Auraria Sustainable Campus Program

Greenhouse Gas Inventory

Fiscal Year 2019

Metropolitan State University of Denver

University of Colorado Denver

Community College of Denver

Auraria Higher Education Center

Published May 2020

Lead Author

Jackie Slocombe
Sustainability Coordinator, Auraria Sustainable Campus Program

Acknowledgements

This inventory required data and information from *numerous* campus stakeholders spread across the four institutions. Without their cooperation, this inventory would not have been possible.

Chris Herr, ASCP Sustainability Officer, helped to contact and collect data for this inventory and provide quantitative analysis of waste and transportation data.

The Facilities departments, procurement offices, and Offices of Institutional Research at the four institutions were heavily implicated by this data collection and worked collaboratively with the ASCP to make data available. A thank you to all those who helped provide data and a special shout out to Ken Ross, who bore the brunt of these data requests.

Table of Contents

Executive Summary

In fiscal year 2019, activity related to Auraria campus operations generated 67,407 metric tons of carbon dioxide equivalents (MT CO2e). This includes emissions related to campus energy consumption, commuting, directly-financed air travel, landfilled waste and a handful of small indirect emissions sources; it does not represent an exhaustive inventory of Auraria's indirect emissions sources, such as embodied energy or supply chain emissions. The portion of emissions generated by building energy use totaled 32,571 MT CO2e in fiscal year (FY) 2019. Put into

KEY STATS

- **64,740 MT CO2e** generated in FY 2019 (Scopes I, II, III)
- **32,571 MT CO2e 22 lb. CO2e/ft² built space** (Scope I and II)
- **3,718 lb CO2e/headcount** (faculty, staff and students)
- **16.4% decrease** from 2008 ACUPCC baseline (Scope I &II)
- **18.5% projected decrease (Scope I & II) by 2020** *without any changes* (just additional library solar production)

perspective, these building-related emissions are generated at a rate of roughly 22 lbs of CO2e per gross square foot of buildings on the Auraria campus (which totaled over 4.3 million square feet in FY2019). Total campus emissions normalized per full-time-equivalent (FTE) pupil (which sums to 38,925 across students, faculty and staff) is 3,718 lbs. of CO2e/FTE. When these emissions are split amongst the three institutions responsible (based on headcount and building occupancy), MSU Denver is responsible for 53%, CU Denver is responsible for 32% and the Community College of Denver (CCD) is responsible for 15%.

Emissions Scopes:

Scope I: Direct, stationary emissions (those combusted on the premises, ie: natural gas, cogeneration, campus power plant)

Scope II: Indirect Purchased Energy (ie: purchased electricity, steam, chilled water)

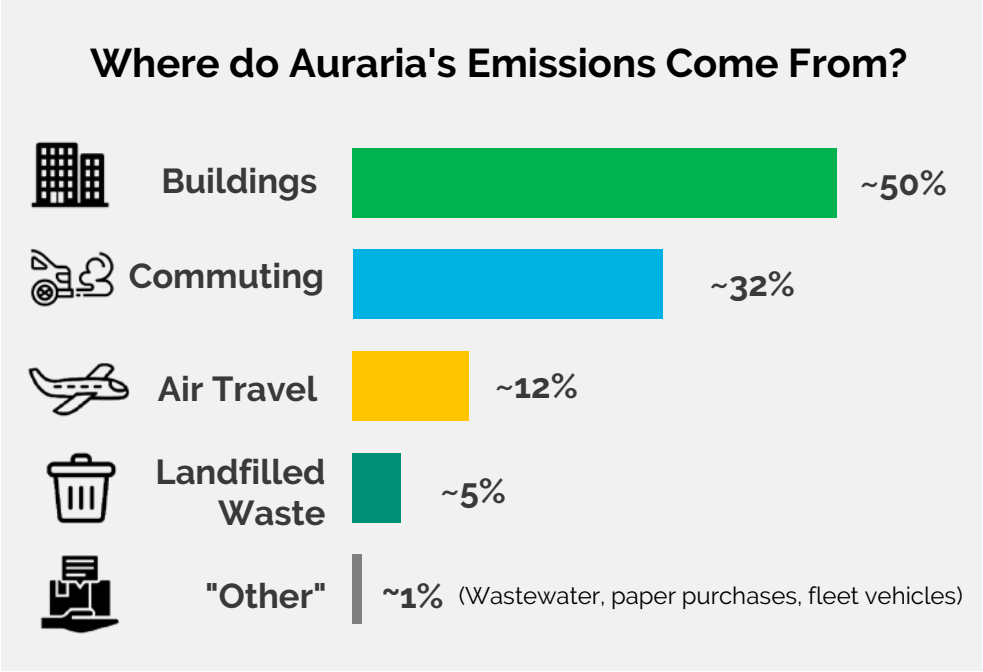
Scope III: Emissions from activities not owned or directly controlled by Auraria, but that wouldn't exist without Auraria (ie: commuting, waste, air travel, paper procurement)

The 2008 ACUPCC Agreement pertains only to scopes I & II

School	% Total	Emissions (MT CO2e)	Scope I & II Emissions (ACUPCC)
MSU Denver	53%	34,961	17,366
CU Denver	32%	20,973	10,418
CCD	15%	9,638	4,787
Total	100%	65,573	32,571

Executive Summary

When broken out by emissions source (by category), 50% of Auaria's emissions are generated by building energy consumption, and a staggering 38% of total emissions are from electricity alone. Thirty-two percent of emissions are generated by commuting behavior to and from campus (automobile, bus and light rail), 12% is generated by directly-financed air travel and 5% is generated from the anaerobic decomposition of landfilled waste. The remaining 1% is comprised of paper procurement, gasoline for fleet vehicles and wastewater treatment. Several emissions sources (ie: supply chain emissions, construction emissions, embodied energy) were not quantified due to lack of time and data and could be investigated in the future.



To limit catastrophic climate change, warming must be limited to 1.5° C (2.7° F).

This means reducing GHG emissions 45% from 2010 levels by 2030, and 100 percent by 2050.

Normalizing emissions per square foot or per full-time-equivalent student offer a means of comparison with other educational institutions. In FY2019 Auraria generated an estimated 20.5 MT CO2e/1,000 square feet and 1.9 MT CO2e per student FTE. When considering *just* building-related emissions (arguably a more relevant metric when normalizing by built square footage), Auraria generated 10.2 MT CO2e/1,000 square feet. When Auraria's normalized metrics are compared with national datasets or peer institutions, the Auraria campus appears to be in the "middle of the pack"—particularly in regards to overall (scope I, II and III) emissions.

In FY2019 Auraria generated an estimated

20.5 MT CO2e/1,000 square feet and 1.9 MT CO2e per student FTE

While Auraria's building-related emissions are slightly lower than the national average and other front range schools, it is worth noting that Auraria, unlike these peer institutions, does not provide 24-hour housing and dining services that require additional electricity, air conditioning and

heating—suggesting that energy efficiency is an area of improvement for this campus. Energy use intensity (EUI) metrics—which define how intensely buildings consume energy—suggest that Auraria lags considerably behind the national average for similar building use types.

While Auraria consumes 93.2 kBtu/square foot on average across its building portfolio, the average college or university building consumes 87.3 kBtu/square foot and the average building at a vocational school consumes 52.4 kBtu/square foot. Based on Auraria's annual energy consumption and expenses, the Department of Energy's ROI calculator suggests that if Auraria operationalizes their energy management information system (EnergyCap) and actively monitors and analyzes energy use (through an Energy Manager), energy consumption could be decreased by 11% (32,863,885 MMBtu) over a two year period, and continue to decrease in the succeeding years. This could save Auraria somewhere in the ballpark of $650,000 a year—over 10% of AHEC's projected FY20 shortfall from lost revenue due to the COVID-19 pandemic.

...energy consumption could be decreased by

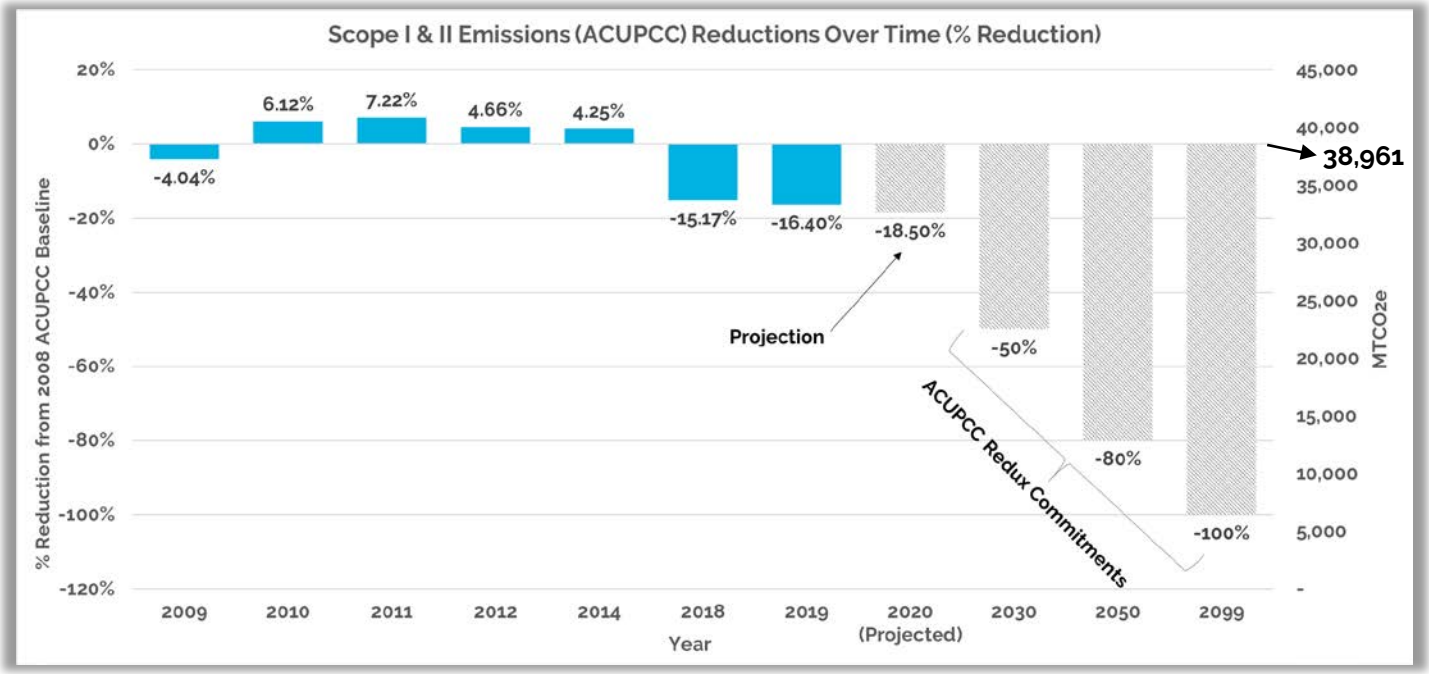
11% over a two year period...

This could save Auraria...

$650,000 a year

—over 10% of AHEC's projected FY20 shortfall from lost revenue due to the COVID-19 pandemic.

In 2007, the three institutions comprising the One Auraria campus signed the American Colleges and Universities President's Climate Commitment (ACUPCC), committing to reduce scope I and II greenhouse gas (GHG) emissions 20% below 2008 levels by the year 2020, 50% by 2030 and 80% by 2050. On the Auraria campus, scope I and II emissions are effectively emissions related to energy consumed in buildings. As of July 2019, Auraria had reduced emissions 16.4% relative to the 2008



baseline; this was almost entirely due to Xcel adding more renewable sources to the local electricity grid that powers the Auraria campus. If energy consumption, commuting behavior and waste generation remain the same in FY2020, the Auraria campus is estimated to achieve an 18.5% reduction from the 2008 baseline, due to partial ownership of Renewable Energy Credits (RECs) associated with the brand new library solar array.* If accurate, this estimate would place Auraria just 1.5 percentage points short of the 2020 ACUPCC commitment.

Climate change and climate action are heating up on the global stage and calls to action are particularly energized by advocacy amongst our global youth—many of whom attend the Auraria campus or will in the near future. The Intergovernmental Panel on Climate Change (IPCC) reports that emissions must be cut by 45% by 2030 and 100% by 2050 to limit global warming to under 1.5° Celsius and therefore avoid catastrophic climate change. Last May, here in Colorado, legislators passed House Bill 1261, requiring adherence to state GHG reduction targets as follows: a 50% reduction from 2005 emissions by 2030 and a 90% reduction by 2080. With the end of FY2020 around the corner, it is time for campus leaders to revisit Auraria's climate commitments and re-commit to even bolder action that is necessary to reduce campus GHG emissions.

House Bill 19-1261: Climate Action Plan to Reduce Pollution

Establishes statewide GHG reduction goals (relative to 2005 baseline):

- 26% reduction by 2025
- 50% by 2030
- 90% by 2050

93%

of surveyed students agree:

"It is important to me that the Auraria Campus prioritize climate action and the reduction of our campus' greenhouse gas emissions."

The next five to ten years will be defining for the issue of climate change. The manner in which this *One Auraria* campus conducts itself over that time frame—as a higher education institution embracing and symbolizing a spirit of ingenuity—will have a lasting impact on the global *One Planet* we share. The ASCP hopes that this report will serve as a blueprint to guide an engaged campus-wide climate action planning process, set to commence this June and conclude by December 2020 with the signing of renewed GHG reduction commitments. It's time to get to work.

*Note: The library array actually offsets ~2.5% of campus electricity consumption (670 MT CO_2e) or ~2% of building emissions. However, until 2040, Auraria only owns 35% of the environmental attributes. For more information, reference footnote 6.

INTRODUCTION

Introduction

According to a special report from the Intergovernmental Panel on Climate Change (IPCC), global warming needs to be limited to 1.5° Celsius to avoid catastrophic climate change[1]. In order to achieve this, the IPCC has declared that greenhouse gas (GHG) emissions must be reduced 45% from 2010 levels by 2030 and reduced 100% by 2050. Over the past few years—and particularly with the recent momentum and visibility of the youth climate movement—cities, companies and academic institutions alike have stepped up to make bold climate and greenhouse gas reduction commitments.

To limit catastrophic climate change, warming must be limited to 1.5° C (2.7° F).

This means reducing GHG emissions 45% from 2010 levels by 2030, and 100 percent by 2050.[1]

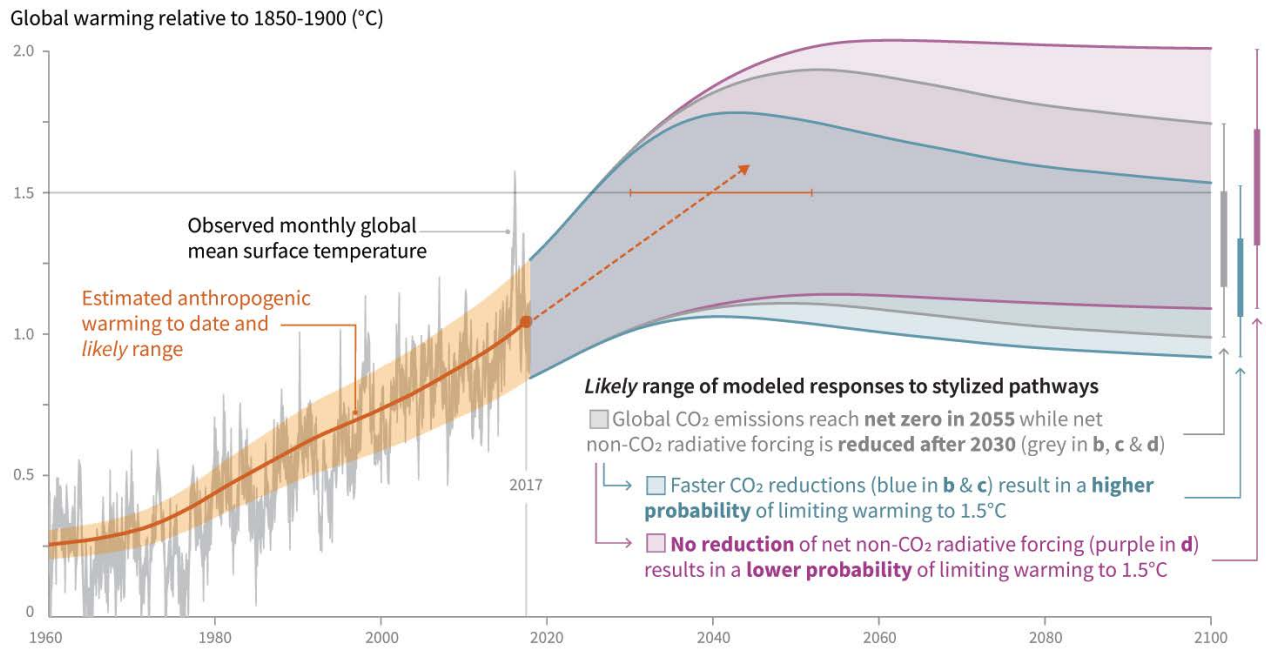


Figure 1: Cumulative emissions of CO2e and future non-CO2 radiative forcing determine the probability of limiting warming to 1.5 C: Observed global temperature change and modeled responses to stylized anthropogenic emission and forcing pathways. As presented in a 2018 IPCC report, "Special Report: Global Warming of 1.5º C."[1]

Just last May (2019), the state of Colorado signed two pieces of legislation into law (Senate Bill 96 and House Bill 1261), requiring mandatory state reporting of GHG emissions and adherence to state GHG reduction targets. These targets include a 50% reduction in emissions by 2030 and a 90% reduction in emissions by 2080. The specific rules and regulations set forth by these two laws will be

[1] IPCC. "Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty." *Intergovernmental Panel on Climate Change*, 2018.

established by July of this year, so it behooved Auraria to conduct a GHG inventory before the end of the fiscal year in preparation to participate. The Auraria Higher Education Center and the three academic institutions comprising the Auraria campus have an opportunity, as community leaders and beacons of innovation, to contribute to these state mandates.

