UNIVERSITY OF WASHINGTON 2022

GREENHOUSE GAS INVENTORY

A tri-campus accounting and analysis of University of Washington emissions.

UNIVERSITY *of* WASHINGTON
(2/26/2024)

ACKNOWLEDGMENTS

This inventory was conducted in the Summer and Fall of 2023. The UW commissioned Cascadia Consulting Group, EcoDataLab LLC, and Hammerschlag LLC to inventory 2022, 2019 and 2005 greenhouse gas emissions, analyze trends and forecast future emissions based on emission-reduction scenarios.

Special thanks to UW staff and partners who contributed to this analysis and report.

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The UW is committed to doing our part to reach a carbon-neutral future."

-Ana Mari Cauce, President of the University of Washington

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UW EMISSIONS

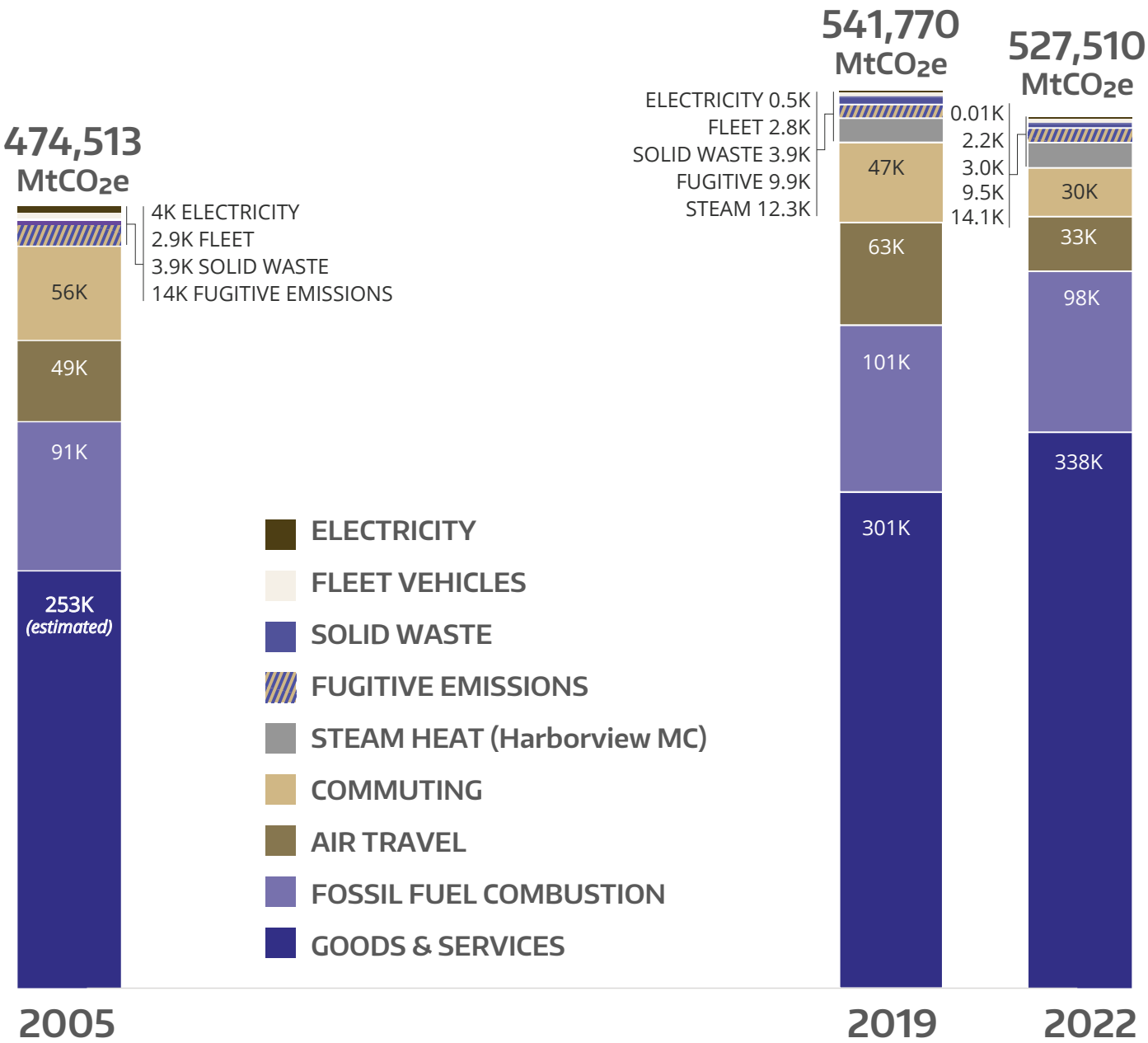


Figure 1. Comparison of total UW emissions from 2005 (baseline year) to 2019 and 2022. Numbers are rounded for graphic simplicity.

EXECUTIVE SUMMARY

The University of Washington conducted this Greenhouse Gas Emissions Inventory in 2023. This is the UW's first comprehensive emissions inventory since 2005, and the first time that UW has quantified emissions from purchased goods and services. Greenhouse gas (GHG) emissions from 2022 and 2019 were measured to encompass data before and after the COVID-19 pandemic response and evaluate the trends over the 2005 baseline.

All three UW campuses (Seattle, Bothell and Tacoma) are included in the report, as well as UW Medicine's Northwest Medical Center and Harborview Medical Center. Emissions are broken down by campus, by large self-sustaining units (UW Medicine, Intercollegiate Athletics and UW Housing & Food Services) and by category.

This inventory provides a better understanding of the UW's GHG emissions and will inform our actions as we work toward our reduction targets established by the state and the UW Sustainability Action Plan. The University of Washington aspires to be net-zero across all emission categories by 2050, and is prioritizing direct emissions reduction in our operations.

