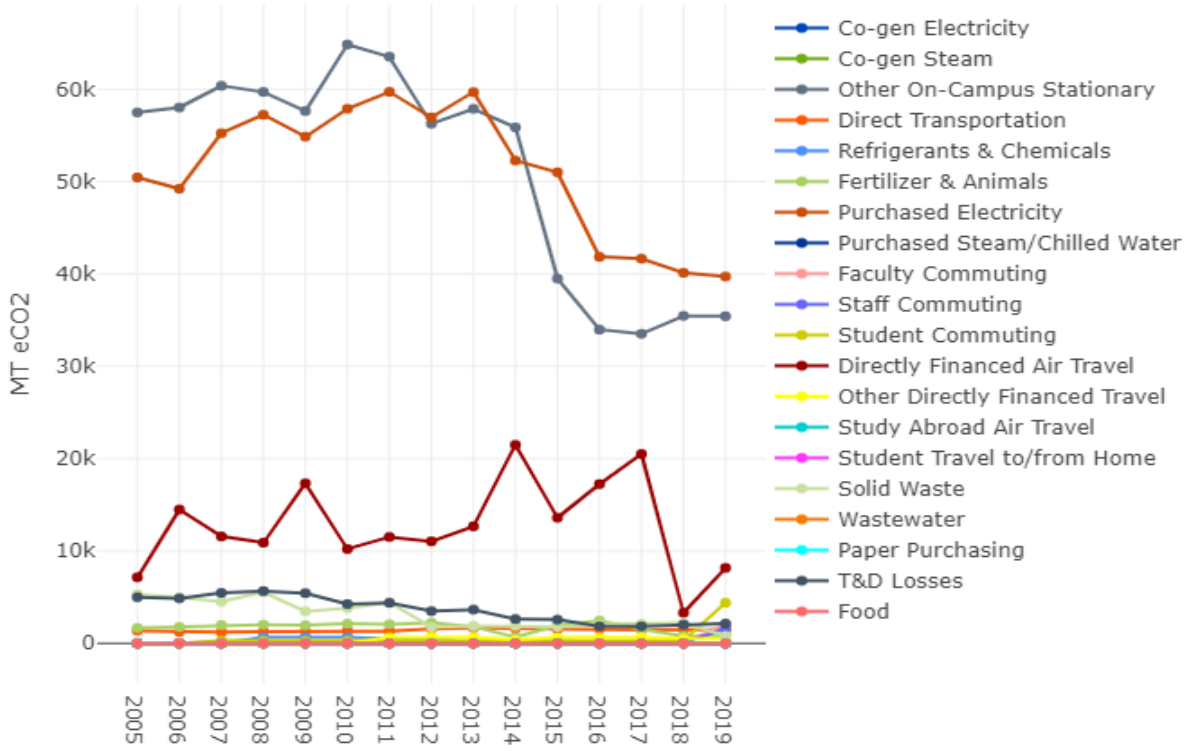

Figure 4: Trends in CO_2e sources since FY 2005.