Colleges and universities have a particularly important role to play in the realm of climate action, as they represent roughly 2% of total U.S. GHG emissions[2] and symbolize a youthful spirit of ingenuity that the world needs to lead and tackle "wicked problems" such as climate change. In 2007, a coalition of higher education staff and faculty recognized this call and came together to found the American Colleges and Universities President's Climate Commitment (ACUPCC). Leadership at all three academic institutions comprising the Auraria campus signed this agreement together in 2007, pledging to reduce campus greenhouse gas emissions 20% (below 2008 levels) by 2020, 50% by 2030, and 80% by 2050.

House Bill 19-1261: Climate Action Plan to Reduce Pollution

Establishes statewide GHG reduction goals (relative to 2005 baseline):

- 26% reduction by 2025
- 50% by 2030
- 90% by 2050

The responsibility of conducting and reporting on these commitments has historically fallen to the Auraria Sustainable Campus Program (ASCP)—the campus's student-fee-funded tri-institutional sustainability program. However, due to vacancy and turnover in the ASCP's Sustainability Officer position between 2015 and 2017 and a program focus on program expansion and project implementation over the past five years, the GHG inventory and CAP are considerably outdated (2014 and 2012, respectively). As the ASCP nears the end of the 2020 fiscal year, the program is overdue for a reevaluation of the campus' greenhouse gas emissions and Climate Action Plan (CAP). The ASCP has gained considerable momentum and consistency over the past two years and is now well-poised to deliver these plans in conjunction with the first 2020 ACUPCC benchmark.

The following report presents a comprehensive GHG inventory for Fiscal Year 2019 (June 2018 through July 2019) depicting campus emissions sources. This inventory will serve as the backbone of Auraria's upcoming Climate Action Plan. Therefore, the discussion section also provides high-level strategic guidance to help the ASCP develop a game plan for conducting Auraria's climate action planning effort, based on best practices observed from other colleges and universities. Without visibility, accountability, benchmarking and buy-in from administration, the intended actions of a CAP may never be implemented and the plan may merely serve as an academic exercise. Therefore, suggestions focus particularly on strategies that enable the plan to be effective, implementable, interactive and engaging.

Colleges and universities represent roughly
2% of GHG emissions
in the United States
(~1/4 of California)[2]

[2] Parikhit Sinha, William A. Schew, Aniket Sawant, Kyle J. Kolwaite & Sarah A. Strode. "Greenhouse Gas Emissions from U.S. Institutions of Higher Education." Journal of the Air & Waste Management Association 60, no. 5 (2010): 568-573. DOI: 10.3155/1047-3289.60.5.568.

METHODOLOGY

Methodology

The following section provides an explanation of the numerous methodologies, assumptions and calculations used to estimate campus GHG emissions. A high level of detail and specificity was prioritized in order to serve as a reference guide for future GHG inventories and to provide readers with whatever level of detail they desire. However, the average reader of this report will not be concerned with this level of minute detail. Therefore, this section provides a broad overview of the concepts and tools applied, while the full methodology is located in Appendix 1 as a separate handout.

The Calculator:
The methodology for this GHG inventory was loosely based off of the Sustainability Indicator Management and Analysis Platform (SIMAP), a tool developed and maintained by the University of New Hampshire's Sustainability Institute. This is primary tool recommended by Second Nature—the lead organization supporting the ACUPCC agreement and reporting platform for university emissions—and has become somewhat of an industry standard for conducting GHG inventories amongst higher education institutions. The tool follows the Greenhouse Gas Protocol, a set of accounting standards jointly established by the World Resources Institute and the World Business Council for Sustainable Development. However, in order to maintain a deeper understanding of the emissions factors being used and the calculations being performed, ultimately a custom Excel-based calculator tool was developed to compile emissions data, customize emissions factors and calculate Scope I, II and III emissions. Having our own customized excel tool allows the ASCP to have a more dynamic relationship with the data, maintain better control over the calculations being performed, pinpoint and resolve data errors, and more easily develop and customize the graphics we desire.

As a result of this hybrid model, some emissions were calculated "in house" using our own emissions factors and some were taken from the results of the SIMAP tool (which was also fully completed and uploaded to the web-based tool as a point of comparison). Specifically, emissions related to energy consumption (all of Scope I and II) and commuting were calculated using our own tool and customized, localized emissions factors. These emissions comprise 82% of our total campus GHG footprint. Emissions related to directly financed outsourced travel (air travel), landfilled waste, fleet vehicles, wastewater and paper procurement emissions were pulled from the results generated by the SIMAP tool. Further information on these emissions factors can be found in the web-based SIMAP tool itself. As with past inventories, the financial control model was used to determine organizational boundaries.

Scope and Boundaries:
This inventory represents a well-founded estimate of the GHG emissions associated with the Auraria campus, as it is geographically designated by Auraria Parkway (north), Speer Boulevard (east) and Colfax Avenue (south). The inventory *does* represent emissions associated with MSU's athletic facilities below Colfax and does not include emissions for the three CU Denver Buildings across Speer Boulevard (the Business School, the CU Building/College of Architecture and Planning, and Planning, and the Lawrence Street Center). CU Denver and CU Anschutz have a full-time Sustainability Manager that reports emissions for these three buildings as part of their GHG inventory, while the ASCP reports on CU Denver emissions that occur on the Auraria campus (west of Speer Blvd).

Methodology

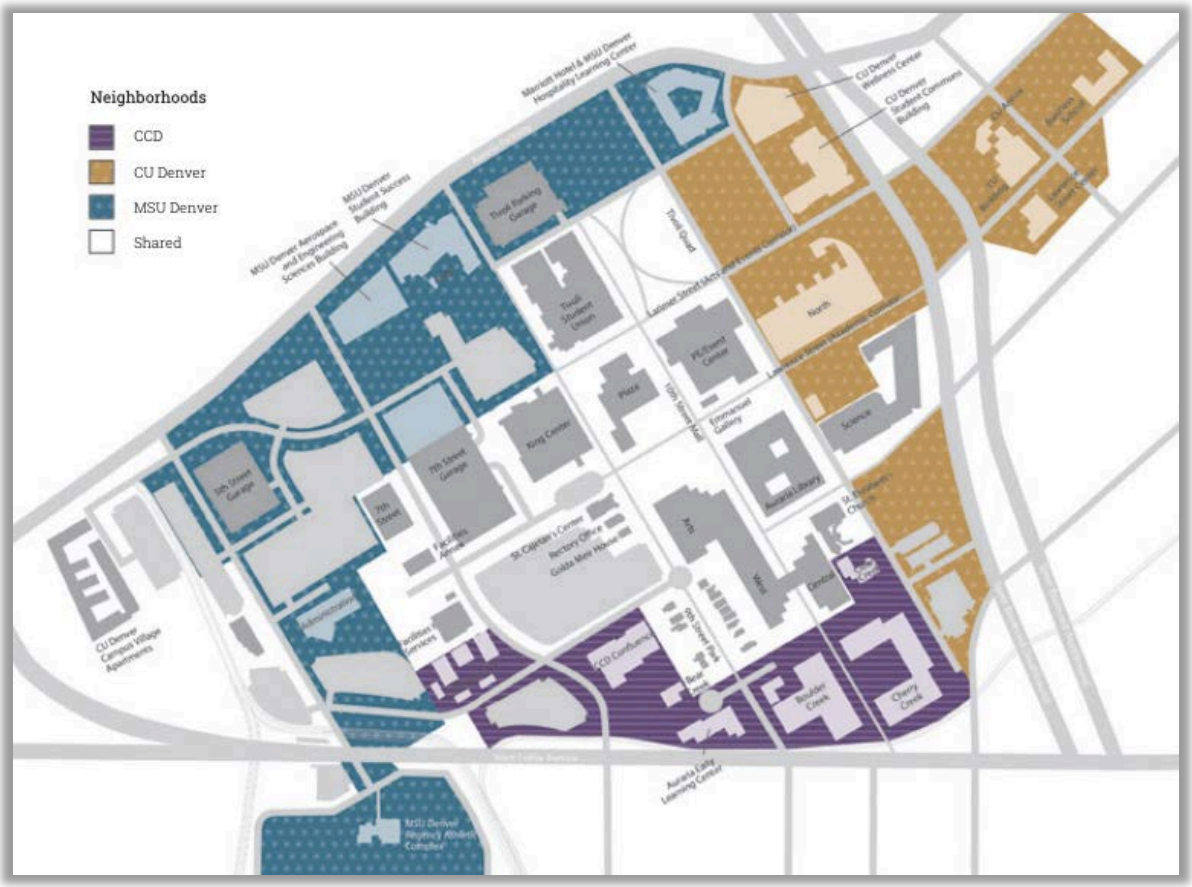


Figure 2: Auraria boundaries defining scope of inventory

Square Footage and Allocating Emissions Across the Three Institutions:
The campus built square footage (measured in Gross Square footage, or GSF) was collected from AHEC's Campus Planning Department via their Archibus database. Square footage was summed across AHEC's shared space (3,650,258 square feet) and institutionally-owned buildings to arrive at a total 4,316,460 square feet[3].

Because AHEC would not exist without the three schools that occupy the Auraria campus, Auraria's emissions have historically been allocated amongst the three schools. In order to maintain continuity and allow for an "apples to apples" comparison, this methodology was utilized again (for context, AHEC's office space represents roughly 7-9% of Auraria's Built Square footage and their staff headcount (315) represents about 0.81% of the total campus headcount). Emissions are divided amongst the three institutions based on their occupancy of Auraria's built square footage and their percent of student headcount.

[3] Up until the 2000s, Auraria's entire building portfolio was comprised of shared buildings (built primarily in the 1970s and 1980s) that served all three schools simultaneously. In the past decade, the three institutions have begun to construct their own additional institutional buildings, including CCD's Confluence Building, MSU Denver's AES and Student Success Building and CU Denver's Student Commons and Wellness Center.

Methodology

In order to determine each school's share of the campus' square footage, AHEC Facilities' utility cost model was utilized. This cost model, provided by AHEC's Campus Engineer, specifies the amount of square footage occupied by each institution amongst all of AHEC's shared buildings and is used to bill the three institutions for utilities and AHEC services. The percentages established by this cost model were applied to the shared square footage from Archibus (3,650,258) to determine *shared* square footage occupied by each school. Then the square footage of *institutional* buildings (ie: MSU Denver's AES building) were added to these three figures to arrive at the *total* campus square footage occupied by each school. Each institution's square footage, when taken as a percent of the total sum of shared GSF plus institutional GSF across all three schools, represents that institution's share of our campus square footage and was used to divvy up emissions related to buildings and energy.[4]

	School	% of Square Footage
2019	MSU Denver	52%
	CU Denver	33%
	CCD	15%
	Total	100%

	School	% of Student FTE
2019	MSU Denver	54%
	CU Denver	31%
	CCD	15%
	Total	100%

	School	% of total headcount (FTE)
2019	MSU Denver	53%
	CU Denver	32%
	CCD	15%
	Total	100%

Table 1: Space and headcount breakdown by school

Emissions related to transportation or per capita behaviors were assigned based on the school's percent of total campus headcount (across students, faculty and staff). Incidentally, when staff and faculty FTE headcount were added in, these two scenarios met in the middle, with MSU Denver accounting for 53%, CU Denver accounting for 32% and CCD accounting for 15%. Therefore, these percentages were applied to total campus emissions to divvy up the reasonability for emissions among the three schools

Reminder: a detailed and comprehensive methodology on how emissions were calculated for buildings/energy, transportation, air travel, waste, wastewater, paper procurement and fleet vehicles can be found in Appendix 2.

[4] There is some discrepancy between the Archibus inventory and AHEC's Master Plan. Per AHEC's Campus Planning Office, the Archibus numbers represent the most recent and most accurate figures and represents gross square footage, whereas the 2017 Master Plan included projected built square footage for incomplete buildings.

RESULTS

(General Overview)

Results

The results of the emissions inventory include Auraria's overall GHG footprint in absolute terms, as well as a breakdown of emissions sources by scope and category. This section also normalizes Auraria's GHG across campus headcount and built square footage and quantifies and places Auraria's emissions in the context of peer institutions and nearby localities. Finally, Auraria's reduction in GHG emissions over time and relative to a 2008 baseline are discussed, as FY2020 is the first reduction benchmark that the three schools committed to by signing the ACUPCC agreement.

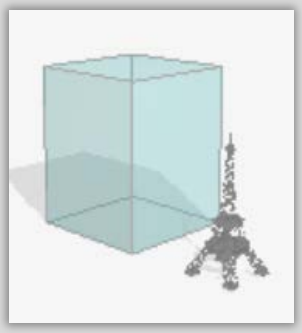
KEY STATS

- **64,740 MT CO_2e** generated in FY 2019 (Scopes I, II, III)
- **32,571 MT CO_2e 22 lb. CO_2e/ft^2 built space** (Scope I and II)
- **3,718 lb CO_2e/headcount** (faculty, staff and students)
- **16.4% decrease** from 2008 ACUPCC baseline (Scope I &II)
- **18.5% projected decrease (Scope I & II) by 2020** *without any changes* (just additional library solar production)

There are three scopes that comprise an emissions inventory:

- **Scope I:** Direct, stationary emissions (those combusted on the premises, ie: natural gas, cogeneration, campus power plant)
- **Scope II**: Indirect Purchased Energy (ie: purchased electricity, steam, chilled water)
- **Scope III:** Emissions from activities not owned or directly controlled by Auraria, but that wouldn't exist without Auraria (ie: commuting, waste, air travel, paper procurement)

While scopes are an important way to report and conceptualize the breakdown of an emissions inventory, many stakeholders prefer to categorize emissions based on the source or locus of control as follows: building energy, commuting, air travel, waste, procurement, etc. For the sake of this report, the three scopes will be discussed briefly here, and categories will be referenced for the remainder of the report, as the average campus stakeholder relates more to these classifications and the solutions we can generate to address each emissions category.



The size of these CO_2 emissions as a box would be[5]:

Volume: 1.22 billion ft^3

Dimensions: ~ 985 x 985 x 1,263 ft

To view an animation of real-time emissions, click here.

[5]Numbers and graphic developed using Real World Visuals:https://www.realworldvisuals.com/.

Emissions Breakdown by Scope:

Scope I and II (Building Energy): Of these emissions, 32,571 metric tons were allocated to Scope I and Scope II emissions, which represent the emissions related to (steam, natural gas and electricity) energy consumed in campus buildings. During fiscal year 2019, Auraria's *conditioned* gross square footage totaled 3,205,851 square feet (parking and non-air-conditioned structures accounted for an additional 1,197,653 square feet), meaning that the Auraria campus' emissions intensity for building-related emissions is about 10.2 MT CO2e/1,000 square feet—a common metric used to normalize and compare emissions across different campuses (see Table 3).

Scope III (Commuting, Air Travel, Waste Treatment, etc.): Emissions related to Scope III represent "indirect" emissions, including commuting to and from campus, directly-financed air travel, waste and wastewater treatment, fuel consumed in fleet vehicles, and supply chain emissions or emissions resulting from procurement decisions (ie: recycled vs. virgin paper). This category could be expanded to provide a more exhaustive review of Auraria's indirect emissions, but for this fiscal year emissions were quantified for data that was readily available (those mentioned directly above). Commuting emissions (the bulk of Scope III) are best conceptualized by normalizing them across the number of full-time-equivalency (FTE) pupils on campus.

Auraria's Scope III emissions intensity is 0.9 MT CO2e/FTE and Auraria's overall emissions intensity (across all three scopes) is 1.9 MT CO2e/FTE.

Emissions by Institution:

Utilizing gross square footage occupancy and total student, staff and faculty headcount, "ownership" and responsibility for these emissions is as follows: MSU Denver owns 34,961 MT (53%), CU Denver

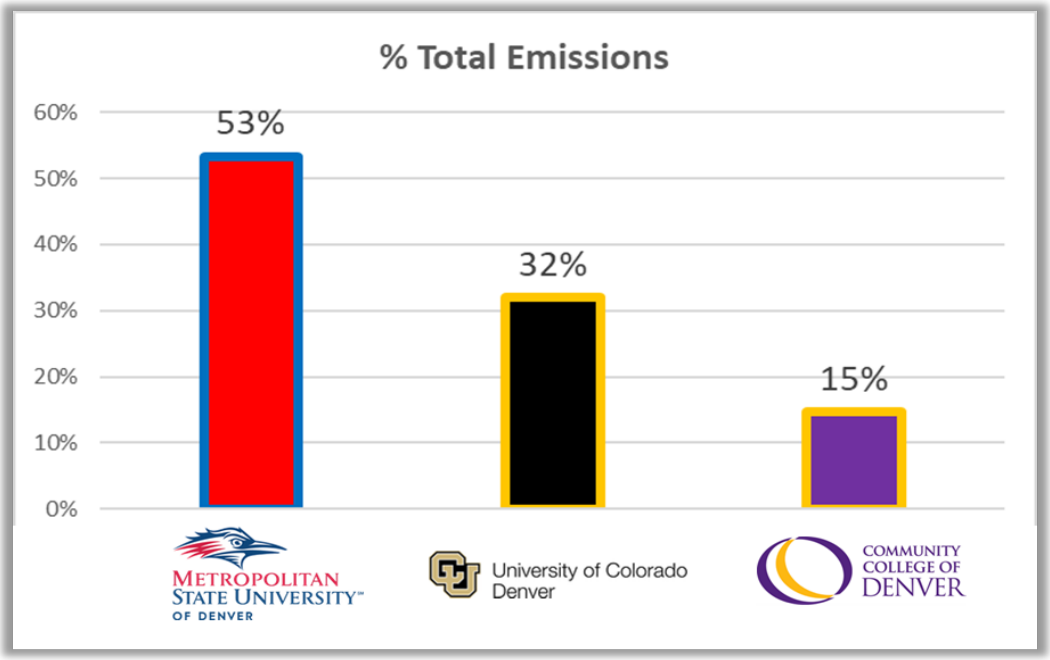


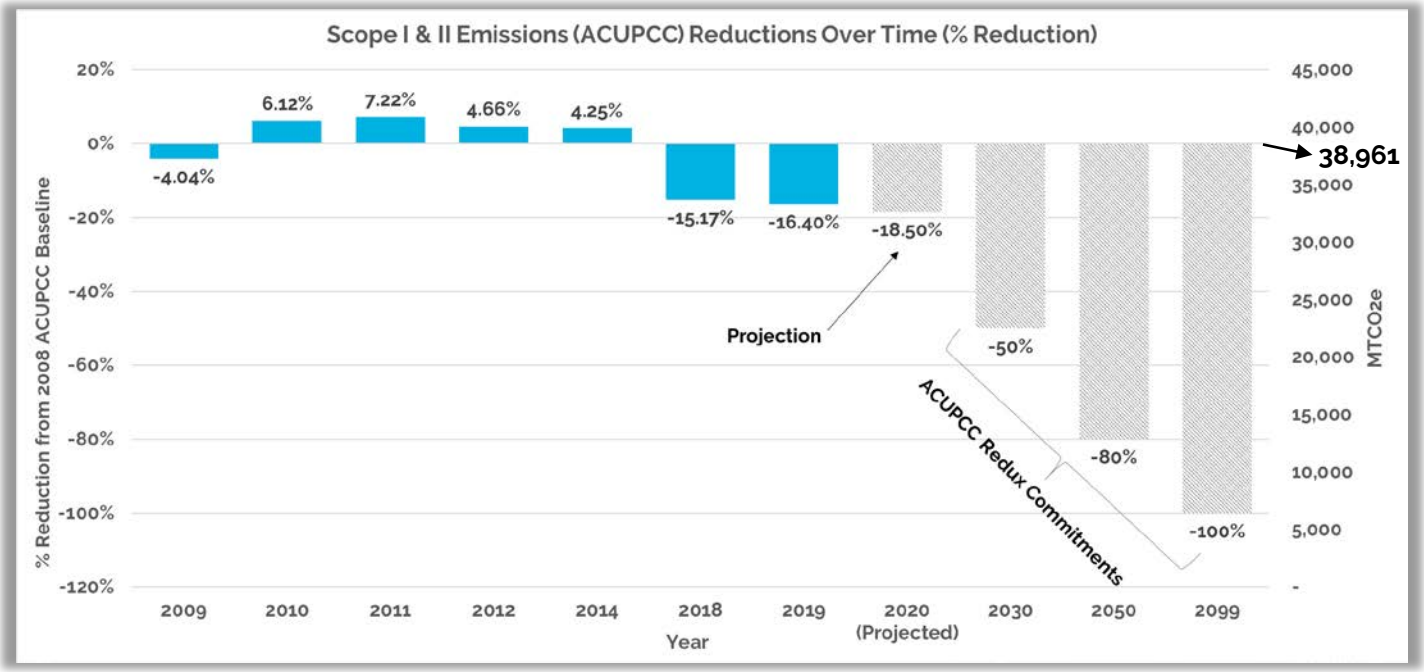
Figure 3: Emissions breakdown by institution

owns 20,973 (32%) and CCD owns 9,638 MT (15%). Because ACUPCC is only concerned with reductions in regards to Scope I and II, those numbers are also included in the table here.

School	% Total	Emissions (MT CO2e)	Scope I & II Emissions (ACUPCC)
MSU Denver	53%	34,961	17,366
CU Denver	32%	20,973	10,418
CCD	15%	9,638	4,787
Total	100%	65,573	32,571

Reductions From Baseline:

The Auraria campus has reduced their Scope I and II emissions 16.4% relative to their 2008 baseline. If energy consumption remains the same in fiscal year 2020, Auraria will hit an estimated 18.5% reduction from their 2008 baseline, just 1.5% shy of the 20% reduction commitment signed by the three schools with ACUPCC in 2007. This additional reduction will be achieved with carbon offsets provided from the new library solar array, which (together with the solar array on the Arts building) will lower our emissions by 345,981 kWh, or 187 metric tons during FY2020[6]. It is estimated that Auraria has reduced their total emissions 10.32% below a 2008 baseline, but estimates were used to fill in Scope III emissions for the 2008 baseline year, as commuting data was the only Scope III data made available for that year.



[6] The library array is actually estimated to produce over one million kWh annually, but Auraria only owns the renewable energy credits (RECs) to 35% of the array's generation. The rest of the environmental attributes are being sold to Xcel for the next 20 years in order to generate revenue to invest in continued development of on-site renewable energy. Auraria also has a 75 kW array on the Arts building that generates about 124,000 kWh per year. In 2040, ownership of the library RECs will transfer back to the ASCP and will increase our renewable energy production credit and offset to 1.24 million kWh a year.

Normalized Emissions:

Normalizing emissions across campus headcount and square footage helps to quantify emissions at a scale the reader can understand and allows for comparison with other institutions. In 2019, Auraria emitted 20.5 MTCO2e per 1,000 square feet and 1.9 MT per full-time-equivalency student. Given that Scope III emissions don't contribute as directly to building maintenance and energy as Scope I and II emissions, it's helpful to note that Auraria's normalized *building-related-only* emissions were actually 10.2 MTCO2e/1,000 square feet.

The table below offers points of comparison among nearby universities, a community college located in a similar climate, and a 2008 average across 90 Masters colleges and universities[7]. Heating-degree-days and cooling-degree-days (dictated by climate and region) have a large impact

Institution	Building Emissions/sq ft (MT CO2e/1,000 Sq Ft) Scope I and II Only	Total Emissions/sq ft (MT CO2e/1,000 Sq Ft) Total Emissions	Scope III/Student (MT CO2e/FTE) Scope III Only	Total Emissions/Student (MT CO2e/FTE) Total Emissions
Auraria	10.2	20.5	0.9	1.9
Average across 29 Masters Colleges and Universities (2011)[7]	10.5	17.3	1.68	4.7
Johnson County Community College (2018)	10.7	21.6	1.0	1.9
University of Denver (2016)	13.8	19.7	2.1	7.0
Colorado State University (2019)	13.8	17.2	1.2	6.2

Table 3: Normalized emissions compared to peer institutions

on campus emissions, so schools from this region were prioritized for comparison. Other important considerations for drawing comparisons with Auraria include the type of school (commuter vs. residential) and setting (urban vs. rural). Following these criteria, square footage and headcount are slightly less important, as numbers are normalized across these metrics. Because laboratories and research facilities use a disproportionate amount of money, a university's research budget is often used to help normalize or compare campuses.

This data suggests that Auraria is performing similarly to a commuter campus in a similar climate (Johnson County Community College). However, when compared to the University of Denver (DU) or Colorado State University (CSU)—which, unlike Auraria, both offer several 24/7 residence halls and dining services—one would expect Auraria's emissions/square foot to fall below these peer institutions, not above. This may suggest that we are not using energy as efficiently as other nearby colleges and universities. For reference, Johnson County Community College is a commuter Associates college located in Overland Park, Kansas, with 21,000 students and 1.9 million gross square feet of buildings.

[7] Klein-Banai, C and Theis, T. L., (2011). Quantitative analysis of factors affecting greenhouse gas emissions at institutions of higher education. *Journal of Cleaner Production, 48*(1), 29-38.

Results

Energy Use Intensity (EUI) is a helpful tool to benchmark building efficiency. In the future, the ASCP hopes to calculate EUI by building instead of as a whole, as building use dictates energy intensity and a college campus is comprised of many different building uses (student union, dining hall, gymnasium, laboratory, office space, etc.). Auraria's EUI across the entire building portfolio (over 45 buildings and 3 parking garages spread across 150 acres), was 93.2 kBtu/square foot and Auraria's source EUI was 284.2. The national average for colleges and universities was 87.3 and 180.6, respectively, in 2018[8]. The fact that Auraria's source EUI is over 50% greater than the national average corroborates the probable conclusion, above, that Auraria is specifically falling behind nearby peer institutions in terms of building energy efficiency. Site EUI signifies the amount of heat and electricity consumed by a building as reflected in utility bills. Source EUI also includes the primary fuel combustion energy (ie: burning coal) required to create secondary forms of energy (electricity). By tracing the heat and electricity requirements of the building back to the raw fuel input, Source EUI accounts for any losses and enables a complete thermodynamic assessment. The EPA recommends that source EUI is the most equitable point of comparison because it uses "national average ratios for the conversion from site to source energy to ensure that no specific building will be credited (or penalized) for the relative efficiency of its energy provider(s)."[9]

	Site EUI (kBtu/sq ft)	Source EUI (kBtu/sq ft)
Auraria	93.2	284.2
Colleges/Universities (U.S.)	87.3	180.6
Vocational Schools	52.4	110.4

Table 4: Source and site EUI of Auraria vs. national average

Points of Comparison (MT CO2e)

Auraria: 64,740 MT CO2e

City of Denver: 12,788,000 (2017, includes embodied energy)

State of Colorado: 126,967,000 (2015)

Median U.S. College[7] (2011): 39,000 MT CO2e

[8] EnergyStar Portfolio Manager. "Technical Reference: U.S. Energy Use Intensity by Property Type" as obtained from "Commercial Buildings Energy Consumption Survey." U.S. Energy Information Administration, August 2018.
[9] EnergyStar Portfolio Manager. "Technical Reference: Source Energy." U.S. Environmental Protection Agency, August 2019.

Local and State Context:

Because absolute emission quantities, on their own, don't mean much to the average campus stakeholder, it is helpful to place them in the context of the surrounding city, state and country. Auraria's emissions represent 0.5% of the scale of the City of Denver's 2017 emissions, which totaled 12,788,000 metric tons CO2e (however, the city's inventory was more exhaustive and accounts for the embodied energy of construction projects). When compared to the emissions of the state of Colorado, Auraria's emissions represent 0.05% of the state's 12,967,000 metric tons.

Emissions Breakdown by Category:

When broken down by emissions *category* instead of scope, Auraria's 2019 emissions breakdown as follows: Building Energy (50%), Commuting (32%), Directly-Financed Air Travel (13%), Landfilled Waste (4.9%) and Other (~1%). "Other" is comprised of the following: AHEC Fleet Vehicles (0.21%), Wastewater Treatment (0.04%) and Paper Procurement (0.73%).

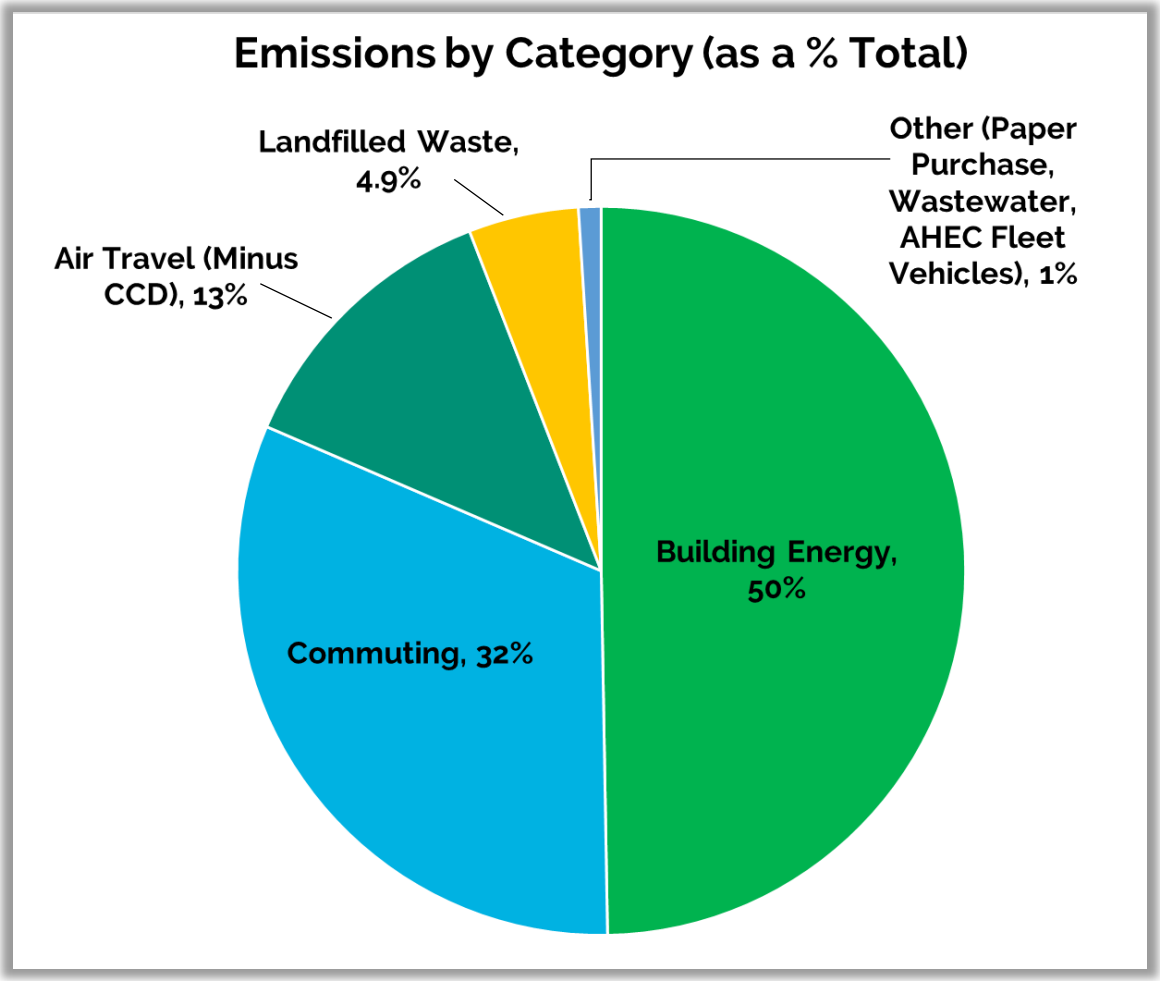


Figure 6: Auraria emissions by category

RESULTS

(Breakdown by Emissions Category)

The Main Components

Buildings **~50%**

- Electricity
- Heating/Cooling

Commuting **~32%**

Air Travel **~12.5%**

Waste **~5%**

Other **1%**

Paper Purchase (0.77%), AHEC Fleet Vehicles (0.22%), Wastewater Processing (0.04%),

Buildings/Energy: 50%

Buildings represent 50% of Auraria's 2019 GHG emissions and are made up of emissions related to the consumption of electricity (79% of energy emissions), natural gas (11%) and steam (10%). As a percent of Auraria's *total* emissions (including transportation and waste), electricity accounts for ~38%, natural gas accounts for ~6.1% and steam accounts for ~5%.