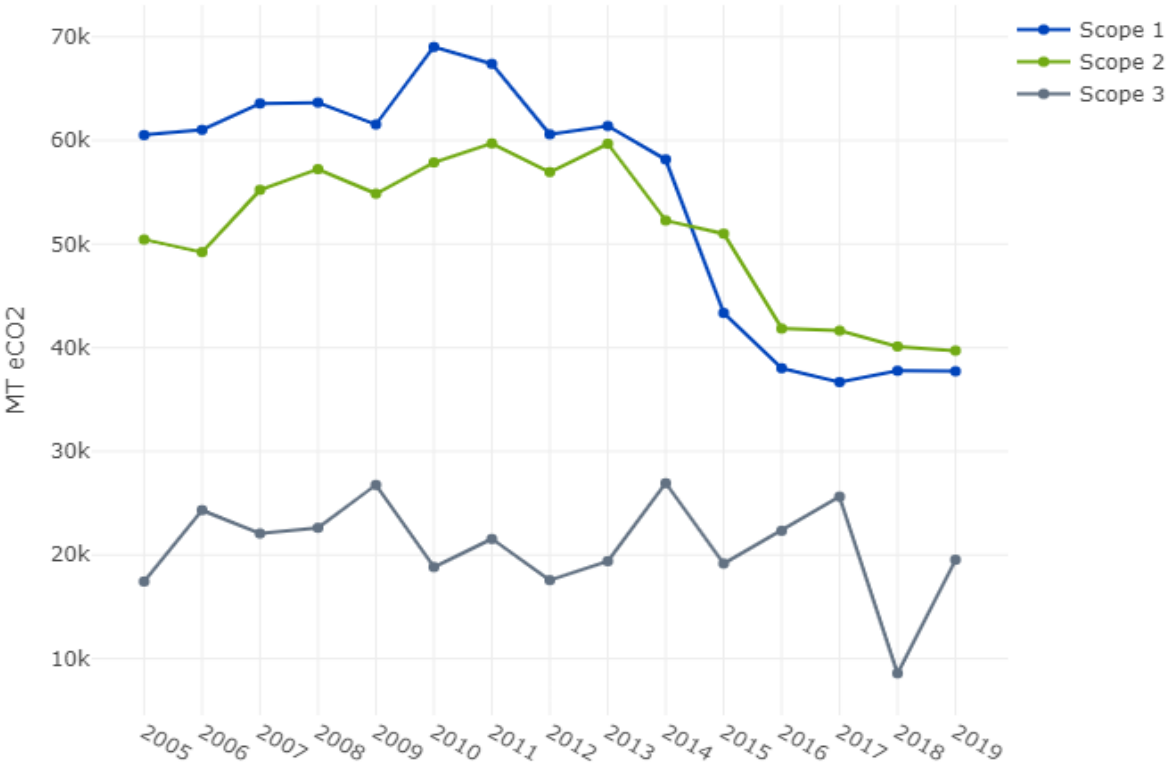

Figure 5: Trends in CO_2e sources by scope since 2005.

Scope 2 emissions reduced from FY 2018 to FY 2019 while scopes 1 and 3 emissions increased. Trends in GHG emissions by scope can be seen in Figure 5. Scope 2 emissions decreased 0.18% from FY 2018 to FY 2019. Scope 3 emissions increased 56.36% from FY 2018 to FY 2019. Scope 1 emissions increased 40.04% from FY 2018 to FY 2019.

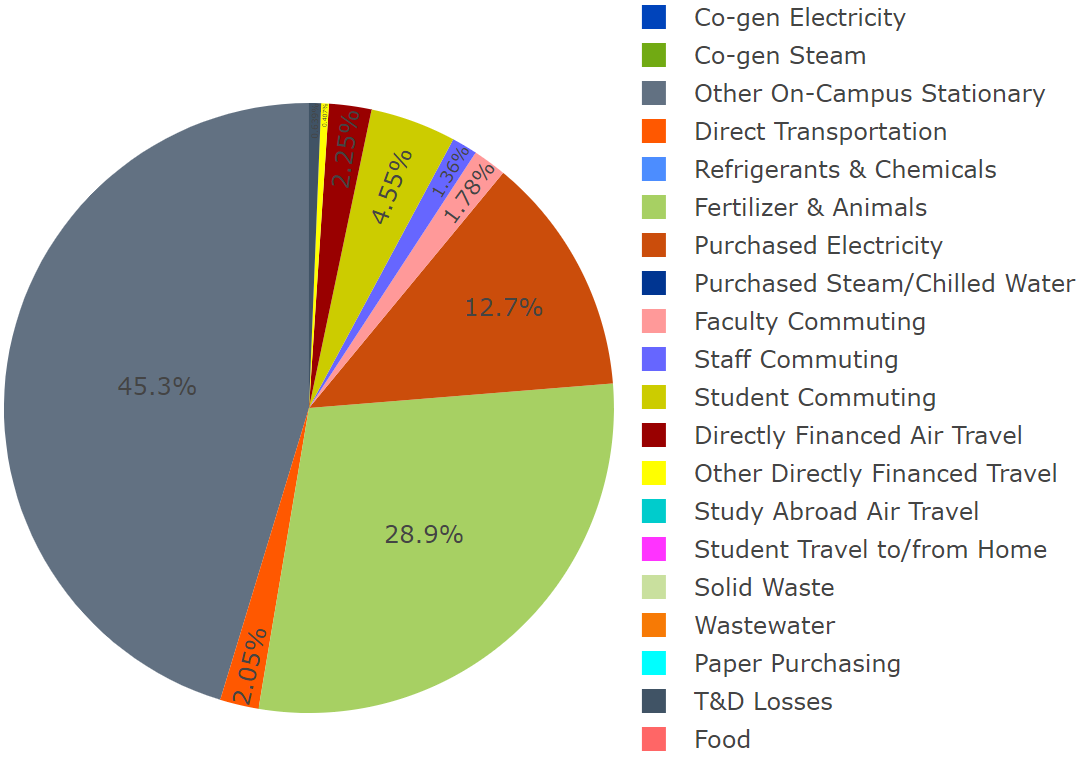

Figure 6: Breakdown of UW nitrogen emissions for FY 2019.