50% Of total Emissions

16.2% From 2008 Baseline

While electricity accounts for 79% of Auraria's energy-related *emissions*, it accounts for only 57% of energy units consumption (see Table 8). This is due to the fact that the emissions intensity (per MMBtu of energy consumed) are not the same for all three sources.

MSU Denver's new AES building and CU Denver's Student Commons Building

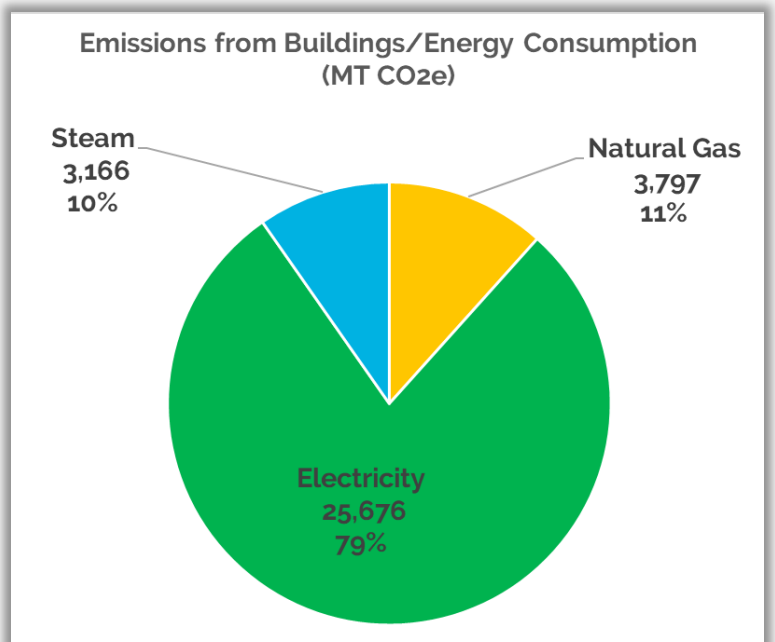


Figure 7: Building energy emissions by energy type

2019 Emissions Factors	
Energy Source	MT CO2e/ MMBtu
Electricity	0.151
Natural Gas	0.053
Steam	0.056

Table 5: 2019 emissions factors

Energy Type	MTCo2e	% of Total MTCO2	MMBtu	% of Total MMBtu
Natural Gas	3,797	12%	71,642	24%
Electricity	25,676	79%	170,450	57%
Steam	3,166	10%	56,671	19%
Total	32,639	100%	298,763	100%

Table 6: Percent of total energy consumption and emissions by energy commodity

Buildings/Energy: 50%

Natural gas has the lowest emissions factor, whereas electricity has the highest (the majority is still produced by fossil fuel combustion and electricity suffers transmission and distribution losses). Steam is similar to that of natural gas because it is now generated by combusting natural gas; formerly it was produced by combusting coal. In fact, the emissions factor for steam went from 0.084 MTCO2e/MMBtu in 2008 to 0.056 MTCO2e/MMBtu in 2019. Therefore, steam emissions have decreased 30% from 2008 levels.

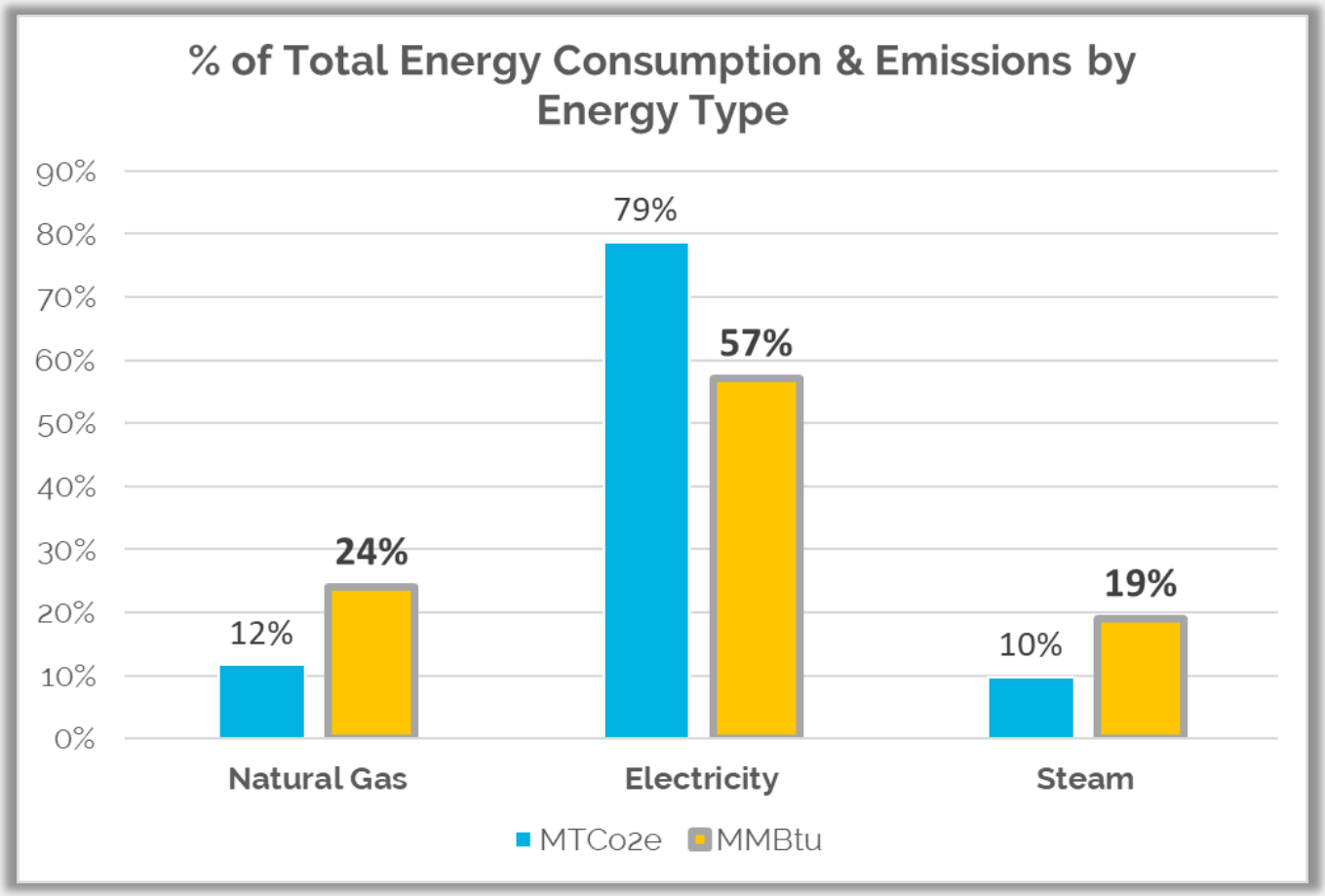


Figure 8: Percent of total energy consumption and emissions by energy type

Natural gas emissions have increased 16% over their 2008 baseline year, largely due to the addition of over one million additional gross square feet of buildings. New buildings recently constructed by the three academic institutions (ie: CU Denver Wellness Center, MSU Aerospace and Engineering Building) are heated with natural gas instead of steam. In fact, AHEC is in the process of switching the campus' shared building portfolio (built primarily in the 1970s and 1980s) from steam to natural gas. This will have minimal, if any, observable emissions reductions which are estimated to be 165 metric tons (or a 0.25% reduction from 2019 levels).

Buildings/Energy: 50%

The majority of energy-related emissions reductions, however, have come from a reduction in electricity related emissions, because electricity represents the largest share of our total energy consumption. While electricity consumption has increased by roughly 19% in the past decade, the related emissions have simultaneously decreased by 21% and energy emissions as a whole have decreased 16.2% since 2008. This is primarily due to the greening of Xcel's electrical grid over the past decade. Since 2008, Xcel has increased the percentage of their generation mix that is derived from renewable sources, lowering the emissions factor associated with electric consumption from 1.698 lbs. CO2e/kWh in 2008[10] to 1.133 lbs CO2e/kWh in 2019[11].

Greening Xcel's Electric Grid

Between 2008 and 2019, Auraria:

~19% Electricity Consumption

~21% Emissions from Electricity Consumption

Fiscal Year	Electricity Usage (kWh)	MTCO2e
2008	40,433,156	32,347
2009	40,531,754	30,115
2010	43,955,138	31,516
2011	45,834,869	34,972
2012	46,942,925	34,456
2013	44,880,157	39,163
2014	48,852,093	42,030
2018	49,285,653	27,058
2019	49,953,863	25,676

Table 7: Auraria electricity consumption and emissions over time

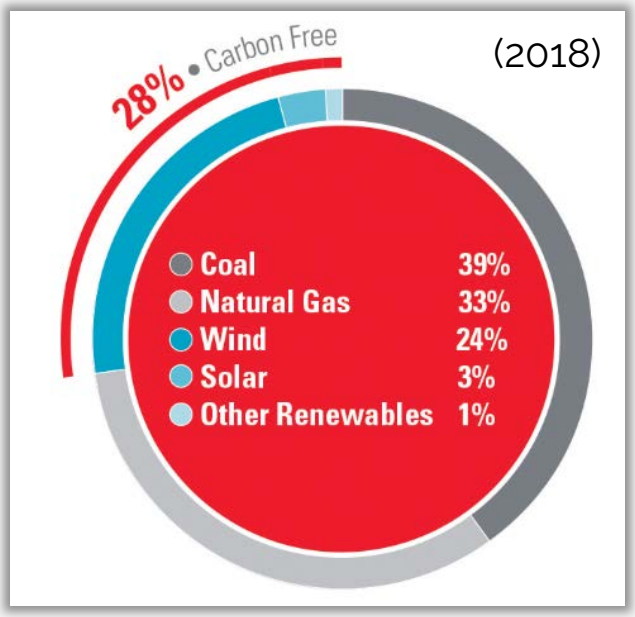


Figure 9: 2018 Xcel electricity generation mix

Xcel Colorado Electricity Emissions Factors (lb CO2e/kWh):

- 2008: 1.698
- 2014: 1.493
- 2019: 1.133

[10] Xcel Energy. (2015). 2014 Carbon dioxide reporting worksheet. Retrieved from https://www.xcelenergy.com/staticfiles/xe/PDF/Environment_2014_CO2_Worksheet.pdf

[11] Xcel Energy. (2020). Carbon dioxide emissions Intensities, 2019 Info Sheet. Retrieved from https://www.xcelenergy.com/staticfiles/xe-responsive/Environment/Carbon/Xcel-Energy-Carbon-Dioxide-Emission-Intensities.pdf

Commuting: 32%

Commuting represents 31.8% of Auraria's total emissions and those commuting emissions are further split amongst the three commute modes that generate greenhouse gasses: automobile (46%), bus (9%) and light rail (45%). As was the case with different energy commodities, different commute modes each have a different emissions intensity. As you can see in Figure 10 and Table 8, automobile travel accounts for 36% of the passenger miles traveled (PMT), but 46% of the commuting emissions generated, whereas light rail accounts for 55% of PMT and only 45% of commuting emissions. Refer to Appendix 1 (Detailed Methodology) to learn more about how emissions factors for these three modes were determined.

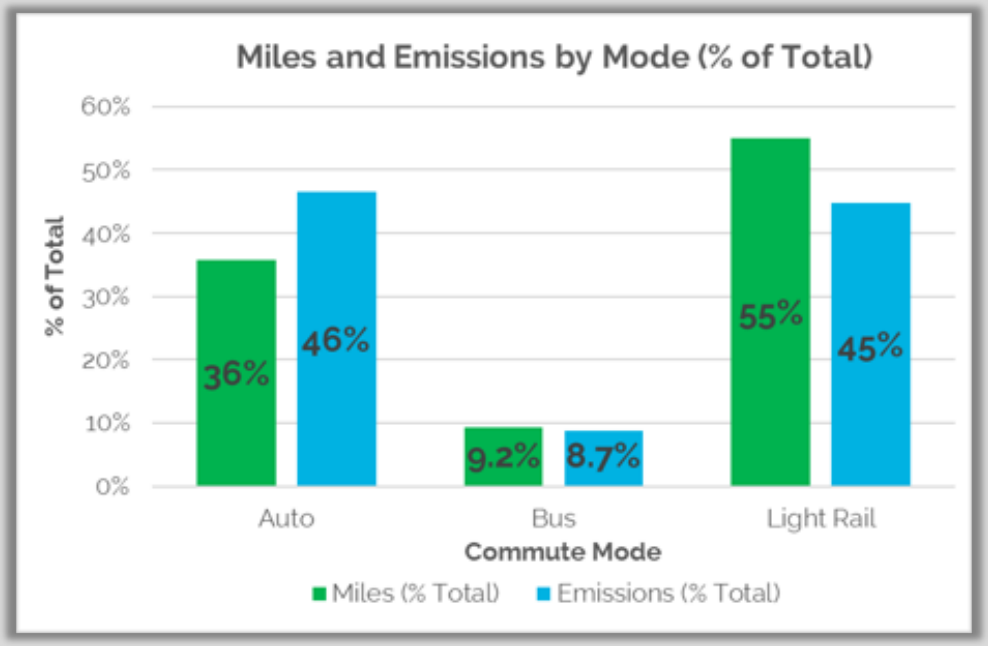


Figure 10: Miles and emissions by commute mode

Commute Mode	Miles Traveled	Miles (% Total)	Trips Across the U.S.	Emissions (MT CO2e)	Emissions (% Total)
Auto	53,592,416	36%	19,126	9,682	46%
Bus	13,778,829	9.2%	4,917	1,819	8.7%
Light Rail	82,376,089	55%	29,399	9,341	45%
Total	149,747,334	100%	53,443	20,841.97	100%

Table 8: Miles vs. emissions by commute mode

Auraria Campus Commuting:[12]

Average Trip Distance:

~15 Miles

Total miles traveled annually:

156 million miles

...that's 55,000 trips across the U.S. **or 325 trips to the moon** and back!

[12] Jackson Shumate, S. (2019). [2019 Auraria Campus Transportation Survey]. Unpublished raw data. This data was obtained from a Transportation Survey conducted by MSU Denver Geography Dept. faculty and students (Fall 2019). There were over 1,700 respondents; 65% were students, 84% of which were full time and 16% part time).

Commuting: 32%

The campus transportation survey (used to calculate these emissions) provides behavioral choices that could be the basis of an entirely separate and lengthy report. For the purposes of this inventory, a few key observations are offered below to provide some insight into Auraria's commuting behaviors and how they affect the campus GHG emissions.

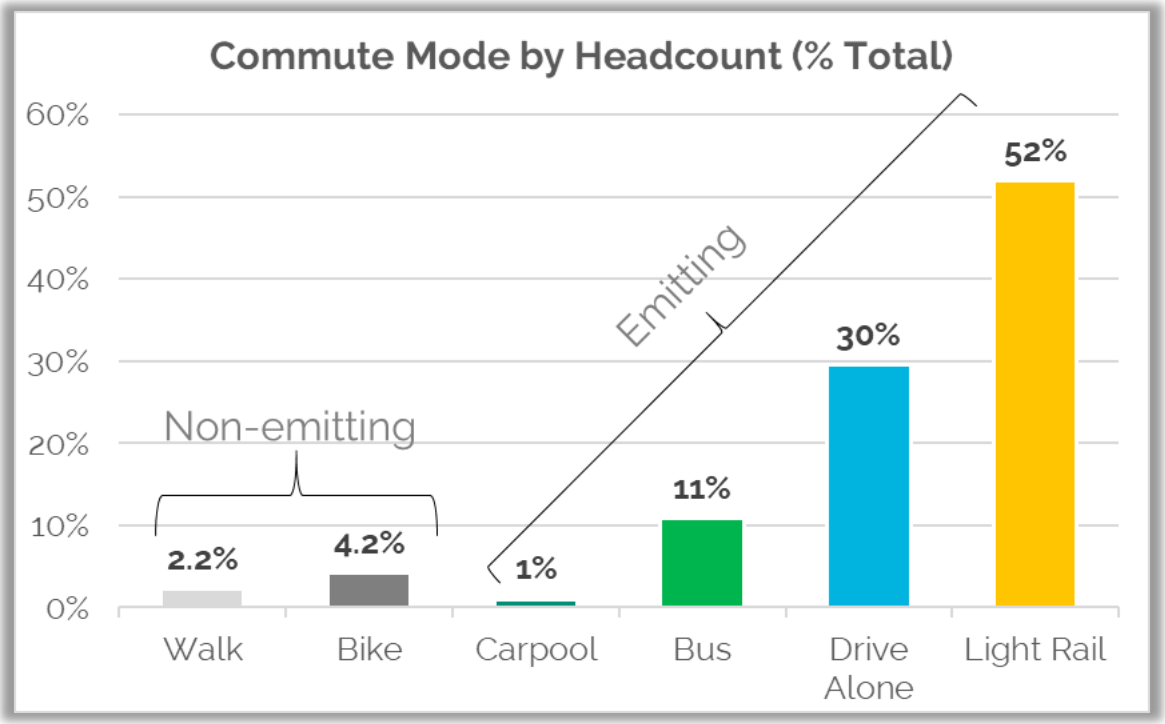


Figure 11: Commute mode by headcount (% total)

	Walk	Bike	Carpool	Bus	Drive Alone	Light Rail
Students	2.1%	4.0%	0.9%	10.6%	29.1%	53.2%
Faculty	4.4%	7.4%	2.5%	12.8%	36.0%	36.9%
Staff	2.5%	5.9%	1.9%	15.2%	32.0%	42.6%
All	**2.2%**	**4.2%**	**1%**	**11%**	**30%**	**52%**

More results from the transportation survey can be found in Appendix 3, and on the resources page of the ASCP website.

A few additional notes on transportation

The occupancy of transit modes (bus and light rail) heavily impacts transit's emissions savings. The more passengers that are riding a bus or train, the lower the emissions per passenger mile. For example, to be more efficient than a single-occupancy vehicle, the average 40-passenger diesel bus must carry a minimum of 7 passengers on board[13]. A bus with 28% of its seats occupied, emits roughly 33% fewer greenhouse gas emissions per passenger mile than the average U.S. SOV, and this efficiency increases to 82% when the bus is fully loaded with 40 passengers[14].

[13] FTA. (2010). "Public Transportation's Role in Responding to Climate Change." US Department of Transportation (USDOT) & the Federal Transit Administration (FTA).

[14] Ibid.

Air Travel (12.5%)

Directly financed outsourced travel represents 12.5% of total emissions. In FY2019, faculty and staff from the four institutions traveled an estimated 19 million miles, generating an estimated 8,292 MTCO2e. Note: purchased air travel data from CU Denver was made available, but MSU Denver's mileage was estimated by applying a formula to their travel-related financial spending. At the time of this report CCD's air travel was not yet obtained. For more detail on how these numbers were calculated, refer to the methodology section.

~19 million miles traveled
~8,292 MT CO2e

	2019 Miles Traveled
CU Denver	8,834,887
MSU Denver + "Other" **	9,991,550
CCD	-
Total	**18,826,437**

Table 10: 2019 air miles traveled by school

**This is an *estimate*. Please see methodology section for detail on how these were calculated.

Landfilled Waste (~5%)

~ 2,070,238 lbs.
of landfilled waste

~3,209 MT CO2e
~4.8% of 2019 emissions

Landfills break down material anaerobically, producing methane—a greenhouse has that is 28x more potent than CO2 (our methane emissions were converted to CO2e)

FY 2019, the Auraria campus sent 2,070,288 lbs. of waste to the landfill (our average diversion rate was ~ 19%). This accounted for about 3,209 MT CO2e, or roughly 4.9% of our total emissions in 2019. When waste is landfilled and decomposed anaerobically, it off-gasses methane—a greenhouse gas that is 28 times more potent than carbon dioxide[15,16]. While some landfills implement methane capture systems, we were informed by our waste hauler, Green For Life (formerly Alpine Waste), that the landfill housing our waste does not[17]. Therefore, the more material we can divert through source reduction, reuse, recycling and composting, the more we can reduce waste-related emissions.

---

[15] The global warming potential (GWP) of methane varies based on the time frame in question. Over 100 years, the GWP of methane is 28 times that of carbon dioxide. Over 20 years, methane's GWP is 86 times that of CO2. See page 714 of the resource cited directly below.

[16] Myhre, G., D. Shindell, F.-M. Bréon, W. Collins, J. Fuglestvedt, J. Huang, D…and Zhang. (2013). Anthropogenic and natural radiative forcing. *Climate change 2013: the physical science sasis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. Retrieved from: https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter08_FINAL.pdf

[17] H. Chaffer (Green For Life). E-mail message to Chris Herr, February 23rd, 2020.

Landfilled Waste (~5%)

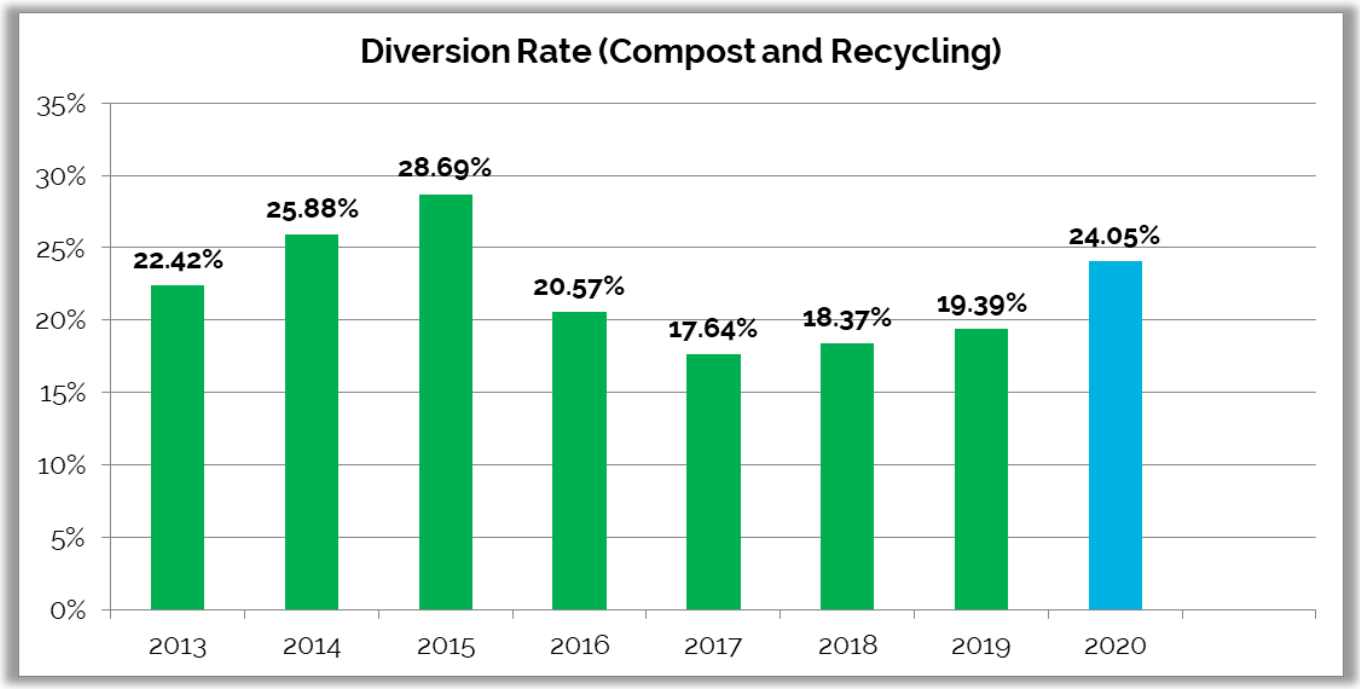


Figure 12: Auraria diversion rate (% of waste diverted to recycle or compost) overt time

The more material we divert from the landfill, the fewer GHG emissions produced!

Check out our monthly and annual waste reports on our reports page.

Other (1%)

There were three sources of emissions that accounted for less than a percentage point and were therefore lumped together in the "other" category. Those are: paper procurement (0.73%), Fleet Vehicles (0.21%) and wastewater (0.04%). Collectively, these sources represent 1% or 658 MT CO2e.

	Amount Consumed	Emissions (MTCO2e)	% Total
Wastewater/ Sewage	45,974,000 (gallons)	24	0.04%
Fleet Vehicles (AHEC Only)	16229 gallons gas	141	0.21%
Paper Procurement	367,009 lbs	493	0.73%

Table 12: "Other" emissions

Paper Procurement: In FY19, Auraria (minus CCD) purchased 367,000 lbs of paper. Most of Auraria's paper consumption consisted of Uncoated Groundwood, which contains 25% recycled content. Sourcing a higher content of recycled paper has a two-fold impact on greenhouse gas emissions: 1) it reduces the amount of energy used to fell and deconstruct the trees and manufacture paper and 2) it reduces deforestation, which allows our natural carbon *sinks* (trees) to remain intact and absorb atmospheric CO2e. The emissions associated with Auraria's paper procurement were taken directly from the results of UNH's SIMAP tool, so emissions factors associated with each paper type were not investigated. However, studies suggest that 100% recycled paper reduces net greenhouse gas emissions at least 38% over virgin paper[18,19].

Other Supply Chain Emissions: Paper was the only procurement item that the SIMAP tool prompted for, so it was the only item investigated in this report. An entirely separate and equally extensive inventory could be conducted on the supply chain emissions associated with the purchasing decisions of the four institutions comprising Auraria, and many would argue that these indirect emissions constitute the largest and most important scope of Auraria's emissions.

	Lbs	% Total
0% Recycled (Paperboard: CUK)	57,525	15.67%
25% Recycled (Uncoated Groundwood)	287,813	78.42%
50% Recycled (Supercalendared)	250	0.07%
100% Recycled (Corrugated Unbleached)	21,422	5.84%
Total	367,009	100%

Fleet Vehicles: Emissions related to AHEC's campus fleet vehicles accounted for 141 MT CO2e (0.21% of total emissions) via the combustion of 16,299 gallons of gasoline. No fleet information was available for the three academic institutions, so this number represents AHEC alone.

Wastewater: In 2019, the Auraria campus sent nearly 46 million gallons of wastewater to Metro Wastewater, which appears to use anaerobic digestion to process wastewater. This contributed an estimated 24 metric tons (0.04% of total) to Auraria's GHG footprint.

---

[18] Smith, R.E. (2011). The Environmental Sustainability of Paper. Graduate Studies Journal of Organizational Dynamics Vol. 1(1). Retrieved from https://repository.upenn.edu/cgi/viewcontent.cgi?article=1003&context=gsjod

[19] It appears the SIMAP calculator used the Environmental Paper Network's Paper calculator to calculate paper-related emissions: https://c.environmentalpaper.org/.

Not Included

Not Included: As mentioned under "Other Supply Chain Emissions" (above), there are several emissions sources that are not considered in this report that may be helpful to investigate as part of an add-on inventory in the future. While it is largely understood that buildings and transportation will likely remain Auraria's two largest emissions sources, the following sources may be pursued in the future to develop a more well-rounded understanding of Auraria's impact on the environment:

Additional Supply Chain/Procurement Emissions (particularly associated with office equipment, appliances, carpet, etc.)

Construction Emissions/Embodied Energy (what are the emissions associated with the construction and related waste of the new buildings being added to campus?)

Food Purchase Emissions (how far did food travel to be sold on this campus, what practices were used during cultivation, harvesting and processing, etc.)—SIMAP has a resource for this

Study Abroad Emissions

Recycling Emissions (the ASCP calculated an estimated emissions factor for campus recyclables)

Propane Fuel (it appeared Auraria does not have propane consumption, but there are propane-powered stoves on campus, so there are likely sources—possibly "de minimus").

DISCUSSION

What's Next?

Discussion: What's Next?

The following section discusses the significance of Auraria's GHG emissions as they relate to existing and future greenhouse gas reduction commitments. Furthermore, this section offers suggestions for conducting a successful, transparent, effective and engaged climate action planning process. This report does not delve deeply into specific steps to reduce GHG emissions—that is reserved for the forthcoming Climate Action Plan, slated to begin in summer 2020. However, given that electricity accounts for a staggering 38% of campus emissions, this section briefly touches on the evident need to invest in energy efficiency and energy management as a clear first step.

Emissions in the Context of Reduction Goals:
As previously discussed, the institutions comprising the Auraria campus signed the ACUPCC agreement in 2008, committing to reduce emissions 20% by 2020, 50% by 2030 and 80% by 2050. Auraria is projected to fall short of this 2020 benchmark (by ~1.5 – 2%), but this cannot be confirmed nor denied until Fall 2020, when utility data is made available to complete the FY20 GHG inventory; the lack of activity on campus during the Spring 2020 semester (due to COVID-19) may slightly decrease emissions from reduced energy use.

Colorado's state statutes were revised last year to require a
26% reduction by 2025, a
50% reduction by 2030 and a 90% reduction by 2050.
It is recommended that the institutions comprising the Auraria campus commit to these goals...

Regardless of where Auraria falls in regards to the ACUPCC agreement, the IPCC and the state of Colorado call for bolder action on climate. Colorado's state statutes were revised last year to require a 26% reduction by 2025, a 50% reduction by 2030 and a 90% reduction by 2050. It is recommended that the institutions comprising the Auraria campus commit to these goals, at a minimum, and explore the plausibility of including a carbon neutrality goal. Rules and regulations related to the two laws passed last year (mandatory GHG reporting and state GHG reduction targets) are set to be established this June and July and will offer more guidance on compliance.

Climate Action Planning: The Path Forward:
This GHG inventory provides the foundation for a campus climate action planning effort, as it provides a clear depiction of the activities from which campus GHG emissions derive. It is critically important that this effort be a collaborative process, undertaken by key stakeholders among all four institutions, in order to ensure that it represents all four institutions and One Auraria. Without visibility, accountability, benchmarking and buy-in, a CAP may never be implemented and may merely serve as an academic exercise. After observing and interviewing other schools about their approach to this process, a set of key recommendations and steps are presented on the next page for consideration.

Discussion: What's Next?

- **Public Buy-In:** Call on the administration at the four institutions to make a public declaration of their intention to participate in this planning effort in order to generate accountability.

- **Directive from "Up Top":** As a part of this public commitment, ask leadership to designate the appropriate key stakeholders (mid-level management, boots on the ground *and* executive staff, where needed) to participate on relevant task force subcommittees.

- **Compile a Task Force with Subcommittees:** Meet on a monthly basis as a whole, and *at least* monthly within subcommittees. Suggested subcommittees could include: Buildings/Energy, Transportation, Water and Grounds, Purchasing and Waste, Academics, Outreach and Engagement. Leverage the existing ASCP Faculty Staff Coalition to commence this process.

- **Define a Timeline:** It is suggested that this process be completed between June 2020 and December 2020, with the goal of re-committing to new reduction targets and beginning the enactment of the plan at the end of calendar year 2020. Key benchmarks of progress should be defined ahead of time and communicated to the task force and the public.