Figure 6 outlines the breakdown of the sources of nitrogen emissions for FY 2019. It is evident the largest contributors were on-campus stationery and fertilizer and animals. Figure 7 shows the trends of nitrogen emissions from FY 2005. It is shown there is a somewhat large decrease in emissions from FY 2018. The notable decrease in the top contributors heavily contributed to the change in nitrogen emissions.

Figure 8 demonstrates the changes in nitrogen emissions by scope. It can be noted that scope 2 and scope 3 emissions slightly increased in FY 2019 from FY 2018, however there was a large decrease in scope 1 emissions.

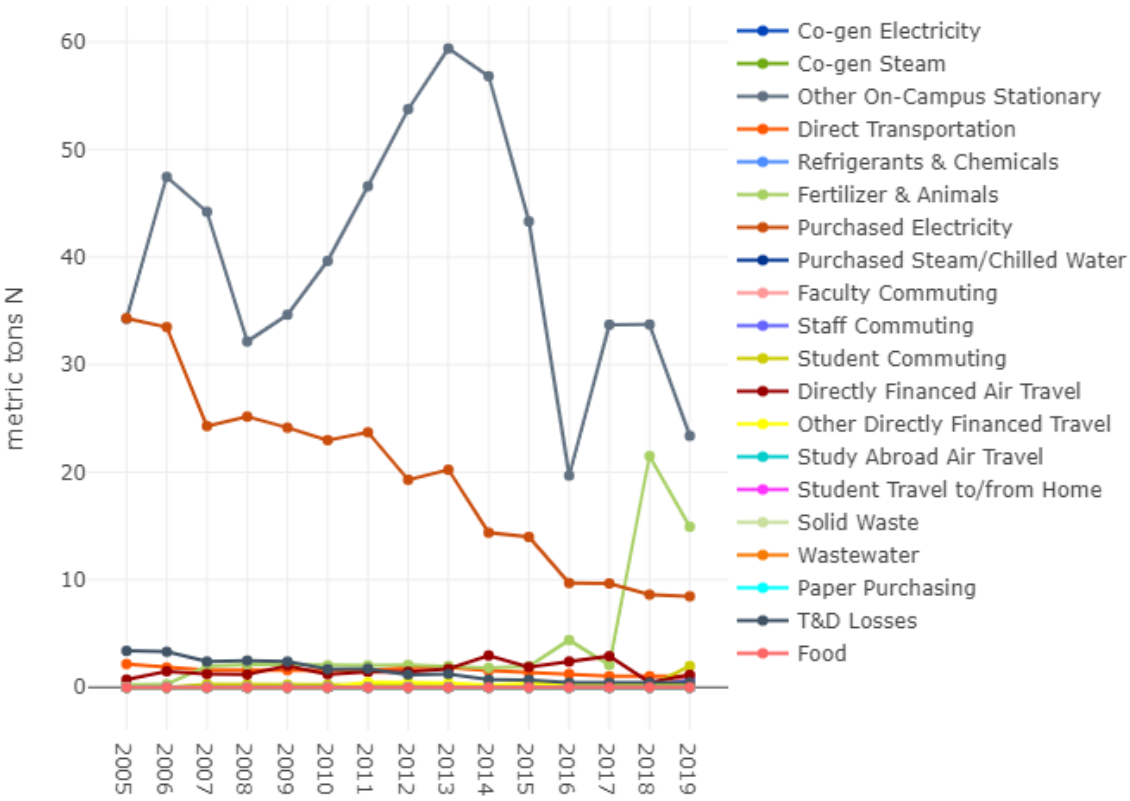

Figure 7: Trends in Nitrogen sources since 2005.