- **Align with International Frameworks:** Align CAP goals with international frameworks (such as the United Nation's Sustainable Development Goals (SDGs), Project Drawdown, etc.) to highlight the campus' actions as part of a global effort to combat climate change.

- **"Bite-Sized" Projects with Project Owners:** If project goals remain too broad (ie: reduce energy consumption by 10%), employees are not empowered or poised to deliver on that goal. Instead, make sure that overarching goals are broken down into tangle projects with designated task owners. Provide task owners with a reporting template to guide the content of their updates at task force meetings.

- **Identify Funding:** While this will likely be impossible for all actions articulated in the CAP, it is critically important that some funding be identified to jumpstart some of these projects—even if that is the identification of a grant opportunity that has not yet been procured. Without the necessary funding, the best of intentions are irrelevant.

Discussion: What's Next?

- **Be Transparent and Engage the Campus Community:** Maintain a webpage that houses meeting minutes, Powerpoint presentations, GHG inventory data and updates on how the plan is progressing. Hold at least one public meeting to gather feedback from community members that are not a part of the task force and/or have a public forum where people can submit dialogue on a webpage (similar to Denver's recent "Consider It" forum).
    - **Host Public Dashboards:** Make the GHG inventory data available through an interactive, public dashboard so that the campus community can "touch and feel" the data themselves.
    - **Include Public Accountability:** Use a tool, such as Airtable, as a project management tool to track the progress of CAP implementation actions and make them visible, as well.

- **Publicly Commit to/Sign GHG Reduction Goals:** Once goals have been agreed upon by task force members, make sure the four institutions take a public stance on achieving them.

- **Integrate An Undertone of Equity:** Diversity, inclusion and equity must be an undertone of this planning process—consider having a separate task force to ensure this remains a consider or inviting a professional to conduct a training sessions with task force members at the onset of this process.

It is critically important that this effort be a **collaborative process, undertaken by key stakeholders among all four institutions**, in order to ensure that it represents all four institutions and One Auraria.

Xcel Carbon Neutral Pathways:
When people learn of Xcel Energy's aggressive goal to achieve 100% carbon neutral electricity supply by 2050 (and 80% by 2030), the following question arises: "If Xcel achieves their carbon neutrality goals, how will that affect Auraria's GHG emissions? If Auraria does nothing, will we still hit our goals because of their progress?" The short answer is that there is not currently enough information available to run that scenario. However, some "back of the envelope" calculations were made to provide a very rough *estimate* of how Xcel's improvements to the electric grid might impact our inventory. This calculation is not scientific and the methodology not approved but rather based on

general logic and assumptions.[20] These numbers should not carry major weight when considering reduction pathway projections.

These calculations suggest that if Xcel hits their goal of 80% carbon free electricity by 2030, and all Auraria consumption and activity remains the same, Auraria *might* observe a 42% reduction in overall emissions (down to 42,501 MT CO2e in 2030) and a 77% reduction in our Scope I and II emissions (down to 8,841 MT CO2e). However, it is also possible that the ASCP increases the scope of the GHG inventory in the future (ie: to include food, supply chain, embodied energy, etc.), which will increase overall emissions and decrease the emissions reductions observed from Xcel's greening of the grid Furthermore, it should be noted that the ACUPCC emissions reductions are absolute—not normalized by square footage. Despite the future build out of campus (ie: CU Denver's new residence hall), total campus emissions must be reduced by a flat percentage decrease across the board. A strategy based around free-riding off of Xcel's progress and failing to reduce Auraria's own energy consumptions does nothing to reduce costs—in fact it exposes the Auraria campus to increasing electricity prices. This strategy also does nothing to reduce demand on the electric grid, which is vital to the future of our rapidly expanding region and our globally shared greenhouse gas emissions.

The Case for Better Energy Management:
Although this report will not jump into climate action solutions in detail, one particular solution is so apparent that it's worth acknowledging immediately: the need for improved energy efficiency on campus. While many of these improvements need to come from investment in retrofits or upgrades to equipment (because Auraria's shared building portfolio is approaching 50 years of age), there are considerable cost savings to be derived just from improved energy management on campus. Based on Auraria's annual energy consumption and expenses, the Department of Energy's ROI calculator suggests that if Auraria operationalizes their energy management information system (EnergyCap) and actively monitors and analyzes energy use (through an Energy Manager), energy consumption could be decreased by 11% (32,863,885 MMBtu) over a

...energy consumption could be decreased by

11% over a two year period,

and continue to decrease in the succeeding years[21].

This could save Auraria...

$650,000 a year

—over 10% of AHEC's projected FY20 shortfall from lost revenue due to the COVID-19 pandemic.

[20]These scenarios were calculated by estimating a 2030 emissions factor for an electric grid with 80% renewable energy based on the average ratio between the percent of renewables on the grid and Xcel emissions factors over the past ten years. Assuming this strategy is remotely accurate, the 2030 emissions factor would be down to around 390 lbs CO2e/Mwh (0.000177 MT CO2e/kWh) under this scenario. Of note: Xcel committed to 100% carbon neutral electricity, not 100% renewable electricity. This means they will utilize advanced nuclear power plants and fossil fuel plants with carbon capture and sequestration. It is uncertain how these resources will impact future reductions in Xcel's electricity emissions factor. Given that Xcel's goal relies on technology that is still being developed, there is zero level of confidence in projecting beyond 2030.

two year period, and continue to decrease in the succeeding years[21]. This could save Auraria somewhere in the ballpark of $650,000 a year—over 10% of AHEC's projected FY20 shortfall from lost revenue due to the COVID-19 pandemic. The fact that Auraria's Energy Use Intensity falls an estimated 50% above the national average further underscores the need for improved energy management. In addition, 54% (or roughly $2.2 million) of Auraria's electricity costs do not even come from electrical consumption, but rather from demand charges that arise when energy is used during peak demand on the grid[22]. By better managing our peak energy demand or enrolling in one of Xcel's Demand Response programs, Auraria has a significant opportunity to lower demand charges and even generate additional revenue (for participating in an Xcel program).

Without operationalizing the current energy management information system or hiring a designated position to monitor energy consumption on campus, the cost benefits described above cannot be realized. The ASCP is prepared to support this position for two years and invest energy savings into a revolving fund to finance future energy efficiency projects. The ASCP implores AHEC and the three institutions to seriously consider an Energy Manager as a first step toward decreasing costs and GHG emissions on campus.

Climate change is no longer a fear on the horizon, it is a reality of the present. However, the severity of that climate change is in our hands. Today's youth—many of whom are already studying here or will be joining this campus in the near future—are watching institutions of higher education and expecting them to both do their part and lead the way. Ninety-three percent of students surveyed in Spring 2020 agreed with the statement "it is important to me that the Auraria Campus prioritize climate action and the reduction of our campus' greenhouse gas emissions," while 96% agreed that "It is important…that the Auraria Campus continue to become more environmentally sustainable."[23] Fifty-two percent of those surveyed said that sustainability had or would have an impact on their choice of college or university.

93% of surveyed students agree:
"It is important to me that the Auraria Campus prioritize climate action and the reduction of our campus' greenhouse gas emissions,"

To avoid catastrophic warming, Auraria needs to do their part to limit warming to 1.5° Celsius[24] by reducing emissions in accordance with Colorado's recent state mandate: 26% by 2015, 50% by 2030 and 90% by 2050. It is time to re-commit to these goals, commence a robust climate action planning process, and lead by example to make our students, faculty and staff proud to call this their One Auraria home.

---

21 The DOE Better Buildings Campaign followed 27 organizations and combined 679 buildings spanning 94 millions square feet and tracked their success in reducing energy usage after installing an EMIS. These are the results (cumulative % reduction of energy use). The results were compiled by Lucid Energy into an ROI calculator that can be found at lucidconnects.com/roi. Auraria's numbers are based on $5.7 million in energy spend across all four institutions and 298 million kBtu annual energy consumption.

22 Ross, Ken. Auraria Higher Education Center Facilities Management. E-mail messages received summer 2018. (Based on conversation with Ken Ross during compilation of 2018 Solar PV Road Map).

23 Out of 170 responses. This is part of an ongoing survey conducted annually by the ASCP.

24 IPCC, 2018.

Climate change is no longer a fear on the horizon,
*it is a reality of the **present**.*

TOGETHER

WE

CAN

DO

THIS

Glossary

- FTE – Full Time Equivalencies
- GHG – Greenhouse Gas
- CAP – Climate Action Plan
- ACUPCC – American College and University's Presidents' Climate Commitment
- CCD
- CU Denver
- MSU Denver
- GSF (Gross Square Footage)
- MTCO2e – Metric Ton of CO2e (Carbon Dioxide) Equivalent
- PMT – Passenger Mile Traveled
- VMT – Vehicle Mile Traveled
- SOV – Single Occupancy Vehicle

Appendix 1: Detailed Methodology

The following section provides an explanation of the numerous methodologies, assumptions and calculations used to estimate campus GHG emissions. A high level of detail and specificity was prioritized in order to serve as a reference guide for future GHG inventories and to provide readers with whatever level of detail they desire. Because the average reader of this report will not be concerned with this level of minute detail, the full methodology has been moved to Appendix 2 and this section provides a broader overview.

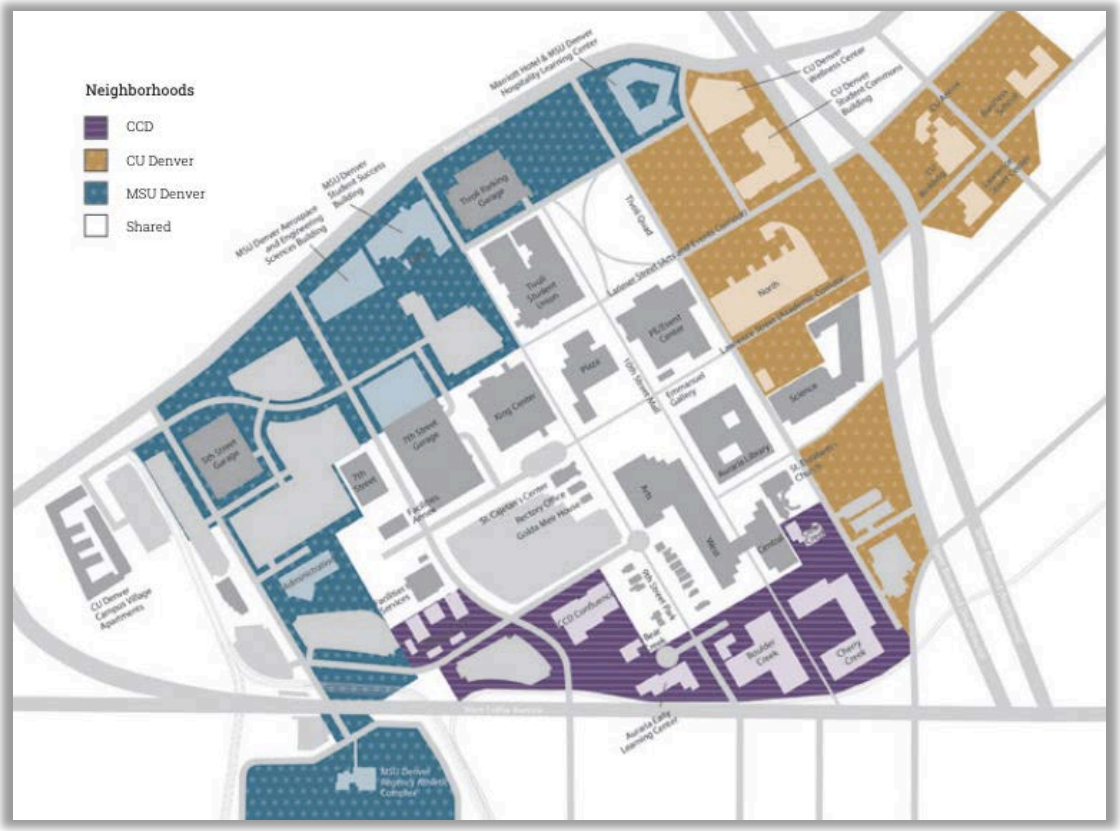
The methodology for this GHG inventory was loosely based off of the Sustainability Indicator Management and Analysis Platform (SIMAP), a tool developed and maintained by the University of New Hampshire's Sustainability Institute. This is primary the tool recommended by Second Nature—the lead organization supporting the ACUPCC agreement and reporting platform for university emissions—and has become somewhat of an industry standard for conducting GHG inventories amongst higher education institutions. The tool follows the Greenhouse Gas Protocol, a set of accounting standards jointly established by the World Resources Institute and the World Business Council for Sustainable Development. However, in order to maintain a deeper understanding of the emissions factors being used and the calculations being performed, ultimately a custom Excel-based calculator tool was developed to compile emissions data, customize emissions factors and calculate Scope I, II and III emissions. Having our own customized excel tool allows the ASCP to have a more dynamic relationship with the data, maintain better control over the calculations being performed, pinpoint and resolve data errors, and more easily develop and customize the graphics we desire.

As a result of this hybrid model, some emissions were calculated "in house" using our own emissions factors and some were taken from the results of the SIMAP tool (which was also fully completed and uploaded to the web-based tool as a point of comparison. Specifically, emissions related to energy consumption (all of Scope I and II) and commuting were calculated using our own tool and customized, localized emissions factors. These emissions comprise 82% of our total campus GHG footprint. Emissions related to directly financed outsourced travel (air travel), landfilled waste, fleet vehicles, wastewater and paper procurement emissions were pulled from the results generated by the SIMAP tool. Further information on these emissions factors can be found in the web-based SIMAP tool itself. As with past inventories, the financial control model was used to determine organizational boundaries.

Due to the unique quad-institutional nature of our campus, data was gathered from *numerous* sources at departments across all four institutions. The remainder of this section describes those sources and explains the methodology and calculation assumptions pertaining to each major category of emissions. Data sources were primarily identified using the SIMAP User Guide and Auraria's prior GHG inventories.

Scope and Boundaries: this inventory represents a well-founded estimate of the GHG emissions associated with the Auraria campus, as it is geographically designated by Auraria Parkway (north), Speer Boulevard (east) and Colfax Avenue (south). The inventory *does* represent emissions associated with MSU's athletic facilities below Colfax and *does not* include emissions for the three CU Denver

Buildings across Speer Boulevard (the Business School, the CU Building/College of Architecture and Planning, and the Lawrence Street Center). CU Denver and CU Anschutz have a full-time Sustainability Manager that reports emissions for these three buildings as part of their GHG inventory, while the ASCP report on CU Denver emissions that occur on the Auraria campus (west of Speer Blvd).



Institutional Data

In order to normalize our GHG emissions by a unit (per capita, per square foot, per $ spent, etc.), the following information was collected: headcounts of students, faculty and staff; built square footage; operating budget; and energy budget.

Headcounts: Headcounts for students, faculty and staff were primarily collected from the offices of Institutional Research and Human Resources. All headcounts (student, faculty and staff) are calculated to Full-Time-Equivalencies (FTEs). Where information was not received in FTEs, part time students and personnel were counted as a 0.5 FTE to adjust accordingly. Additional notes:

- CCD Student enrollment and faculty headcount were obtained from CCD's public datasets. Staff counts were obtained from their Office of Institutional Research.
- CU Denver FTE data was provided by their Office of Institutional Research. To exclude students primarily taking courses on the east side of Speer Blvd, the total headcount was multiplied by the % of course enrollments occurring in buildings on the Auraria side of Speer. Those percentages were 72.4% and 73% for FY18 and FY19, respectively. This avoids overstating the student population that is contributing to emissions at Auraria.

Budget: Operating budgets were provided by AHEC's Chief Financial Officer, CU Denver's Budget Office (via contact with the Office of Institutional Research) and MSU Denver's Chief of Staff. We were unable to obtain an operating budget for CCD.

Energy budget: Energy budget includes any money spent on electricity, natural gas or steam. Most of Auraria's energy spend is billed to AHEC Facilities and then distributed to the three institutions based on their occupancy of square footage. AHEC's Campus Engineer provided AHEC's energy budget. Additional energy spend occurring at one of the three institutions (for example, natural gas purchased on a separate supply contract) represents energy that is purchased directly from a utility provider (ie: nTherm, Xcel) and usually represents energy consumed in a newer institutional building. Institutional energy spend outside of AHEC was obtained from MSU Denver's Chief of Staff and CU Denver's Executive Director of Facilities. It is believed that CCD did not have additional energy spend outside of AHEC's utility contracts.

Square Footage and Allocating Emissions Across the Three Institutions

The campus built square footage (measured in Gross Square footage, or GSF) was collected from AHEC's Campus Planning Department via their Archibus database. Square footage was summed across AHEC's shared space (3,650,258 square feet) and institutionally-owned buildings to arrive at a total 4,316,460 square feet.[1]

Because AHEC would not exist without the three schools that occupy the Auraria campus, emissions have historically been allocated amongst the three schools based on their occupancy of Auraria's built square footage and their percent of student headcount. In order to maintain continuity and allow for an "apples to apples" comparison, this methodology was utilized again. For context, AHEC's office space represents roughly 7-9% of Auraria's Built Square footage and their staff headcount (315) represents about 0.81% of the total campus headcount. These two metrics were dispersed amongst the three schools based on the percent of square footage occupied by each school.

In order to determine each school's share of the campus' square footage, AHEC Facilities' utility cost model was utilized. This cost model, provided by AHEC's Campus Engineer, specifies the amount of square footage occupied by each institution amongst all of AHEC's shared buildings and is used to bill the three institutions for utilities and AHEC services. The percentages established by this cost model were applied to the shared square footage from Archibus (3,650,258) to determine *shared* square footage occupied by each school. Then the square footage of *institutional* buildings (ie: MSU Denver's AES building) were added to these three figures to arrive at the *total* campus square footage occupied by each school. Each institution's square footage, when taken as a percent of the total sum of shared GSF plus institutional GSF across all three schools, represents that institution's share of our campus

[1] Up until the 2000s, Auraria's entire building portfolio was comprised of shared buildings (built primarily in the 1970s and 1980s) that served all three schools simultaneously. In the past decade, the three institutions have begun to construct their own additional institutional buildings, including CCD's Confluence Building, MSU Denver's AES and Student Success Building and CU Denver's Student Commons and Wellness Center.

square footage and was used to divvy up emissions related to buildings and energy[2]. Emissions related to transportation or per capita behaviors were assigned based on the school's percent of total campus headcount (across students, faculty and staff).

In 2019 (very similar to most years prior), MSU Denver occupied 52% of gross square footage (GSF) and 54% of student headcount; CU Denver accounted for 33% of GSF and 31% of headcount and CCD accounted for 15% by both metrics.

	School	% of Square Footage
2019	MSU Denver	52%
	CU Denver	33%
	CCD	15%
	Total	100%

	School	% of Student FTE
2019	MSU Denver	54%
	CU Denver	31%
	CCD	15%
	Total	100%

Incidentally, when staff and faculty FTE headcount were added in, these two scenarios met in the middle, with MSU Denver accounting for 53%, CU Denver accounting for 32% and CCD accounting for 15%. Therefore, these percentages were applied to total campus emissions to divvy up the reasonability for emissions among the three schools.

	School	% of total headcount (FTE)
2019	MSU Denver	53%
	CU Denver	32%
	CCD	15%
	Total	100%

<u>Buildings/Energy</u>

Data Collection

Electricity consumption was provided directly by Xcel Energy, while steam and natural gas consumption were provided by our Campus Engineer via reports run from our EnergyCap energy management database. Energy consumption outside of AHEC's serviced spaces or related to new institutional buildings that established direct billing contracts with utilities (particularly, natural gas for MSU Denver and CU Denver's new buildings and electricity for some of MSU Denver's athletic facilities and new buildings) were retrieved from the facilities departments at MSU Denver and CU Denver and added into the total energy consumption.

Emissions Factors

[2] There is some discrepancy between the Archibus inventory and AHEC's Master Plan. Per AHEC's Campus Planning Office, the Archibus numbers represent the most recent and most accurate figures and represents gross square footage, whereas the 2017 Master Plan included projected built square footage for incomplete buildings.

Each energy commodity is assigned an emissions factor (lb or metric ton of CO2e) per unit of energy consumed (kWh, therm, lb, MMBtu, etc). The emissions factors for electricity for FY18 and FY19 were provided by Xcel Energy's 2018 and 2019 Carbon Dioxide Emissions Intensities reports. At the time of this report, Xcel had not yet published their official 2019 emissions factors for electricity, so projected emissions factors from the 2019 report were utilized. The emissions factor for natural gas (0.0053 MTCO2e/therm) was based on the Environmental Protection Agency's (EPA) Greenhouse Gas Equivalencies Calculator sources[3]. The emissions factor for steam (123.16 lbs/MLB) was provided by AHEC's Xcel Energy Account Manager via direct communication[4]. The consumption values of each of the three energy commodities were multiplied by their respective emissions factors obtain the metric tons of CO2 equivalent (MTCO2e) produced by that fuel use.

Transportation

Data Collection

Transportation emissions were calculating using the commuter element of the SIMAP tool and adapted into Auraria's GHG report. Campus commuting data was based on a 2019 transportation survey, conducted by faculty and students among MSU Denver's Earth and Atmospheric Sciences department[5,6]. The survey had over 1,700 respondents across all four institutions and all three user groups (faculty, staff and students). This survey provided the following information for each of the three user groups (faculty, staff, students):

- Weekly one-way trips to campus (7.02, 9.07 and 6.6, respectively)
- % of user group taking each mode (walk, bike, light rail, bus, carpool, drive alone)
- Average miles traveled via each mode

It was assumed that students commute to campus 32 weeks a year, faculty commute 35 weeks a year and staff commute 50 weeks a year. This data was entered into the SIMAP tool to calculate the emissions associated with the commute mode of each user group.

For further detail on the assumptions and methodology used to calculate transportation related emissions, please see Appendix 1.

Emissions Factors

The three modes of travel that produce GHG emissions are the bus, light rail and automobile (driving alone or carpooling). The emissions factors used for each of these three modes are depicted in the table here below, where PMT represents Passenger Mile Traveled:

[3] EPA. "Greenhouse Gases Equivalencies Calculator - Calculations and References." U.S. Environmental Protection Agency, Washington, DC. 2019.
[4] Melanie Gavin (Xcel Energy), e-mail message to Jackie Slocombe, February 27, 2020.
[5] Jackson Shumate, S. (2019). [2019 Auraria Campus Transportation Survey]. Unpublished raw data.
[6] This study has not been published, but some data is being housed on the ASCP Research page.

Mode	Lbs CO2e/PMT
Auto	0.8
Bus	0.58
Light Rail	0.5

These emissions factors numbers represent *best estimates* for these three modes as they relate to travel *in the metro Denver area*, and were determined after considerable research and outreach to nearby reporting entities.

The bus emissions factor (0.582 lbs/passenger mile) was taken from a 2010 report from the Federal Transit Authority specifying Denver RTD diesel busses[7]. The light rail emissions factor was taken as a combination of the emissions factor for RTD light rail specified in this same 2010 report[8] (0.683 lbs/PMT) and the national average for major U.S. light rail systems (0.365), based on the assumption that the efficiency of Denver's light rail has improved since 2010 (where it was almost twice the national average). This is likely, due to probable increased ridership (assumed to be only 22% at the time of this report) and the addition of renewables to the Xcel Energy electric grid—which powers RTD's light rail—between 2010 and 2019. While the average of the two values mentioned above was 0.524, the factor was adjusted down to 0.5 to account for these factors and for the sake of simplicity. The emissions factor for automobiles was based off the city of Denver's 2017 GHG Inventory. An average fuel efficiency of 24.3 miles per gallon (mpg) was assumed for FY19, representing a conservative 1% increase from the fuel efficiency used in the City of Denver's 2017 GHG inventory (24.1 mpg)[9]. These emissions factors were applied to the PMTs associated with each of the three polluting modes to calculate their respective emissions.

Only half of the emissions associated with commuting were allocated to the Auraria campus, per the methodology used in previous GHG inventories. Dividing commuting emissions between the city of residence and the workplace prevents double-counting of GHG emissions and evenly distributes travel demand between a person's workplace and residence[10]. In order to determine the percent of commuting emissions allocated to each of the three institutions, the institutions share of total headcount (across faculty, staff and students) was multiplied by the commuting emissions.

Further Clarification on Commuting Emissions Calculations:
Previous Auraria GHG inventories used the same fuel efficiency between 2008 and 2014. Given the national increases in fuel efficiency due to President Obama's CAFE standards and trade-in policies, the author did not agree with this approach and therefore adjusted the transportation emissions from previous emissions inventories. Specifically, VMT were recalculated for these year by dividing the

[7] FTA. "Public Transportation's Role in Responding to Climate Change." US Department of Transportation (USDOT) & the Federal Transit Administration (FTA), 2010. (See pg. 13).
[8] Ibid. (See pg 12).
[9] City and County of Denver / Department of Public Health & Environment. "2017 Denver GHG Inventory." City of Denver Open Data Catalog, 2017.
[10] Anu Ramaswami, Tim Hillman, Bruce Janson, Mark Reiner, and Gregg Thomas. "A Demand-Centered, Hybrid Life Cycle Methodology for city-Scale Greenhouse Gas Inventories." *Journal of Environmental Science and Technology* 42, no. 17 (2008), 66455-6461.

gallons consumed (pg. 25 of the 2012 GHG inventory) by the fuel efficiency assumed for that inventory, and then dividing those VMT by a new fuel economy.

A note on student emissions and student headcount: The total student headcount (44,000) was used to quantify student-related GHG emissions instead of FTE headcount (34,867). Eighty-four percent of students surveyed were full-time students and only 16% were part-time when, in reality, roughly 42% of Auraria's students are classified as "part time." However, both Auraria's full and part time students commute to campus, and not at a much different frequency (many of Auraria's *full-time* students only commute to campus two to three days a week). Furthermore, the transportation survey asks participants the number of weekly one-way trips they make, so hypothetically the total trips/student averages out to reflect the fact that some students are part time and only commute to campus fewer days. Therefore, no adjustments were made to normalize for part time status. While this may *slightly* overstate student-related commuting emissions, the next assumption (described below) may slightly *understate* student-related emissions, so it's quite possible the two balance each other out.

Institutional headcount data suggests that over 12,000 students (27% of fall/spring headcount) enroll in summer classes. However, the transportation survey did not solicit responses on summer commuting behavior and therefore, it was not possible to precisely account for students' summer commuting emissions. Instead, one additional commuting week was added across the entire student population. This should be a fairly accurate estimation of summer commuting because a typical summer class runs for 8 weeks, but with about a quarter of the student body community and roughly half the frequency (students usually take fewer courses in summer). In other words, summer emissions would account for about one eighth (1/4 x 1/2) of a commute week during the spring/fall semesters.

A Note on Assumptions Made from Transportation Survey Data:
Sara's transportation survey split out light rail, bus and bike options into subcategories that involved a combination of modes.

- Light rail
    - Light rail only
    - Light rail + bus
    - Light rail + walk
- Bus
    - Bus only
    - Walk and bus
- Bike
    - Bike only
    - Bike and light rail
    - Bike and bus

In order fit our data within the parameters of the SIMAP tool (which does not get this granular), we assumed that the primary commute mode in the subcategories for the light rail were comprised of light rail travel (not walking or busing) and that the primary mode in the bus subcategories were bus. Therefore, these distances and # of trips were all lumped into "light rail" and "bus" respectively.

Because there were so few responses for “bike + light rail” or “bike + bus,” we redistributed these commute counts into the bike category, but only used the distances associated with “bike only” responses to represent out biking category. We believe this approach to be imperfect, but very representative of our mode split based on past surveys and other quantitative analysis we performed on the transportation data. In the future, we will work more closely with our transportation survey administrators to make sure this data can be parsed out as we need it.

There were also 320 entries in the transportation survey reporting a combination of “driving + ____” (light rail or bus). These *tallies* were counted toward light rail/bus *counts*, but the mileage from these trips were not included in the average commute distance for that mode—they were excluded from the data set so as to not overstate the distance traveled by bus or light rail.

<u>Air Travel</u>

Data Collection

Directly-financed travel emissions (mainly airfare for business travel, conferences, etc.) were calculated by obtaining travel data (either miles or spend) from the institutional procurement offices. CU Denver’s air travel data reflects actual air miles traveled, as provided by their procurement reporting (made available by the University of Colorado Sustainable Procurement Program Manager). MSU Denver’s miles were estimated based on travel spend for faculty/staff because MSU Denver’s procurement tracking system was unable to separate flights from travel-related expenses (conference fees, per diem, hotel fees) prior to 2019. Therefore, MSU Denver’s spend likely over represents staff *travel*. However, due to the fact that data was not able to be collected from CCD, this larger value was maintained to offset an underrepresentation of air-travel emission rom CCD. AHEC’s air travel was de minimus and therefore not included here.

MSU Denver’s 2019 travel spend was partly extrapolated. 2019 data represents 6 months of data (from the second half of 2019) that was collected in MSU Denver’s newer procurement database (which allows them to track flights separately) and scaled up (by ~ 50%) to represent 12 months of flights.

In order to convert MSU Denver’s financial spend to miles traveled, the average of the ratio between CU Denver’s 2018 and 2019 mileage (miles) and spend ($) was calculated to obtain an estimated mile/$ multiplier. This multiplier was then applied to MSU Denver’s spend ($) to calculated the estimated miles associated with their travel budget.

Note: MSU had an additional $300,000 of travel-related expenses billed for students, too, but those were not included because CU Denver’s student spend was not included. Hopefully this compensates a little for the fact that we could not extricate the conference and hotel fees from MSU’s spend and for the fact that we didn’t include air travel for CCD. AHEC’s travel for any purchases spent on a p-card was provided but so de minimus it was not included here. It’s probable that AHEC employees are booking travel through other means outside of their p-card (ie: travel reimbursement) but we were not able to obtain that data.

Emissions Factors

Miles traveled were then entered into the SIMAP tool and run through the online calculator to obtain the emissions generated by air travel—these emissions were not calculated by hand. To better understand the specific emissions factors assumed for this calculation, please consult the carbon references section of the SIMAP tool.

Solid Waste

Data Collection
The SIMAP tool asks only for the weight of an entity's landfilled waste, and therefore this was the only category included in the solid waste section of the inventory (not recycling or composting related emissions). Auraria's waste hauler (Green For Life, formerly known as Alpine Waste), provides AHEC with monthly waste reports quantifying the weight of waste sent to the landfill, recycling facility and compost facility. Weights for landfilled waste were input into the SIMAP calculator to obtain related emissions.

Emissions Factors
AHEC's Green For Life Account Manager testified that GFL's landfills do not utilize methane capture. Therefore, "no methane capture" was selected as a toggle on the SIMAP tool. Emissions were pulled from the results output of the SIMAP tool and not calculated by hand. See SIMAP's carbon references section for more information.

Other

- **Paper Procurement:** Pounds of paper (categorized by their recycled content) was collected from the procurement offices at MSU Denver, CU Denver and AHEC. CCD was unable to readily provide this information, so the figures represent a slight underrepresentation of campus paper usage. The SIMAP tool was utilized to calculate the associated emissions and therefore an emissions factors for paper were not directly investigated by the author. To further investigate the emissions factor used, see the carbon references page on the SIMAP tool.
- **Wastewater Treatment:** Wastewater data was collected from the Campus Engineer and the SIMAP tool was used to calculate the associated emissions—therefore there is no visible emissions factor to report in this regard. To further investigate the emissions factor used, see the carbon references page on the SIMAP tool; it appears the SIMAP tool makes reference to an EPA report detailing U.S. GHG emissions[11]. Since wastewater constitutes such a small portion of emissions, further investigation was not pursued for the sake of time.
- **Fleet Vehicles:** Annual gasoline consumption associated with AHEC's fleet vehicles was received from AHEC's Facilities Department and input into the SIMAP tool calculate the associated emissions. The SIMAP tool likely used an average American fuel efficiency and the standard emissions factor associated with the combustion of gasoline fuel to calculate the emissions associated with fleet vehicles. To further investigate the emissions factor used, see the carbon

[11] For more information, see EPA. (2010). Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2008.

references page on the SIMAP tool.

De Minimus

Some emissions were deemed "de minimus" because they represented a miniscule percent of Auraria's total emissions and the time taken to gather them would far outweigh their impact on the numbers. For example, our campus does not "consume" refrigerant unless one of our HVAC units is not functioning properly and leaks. These instances would technically be documented and reported to the EPA, and we had no record of this occurring in FY19.