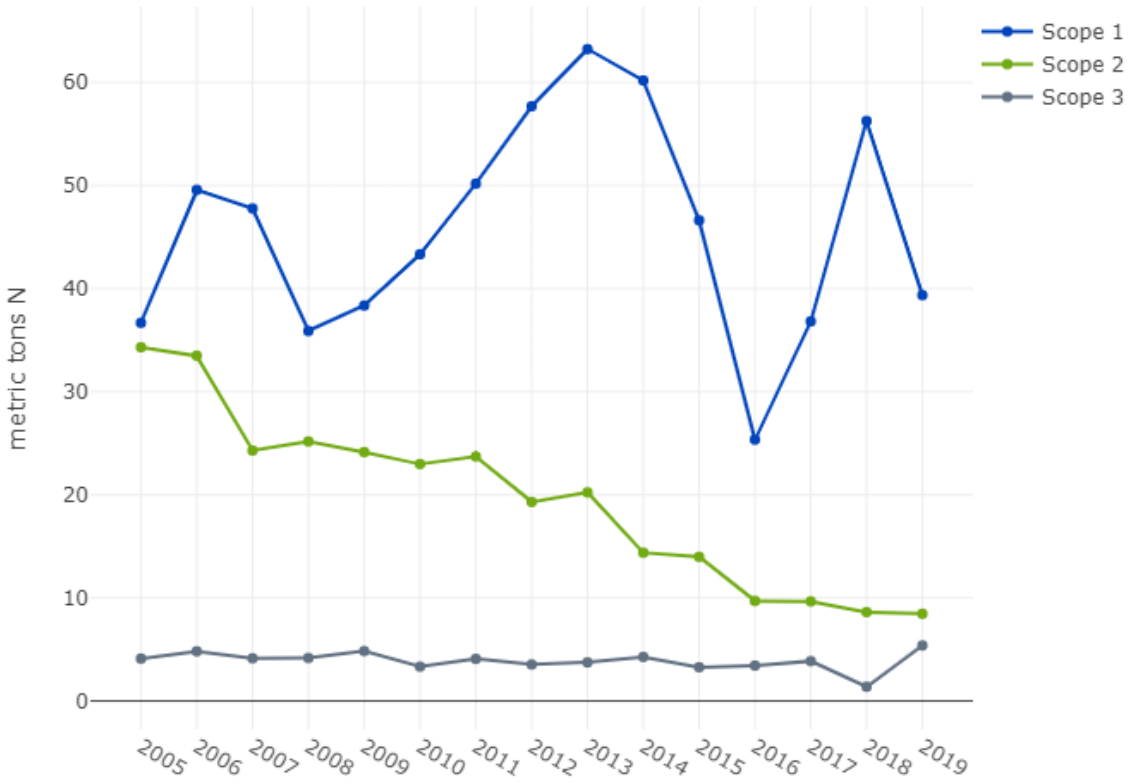

Figure 8: Trends in Nitrogen sources by scope since 2005.

Discussion

In FY 2019, the two major sources of emissions are on-campus stationary and purchased electricity. From the Table 1, we see that in FY 2018 the University used 10,561 metric short tons of coal and 298,050 MMBtu of Natural Gas. In FY 2019, the University used 6,468 metric short tons of coal and had a significant jump to 442,604 MMBtu of Natural Gas. No significant change in emissions from this category was observed even though there was a change in type of fuel mainly used. Note that in this report uses the corrected natural gas usage for FY 2018

Table 1: Fuel sources for on-campus stationary sources FY 2007 to FY 2019. All are scope one except electricity which is scope two.

Fiscal Year	Natural Gas (MMBtu)	Propane (Gallons)	Coal (Short Tons)	Electricity (kWh)
2007	107,146	6,841	25,864	63,602,733
2008	113,269	8,867	24,510	65,921,694
2009	113,076	6,416	23749	66,024,455
2010	120,815	5,418	27,137	66,990,963
2011	102,949	6,565	27,529	69,113,643
2012	89,637	6,712	25,269	68,607,169
2013	84,566	6,876	26,255	71,865,545
2014	119,494	8,117	24,282	65,875,211
2015	213,460	4,892	14,165	64,054,126
2016	451,794	4,355	5,161	66,386,071
2017	251,879	4,750	10,722	66,047,070
2018	298,050	4,178	10,561	67,066,847
2019	442,604	3,307	6,468	66,921,706

Electricity usage has increased 13% since 2005, this has been associated with a 24% increase in emissions. Since 2005 coals make-up of the overall mix has dropped 11.9% and the capacity has been replaced by natural gas and wind and solar. Specific eGrid make-up year by year was not available. Again, it should be noted that eGrid data from 2006, 2008, and 2011 was not available. This information can be seen in Table 2.

Table 2: Changes in fuel make-up for electrical supply since 2005.

Year	Biomass %	Coal %	Distillate Oil (#1-4) %	Hydro-Electric %	Natural Gas %	Net Purchased %	Nuclear %	Renewable (wind, solar) %
2019	1.3	22.5	0	47.2	15.3	0	3.4	9.8
2018	0	36.2	0.2	39.7	11.9	0	2.8	8.9
2017	0	36.2	0.2	39.7	11.9	0	2.8	8.9
2016	0	36.2	0.2	39.7	11.9	0	2.8	8.9
2015	0	26.3	0	51.32	10.8	0	3.14	8.81
2014	0	30.43	0.3	45.8	15.32	0	2.46	5.4
2013	0	30.4	0.3	45.8	15.3	0	2.5	5.4
2012	0	30.4	0.3	45.8	15.3	0	2.5	5.4
2011	0.618	30.8	0.32	44.677	14.819	0	2.9743	5.46
2010	1.237	31.2	0.33	43.551	14.338	0	3.4486	5.53
2009	1.0927	29.834	0.34	46.502	15.1503	0	2.4632	4.35
2008	1.098	30.895	0.28	47.434	13.963	0	2.734	3.29
2007	1.104	31.957	0.22	48.366	12.776	0	3.004	2.22
2006	1.1863	33.15	0.25	48.48	11.809	0	3.1399	1.63
2005	1.2686	34.35	0.27	48.613	10.842	0	3.2758	1.04

The increase in overall emissions can be owed to increase on directly financed air travel from 2018 to 2019 along with increase in student commuting. It should be noted that in FY 2018, the University of Wyoming had instituted a travel freeze to limit unnecessary spending which resulted in a reduction of emissions from air travel of 78.7% from FY 2017 to FY 2018 with the numbers reported in 2018. However, with updated efficiencies in SIMAP, the FY 2018 directly financed air travel emissions can be updated to a total of 3,812.53 MT CO_2e . With this noted, updated cumulative emissions from air travel in FY 2018 totaled 3,812 MT CO_2e and 8,647.27 MT CO_2e in FY 2019. This led to a 44% increase in air travel emissions from FY 2018 to FY 2019. This increase can be vastly attributed to the travel freeze in FY 2018. When concerning prior years, however, there was still a 62% decrease in air travel emissions from FY 2017 to FY 2019. Although there was a direct increase from FY 2018, air travel emissions are still on the decline in comparison to past years prior to FY 2018.

The increase in emissions from Fertilizers and Animals can be attributed to a more accurate inventory of the University for FY 2018 and FY 2019. To ensure consistency in reporting sustainability endeavors, the University boundary was aligned with that defined in the UWYO

submissions to AASHE STARS. As a result, four research farms with large numbers of animals and land holdings that require substantial fertilizer use were added to the inventory. The four farms that were included are listed above in Methodology for Collection of Data: Nitrogen. The number of animals reported for FY 2019 was not as accurate as it could have been due to the fact that records were not kept, and instead only rough estimates were given. This is due to a significant number of animals that are only in control of the University for a short period of time.

The FY 2019 inventory found that the University of Wyoming met its 2020 GHG emission reduction target of 25% reductions from 2005 levels by 2020. The University was found to have reduced its emissions by 32.32% from the 2005 levels. The FY 2020 report will likely find that the University will also meet a reduction. The reductions recorded in this report are not permanent and more changes will need to be done to ensure future goals are met.

Recommendations

The University of Wyoming signed the ACUPCC to demonstrate its commitment to reducing GHG emissions in a way that is compatible with the economy of the State and the University. The Campus Sustainability Committee, through the Climate Action Plan, has devised ways to achieve that goal. Additional recommendations to reduce emissions include:

- The University of Wyoming should implement a corporate travel program to save money, minimize greenhouse gas emissions, and track mileage. Corporate travel programs save money by allowing organizations to negotiate preferred partnerships with travel providers which can save money. Concur, a common corporate travel program allows users to book flights that "minimize emissions" meaning they are often direct and the shortest duration. Lastly, these programs generally allow for the tracking of flights on a mileage basis which would further increase the accuracy of the inventory.

- A notable amount of equipment still uses R-22 which is an ozone depleting hydrofluorocarbon. As a result of the Montreal protocol, all production an import of R-22 will be banned as of January 1st, 2020. All R-22 needs after that point must be satisfied from recycled and stockpiled stores. Due to phaseout, replacement costs are anticipated to increase substantially in the future for R-22 refrigerant and related equipment. Beyond this, R-22 has a huge CO_2 equivalent. Refrigeration equipment that still relies on R-22 should be transitioned to R-458A. The transition can be done for approximately $175/ton.