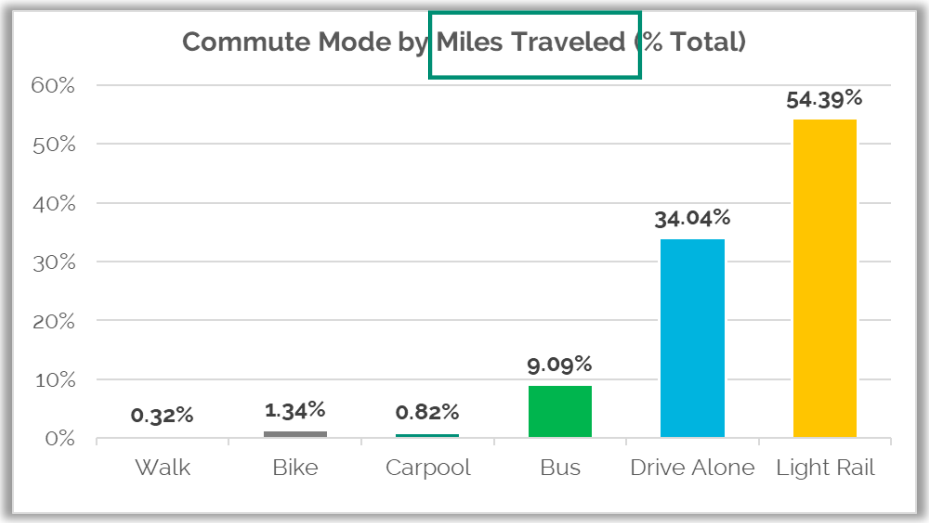
Data Not Represented

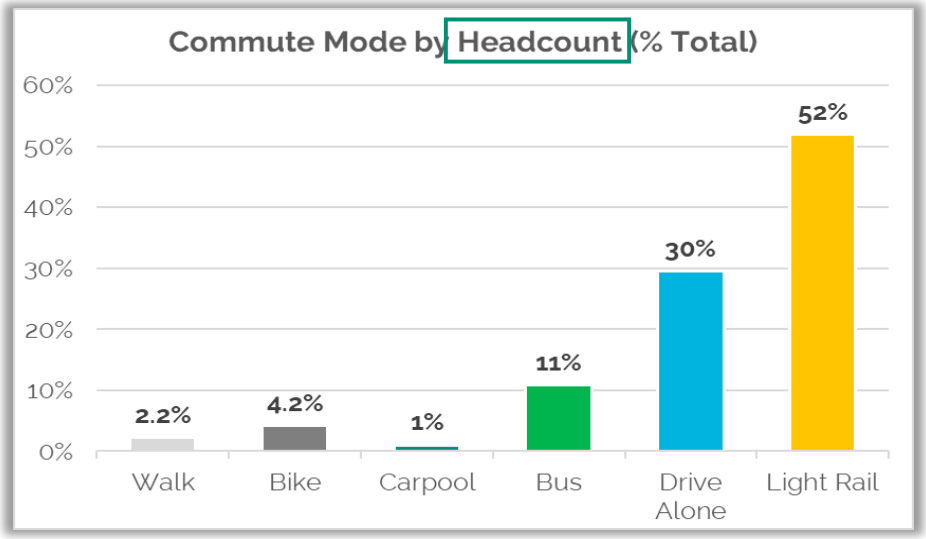
Data Collection

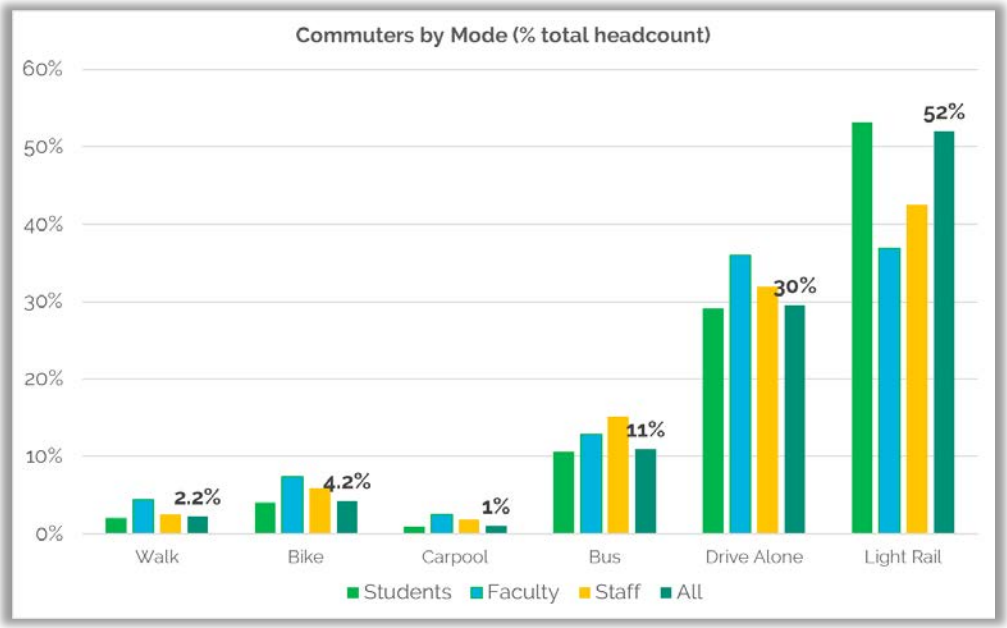
As mentioned at the beginning of this section, data collection and sources were guided primarily by UNH's SIMAP tool. The approach was to collect whatever data was readily available, prioritizing Scope I and II emissions (which the three schools are required to report on per the ACUPCC agreement) and treat Scope III/Indirect Emissions as a bonus if and when data was retrievable. Examples of emissions sources that were not considered in this inventory include:

- **Additional Supply Chain/Procurement Emissions** (particularly associated with office equipment, appliances, carpet, etc.)
- **Construction Emissions/Embodied Energy** (what are the emissions associated with the construction and related waste of the new buildings being added to campus?)
- **Food Purchase Emissions** (how far did food travel to be sold on this campus, what practices were used during cultivation, harvesting and processing, etc.)—SIMAP has a resource for this
- **Study Abroad Emissions**
- **Recycling Emissions** (the ASCP calculated an estimated emissions factor for campus recyclables)
- **Propane Fuel** (it appeared Auraria does not have propane consumption, but there are propane-powered stoves on campus, so there are likely sources—possibly "de minimus")

Appendix 2: Additional Charts/Tables

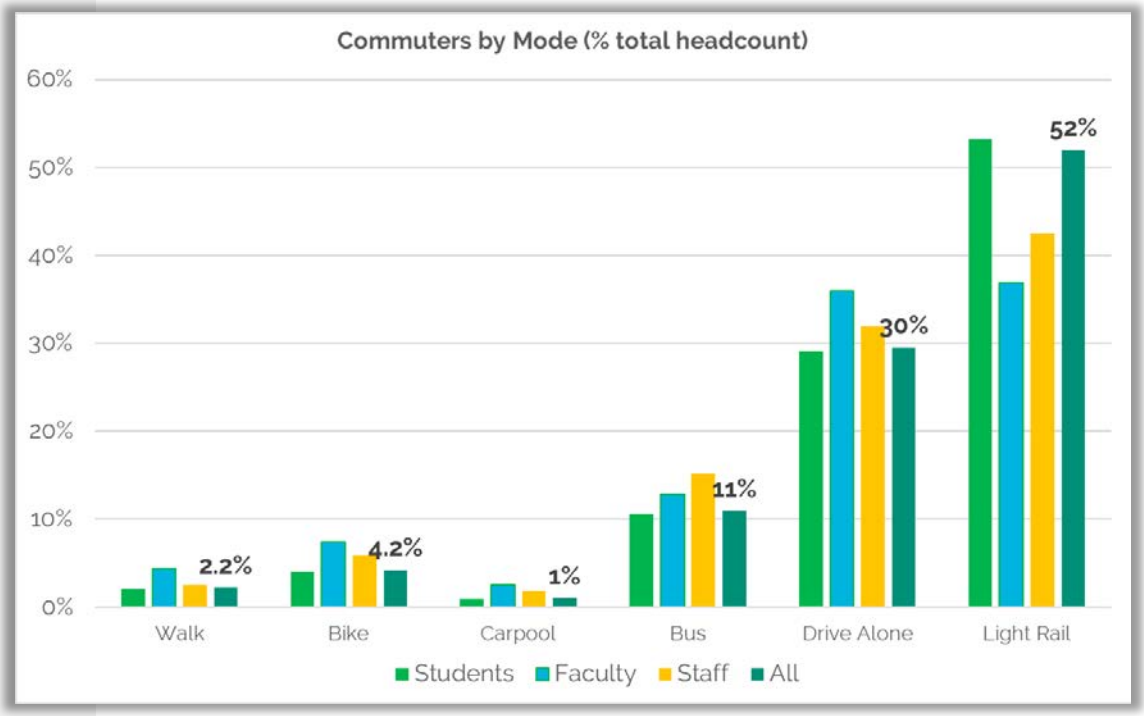


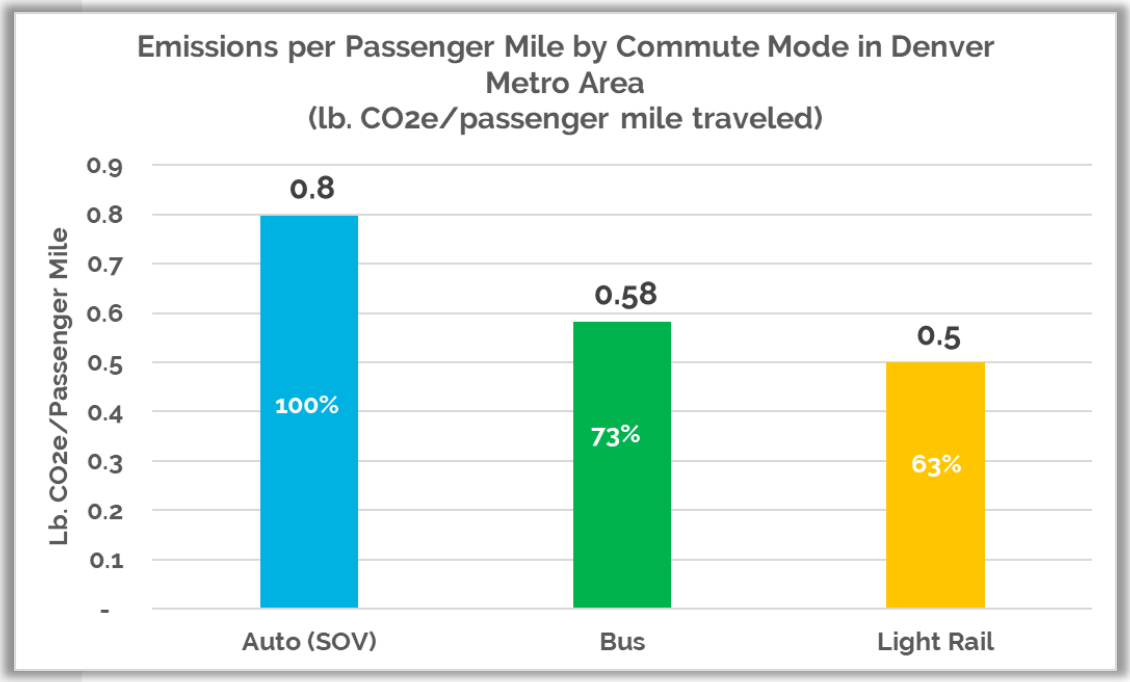




Appendix 2: Additional Charts/Tables

	Walk	Bike	Carpool	Bus	Drive Alone	Light Rail
Students	2.1%	4.0%	0.9%	10.6%	29.1%	53.2%
Faculty	4.4%	7.4%	2.5%	12.8%	36.0%	36.9%
Staff	2.5%	5.9%	1.9%	15.2%	32.0%	42.6%
All	**2.2%**	**4.2%**	**1%**	**11%**	**30%**	**52%**





Appendix 3: FAQs

- **Will the conversion from steam to natural gas lower our emissions?**
  - Uncertain, but our emissions factor (MT CO2e/MMbtu) for natural gas is 5% lower than for steam, so hypothetically if our heating demand is the same next year, it will reduce our emissions 165 MT, or 0.25%.

- **Will COVID 19 affect our emissions?**
  - Yes, but the degree to which is unknown. Early predictions suggest a 4% global reduction (we need 7.6% this year according to the IPCC)
  - In the U.S. analysts expect a ~7% decrease in emissions from gas and energy this FY
  - Sources: *Sommer, Lauren. (2020). "Carbon Emissions Are Falling, But Still Not Enough, Scientists Say."NPR. Retrieved from: https://www.npr.org/sections/coronavirus-live-updates/2020/04/14/834295861/carbon-emissions-are-falling-but-still-not-enough-scientists-say

References

City and County of Denver / Department of Public Health & Environment. "2017 Denver GHG Inventory." City of Denver Open Data Catalog, 2017.

EnergyStar Portfolio Manager. "Technical Reference: U.S. Energy Use Intensity by Property Type" as obtained from "Commercial Buildings Energy Consumption Survey." *U.S. Energy Information Administration*, August 2018.

EnergyStar Portfolio Manager. "Technical Reference: U.S. Energy Use Intensity by Property Type" as obtained from "Commercial Buildings Energy Consumption Survey." *U.S. Energy Information Administration*, August 2018.

EnergyStar Portfolio Manager. "Technical Reference: Source Energy." U.S. Environmental Protection Agency, August 2019.

EPA. "Greenhouse Gases Equivalencies Calculator - Calculations and References." U.S. Environmental Protection Agency, Washington, DC. 2019.

EPA. (2010). Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2008.

FTA. "Public Transportation's Role in Responding to Climate Change." US Department of Transportation (USDOT) & the Federal Transit Administration (FTA), 2010. (See pg. 13).

Gavin, Melanie (Xcel Energy), e-mail message to Jackie Slocombe, February 27, 2020.

H. Chaffer (Green For Life). E-mail message to Chris Herr, February 23rd, 2020.

Jackson Shumate, S. (2019). [2019 Auraria Campus Transportation Survey]. Unpublished raw data. This study has not been published, but some data is being housed on the ASCP Research page.

Klein-Banai, C and Theis, T. L., (2011). Quantitative analysis of factors affecting greenhouse gas emissions at institutions of higher education. *Journal of Cleaner Production, 48*(1), 29-38.

Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.). "Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty." *Intergovernmental Panel on Climate Change*, 2018.

Myhre, G., D. Shindell, F.-M. Bréon, W. Collins, J. Fuglestvedt, J. Huang, D…and Zhang. (2013). Anthropogenic and natural radiative forcing. *Climate change 2013: the physical science sasis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. Retrieved from: https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter08_FINAL.pdf

Parikhit Sinha, William A. Schew, Aniket Sawant, Kyle J. Kolwaite & Sarah A. Strode. "Greenhouse Gas Emissions from U.S. Institutions of Higher Education." Journal of the Air & Waste Management Association 60, no. 5 (2010): 568-573. DOI: 10.3155/1047-3289.60.5.568

References

Ramaswami, Anu; Tim Hillman, Bruce Janson, Mark Reiner, and Gregg Thomas. "A Demand-Centered, Hybrid Life Cycle Methodology for city-Scale Greenhouse Gas Inventories." Journal of Environmental Science and Technology 42, no. 17 (2008), 66455-6461.

Ross, Ken. Auraria Higher Education Center Facilities Management. E-mail messages received summer 2018. (Based on conversation with Ken Ross during compilation of 2018 Solar PV Road Map).

Smith, R.E. (2011). The Environmental Sustainability of Paper. Graduate Studies Journal of Organizational Dynamics Vol. 1(1). Retrieved from https://repository.upenn.edu/cgi/viewcontent.cgi?article=1003&context=gsjod

Xcel Energy. (2015). 2014 Carbon dioxide reporting worksheet. Retrieved from https://www.xcelenergy.com/staticfiles/xe/PDF/Environment_2014_CO2_Worksheet.pdf

Xcel Energy. (2020). Carbon dioxide emissions Intensities, 2019 Info Sheet. Retrieved from https://www.xcelenergy.com/staticfiles/xe-responsive/Environment/Carbon/Xcel-Energy-Carbon-Dioxide-Emission-Intensities.pdf