- Continue building efficiency efforts. This includes the implementation of building automation systems and other efficiency measures such as installation of VFDs, lighting control systems, digital controls, scheduling, installation of remote boilers, temperature set points and monitoring, and HVAC retro-commissioning.

- Enhance the Universities' capital expenditure planning in order to optimize spending on maintenance vs. replacement. This will ensure that the institution isn't spending unnecessary money on maintaining equipment and systems beyond their useful lives. By having a resilient capital expenditure plan the institution can utilize its CERF funding to its highest potential. It is recommended that the implementation of energy efficiency

measures be planned to coincide with the end of the useful life of MEP equipment. This should coincide with the full roll out of a Computerized Maintenance Management System (CMMS) to ensure that all systems are accounted for. It is currently believed that not all systems have been integrated and accounted for.

- The University of Wyoming should investigate a Financial or Physical Power Purchase Agreement to receive renewable energy at rates that create long term savings for the purchase and use of renewable energy. A Financial Power Purchase Agreement (Financial PPA) is where an organization enters into a long-term agreement with an electricity producer or buyer for the purchase of a set amount of electricity (Financial, 2018). A Physical Power Purchase Agreement (Physical PPA) is where an organization enters an agreement with a third party who agrees to build, maintain, and operate a renewable energy system on the customer's property or offsite (Physical, 2018). Physical PPAs offer the potential for the entity to own the energy source which offers the benefit of ownership to the organization (Physical, 2018). Both of these represent attractive options to organizations that are exempt from federal tax credits that incentivize the development of renewable resources (Physical, 2018). In both of these negotiations it is important that the RECs from the energy be maintained by the organization as they can be sold independently of the electricity (Physical, 2018). Developing a Physical of Financial PPA has the potential to reduce the University's GHG emissions by up to 41.1% or 29,800 MTCDE if all energy usage were to be satisfied through these agreements. Pursuing a Physical PPA or Financial PPA would also help the University realize savings in energy spending. Changes such as these are crucial for the university to be carbon neutral by 2050.

- Transition fuel usage at the Central Energy Plant from coal to natural gas, as long as economically feasible. Natural gas emits 50 – 60 percent less carbon dioxide when combusted with new combustion techniques when compared to a typical new coal plant. However, this neglects to consider up stream emissions. Much of the emission reduction that has been realized due to the transition of natural gas could be reduced by upstream fugitive emissions. Fugitive emissions are the emissions that escape as part of the exploration, transportation, and management of natural gas. While the University has reduced its scope one emissions, it has increased its scope two emission in a manner that is not directly tied to the University. In this case it has shifted a component of its emissions to the natural gas exploration, production, and transportation companies. At the time of this report a way to quantify how fugitive emissions impact lifecycle emissions of Natural Gas is still being developed. In a recent study, fugitive emissions from exploration and transportation were found to be 60% higher than EPA estimates (Alvarez et al. 2018). While this does not nullify the savings from transitioning from coal to natural gas, it does signify that the emissions from the University of Wyoming are likely higher than the current inventory found. This further reinforces the need to move beyond natural gas to even cleaner energy sources.

- The University of Wyoming has a unique potential to become a net-carbon sink. This could be done by pursuing regenerative agriculture. Regenerative agriculture is the practice of promoting soil carbon. It is generally noted that agricultural soils have lost 20- to 60% of the carbon that would have existed in the soil under natural circumstances (Olsson, L, et

al. 2019). Strategies to rebuild soil carbon levels generally include cover crops, inter-cropping, and no-tillage to name a few (Olsson, L, et al. 2019). This offers the potential to transition from having 8.54% of GHG emissions come from solid waste and livestock and agriculture to these activities being a net carbon sink. This would also allow the University of Wyoming to leverage its Agriculture and Environment and Natural Resource leadership to become a leader in research and implementation in this field. This solution includes implementing composting.

There continues to be financial reasons why the University of Wyoming uses fossil fuels to generate on-campus stationary energy. In such cases, there can be a balance between being environmentally friendly and financially viable. The Emission Factor section of Data Entry Tab in SIMAP provides a summary of the emission factor for every source and is very helpful if one wants to consider replacing a particular source or to increase the use of another.

Appendix A: Major Sources of Emission in Metric Tons CO2e

Fiscal Year (MT CO_2e)	Agriculture (MT CO_2e)	On-Campus Stationary (MT CO_2e)	Purchased Electricity (MT CO_2e)	Solid Waste (MT CO_2e)	Directly Financed Airfare (MT CO_2e)	Direct Transportation (MT CO_2e)
2002	1,653.00	53,626.00	47,166.00	6,543.00	5,306.00	1,100.00
2003	1,268.00	56,832.00	50,402.00	5,473.00	5,939.00	1,190.00
2004	1,089.00	57,635.00	50,392.00	5,258.00	3,113.00	1,309.00
2005	1,216.00	57,584.00	50,469.00	4,737.00	7,149.00	1,371.00
2006	1,312.00	58,089.00	49,251.00	4,443.00	14,490.00	1,228.00
2007	1,489.00	60,445.00	55,111.00	4,014.00	11,577.00	1,218.00
2008	1,515.00	57,037.00	57,120.00	4,938.00	10,902.00	1,273.00
2009	1,469.00	55,819.00	54,767.00	3,095.00	17,323.00	1,290.00
2010	1,597.00	61,250.00	57,763.00	3,406.00	10,217.00	1,400.00
2011	1,553.00	63,308.00	59,594.00	3,944.00	11,563.00	1,346.00
2012	1,672.00	55,896.00	56,851.00	3,779.00	11,815.00	1,610.00
2013	1,350.00	57,453.00	59,551.00	4,064.00	13,199.00	1,690.00
2014	511.00	55,510.00	54,588.00	4,064.00	22,806.00	1,632.00
2015	1,404.00	39,535.00	53,078.00	3,913.00	14,586.00	1,564.00
2016	1,794.00	34,304.00	55,011.00	4,480.00	18,562.00	1,600.00
2017	766.00	61,754.00	60,222.00	2,432.00	18,131.00	1,781.00

Appendix B: Major Sources of Emission in Metric Tons CO2e after SIMAP Update

SIMAP was updated in the year 2017 and the following table states the updated emissions.

Fiscal Year	Fertilizer & Animals (MT CO_2e)	On Campus Stationary (MT CO_2e)	Purchased Electricity (MT CO_2e)	Solid Waste (MT CO_2e)	Directly Financed Air Travel (MT CO_2e)	Direct Transportation (MT CO_2e)
2005	1,339.62	57,574.70	24,021.28	5,305.35	7,146.45	1,368.85
2006	1,442.07	58,079.60	22,888.20	4,976.35	14,485.04	1,226.75
2007	1,630.72	60,434.11	24,048.21	4,495.37	11,573.52	1,216.32
2008	1,658.28	57,027.35	24,565.89	5,530.90	10,898.28	1,271.37
2009	1,607.86	55,809.55	24,280.82	3,466.79	17,317.30	1,288.54
2010	1,748.78	61,239.17	25,302.08	3,815.03	10,213.37	1,397.66
2011	1,701.56	63,296.70	25,931.10	4,417.81	11,559.22	1,343.78
2012	1,832.05	55,927.72	27,802.56	4,233.03	11,811.10	1,607.71
2013	1,480.45	57,487.45	28,381.75	4,551.79	13,194.89	1,687.65
2014	555.44	55,541.86	26,042.76	4,551.79	22,797.88	1,629.94
2015	1,544.07	39,561.35	21,132.11	4,382.29	14,580.70	1,562.20
2016	1,964.82	34,324.70	29,508.81	5,017.11	18,555.81	1,597.43
2017	1,260.53	34,756.18	29,391.46	5,155.92	22,411.43	1,524.28
2018	799.87	35,456.93	39,360.89	5,401.36	3,812.53	1,488.61
2019	802.46	35,372.90	39,287.94	802.17	8,647.27	1517.83

Appendix C: Data Request Contact Personnel

		Main Campus	
Category	**Subcategory**	**Contact Office**	**Contact Person**
Budget	Operating Budget	Budget Office, 307-766-5766, http://uwadmnweb.uwyo.edu/administration/budget.asp	P.J. Shumway 307 766-4183 shumway@uwyo.edu
Budget	Research Dollars	Office of Research, 307-766-5353, http://uwacadweb.uwyo.edu/Research/	Amanda Larson 307-766-2074 amanda.larson@uwyo.edu
Budget	Energy Budget	Physical Plant, Utilities Management, 307-766-2077, http://uwadmnweb.uwyo.edu/PPLWEB/utilities/index.asp	Forrest (Frosty) Selmer Deputy Director Utilities Management 307-766-2077 fselmer@uwyo.edu
Population	# students, faculty and staff	Office of Institutional Analyses, 307-766-2898, http://oia.uwyo.edu	Suzanne Koller Associate Director Office of Institutional Analyses 307-766-2896 ssavor@uwyo.edu OR Suzie Waggoner scash@uwyo.edu
Physical Size	Total Building Space	Real Estate Operations, 307-766-2936, http://uwacadweb.uwyo.edu/REALESTATE/	Christina Maki Merica Hall 307-766-2648 cmaki1@uwyo.edu
	Research Building Space	Real Estate Operations, 307-766-2936, http://uwacadweb.uwyo.edu/REALESTATE/	Christina Maki Merica Hall 307-766-2648 cmaki1@uwyo.edu
Purchased Energy	--	Physical Plant, Utilities Management, 307-766-2077, http://uwadmnweb.uwyo.edu/PPLWEB/utilities/index.asp	Forrest (Frosty) Selmer Deputy Director Utilities Management 307-766-2077 fselmer@uwyo.edu
On-Campus Stationary Sources	--	Physical Plant, Utilities Management, 307-766-2077, http://uwadmnweb.uwyo.edu/PPLWEB/utilities/index.asp	Forrest (Frosty) Selmer Deputy Director Utilities Management 307-766-2077 fselmer@uwyo.edu
Transportation	Fleet Services	Fleet Services, 307-766-3229, http://uwadmnweb.uwyo.edu/FLEET/	Shawn Fletcher sfletche@uwyo.edu

			Fleet Services & Auto Shop/Car Rental Services 307-766-3334
	Private Air Travel	Department of Atmospheric Science, 307-766-3245, http://www-das.uwyo.edu/	Nicole N. Lawrence Dept. Atmospheric Science nlawren2@uwyo.edu
	Commercial Air Travel	Accounting Office (Accounts Payable) 307-766-5296 http://www.uwyo.edu/FINOPS/Payables/payables.htm	Jon D. Kelly Accounts Payable Supervisor jkelly1@uwyo.edu 307-766-5776 Old Main Rm. 101
	Commuter Info	UW Transportation Services	Paul Kunkel 307-766-9802 paul.kunkel@uwyo.edu
Agriculture	Fertilizer Application Grounds	University Physical Plant 307-766-6225 http://uwadmnweb.uwyo.edu/PPLWEB/	Andy Smith Main Campus Fertilizer Manager flowers@uwyo.edu
	Fertilizer Application Athletic Facilities	University Physical Plant 307-766-6225 http://uwadmnweb.uwyo.edu/PPLWEB/	Tyson Drew Athletics Fertilizer tdrew@uwyo.edu 307-766-2007
	Fertilizer Application Res Life	Residence Life and Dining 307-766-3175 http://uwadmnweb.uwyo.edu/reslife-dining/	Kim Zafft Res Life Fertilizer zafft@uwyo.edu 307-766-3763
	Fertilizer Application Plant Sciences	Agriculture Experiment Station, 307-766-3112, http://uwadmnweb.uwyo.edu/UWEXPSTN	Joe Jensen Golf/Grounds Fertilizer 307-766-4359 joej@uwyo.edu
	Fertilizer Application SAREC	Sustainable Agriculture Research and Extension Center http://www.uwyo.edu/uwexpstn/centers/sarec/	Kelly Greenwald Administrative Associate (307) 837-2000 kgreenwa@uwyo.edu
	Fertilizer Application LREC	Laramie Research and Extension Center	Richard Pendleton Greenhouse Operations Coordinator (307) 766-5043 pendletn@uwyo.edu Scott Lake Director (307) 766-3892 scott.lake@uwyo.edu
	Fertilizer Application	Sheridan Research and Extension Center	Rochelle Koltiska Secretary

	Sheridan R&E		(307) 673-2856 rkoltis2@uwyo.edu
	Fertilizer Application Powell R&E	Powell Research and Extension Center	James Heitholt Director jim.heitholt@uwyo.edu
Solid Waste	Historical Data	Physical Plant, Facilities Services, Waste Services, 307-766-6225, http://uwadmnweb.uwyo.edu/PPLWEB/services/index.asp	Forrest (Frosty) Selmer Deputy Director Utilities Management fselmer@uwyo.edu 307-766-2077

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