EMISSION SOURCES, 2022

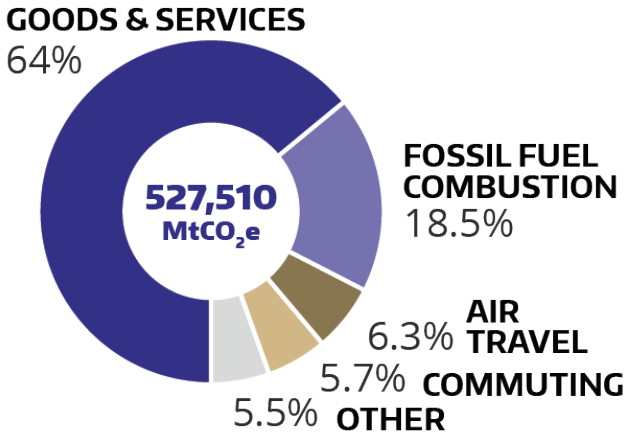


Figure 2. Emission sources by category

KEY FINDINGS

11% increase over 2005 baseline

In 2022, the University of Washington's emissions totaled approximately 527,510 metric tons of carbon dioxide equivalent ($MtCO_2e$), which is an 11% increase over the 2005 baseline of 474,513 $MtCO_2e$ (figure 1).

About 64% of 2022 emissions are from goods & services (337,805 $MtCO_2e$).

This is the first time that emissions embodied in the goods and services purchased were measured. As expected, these emissions are larger than any other source.

18.5% of 2022 emissions are from fossil fuel combustion (97,634 $MtCO_2e$) This is the second largest source of emissions. Over 88% of these emissions are generated from burning natural gas or fuel oil in the Power Plant on the Seattle campus to produce steam for heating buildings. This is an opportunity for substantial emission reduction through the Energy Transformation strategy.

Emissions from commuting decreased Commuting is a success story. Emissions were 46.5% lower in 2022 than 2005, a reduction of 26,061 $MtCO_2e$.

Emissions from air travel decreased The air travel emissions calculations for 2005 were based on incomplete data and are therefore not truly comparable to 2019 and 2022 data. There was a 47.7% reduction in emissions (29,671 $MtCO_2e$) between 2019 and 2022. Initial 2023 data suggests that emissions have since increased.

EMISSION PROFILES

In addition to calculating emissions for the campus as a whole, emissions are disaggregated to the each of the three campuses, outlying units and three self-sustaining units: UW Medicine, Intercollegiate Athletics and Housing & Food Services. Figure 4 shows the distribution of emissions across these units and across emission categories. The emission profiles of UW Medicine and Housing & Food Services are dominated by goods and services purchased at 78% and 73%, respectively. This reflects the nature of the services these units provide to patients and students. Intercollegiate Athletics emissions are dominated by air travel at 52%. UW Bothell and UW Tacoma emissions are dominated by commuting at 38% and 48% respectively. UW Seattle emissions are notably influenced by emissions associated with construction, which is included within the goods & services category.

UW EMISSION PROJECTIONS

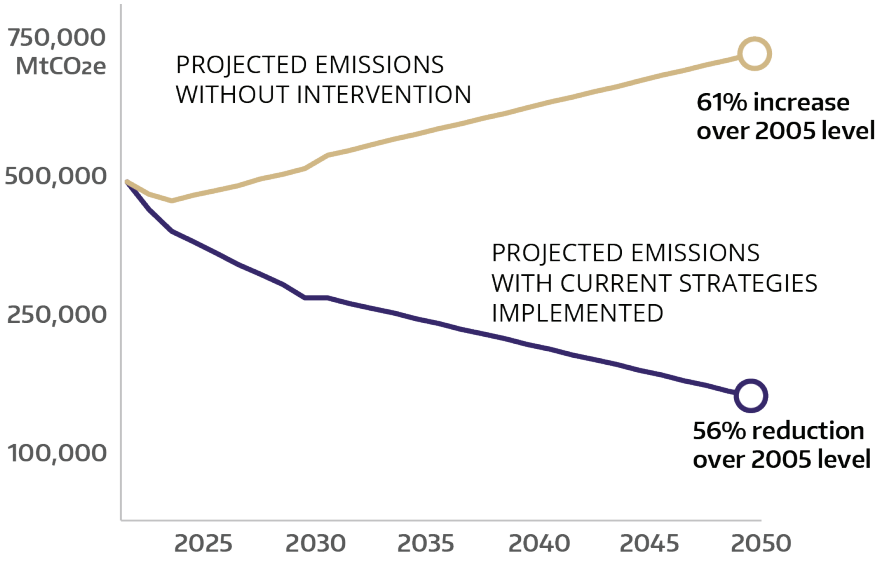


Figure 3. Projected emission reductions.

Traditionally, greenhouse gas inventories group emissions based upon whether they are emitted directly by the organization (Scope 1), emitted during the generation of electricity consumed by the organization (Scope 2) or emitted indirectly in support of the organization (Scope 3). This report does not organize emissions in this way, but Appendix D shows this breakdown.

FUTURE PROJECTIONS

In Figure 3, UW's GHG estimated emissions are projected out to 2050 under two scenarios. The first scenario (BAU: Business As Usual) assumes continued growth, but no emission reduction efforts. This scenario would lead to an approximately 61% increase in emissions from 2005 levels by 2050. The second scenario assumes that current and planned reduction strategies are implemented and result in a 56% decrease in emissions from 2005 levels. These two scenarios are explored in more detail in the "Forecast" section of this report.

UW GREENHOUSE GAS EMISSION PROFILES

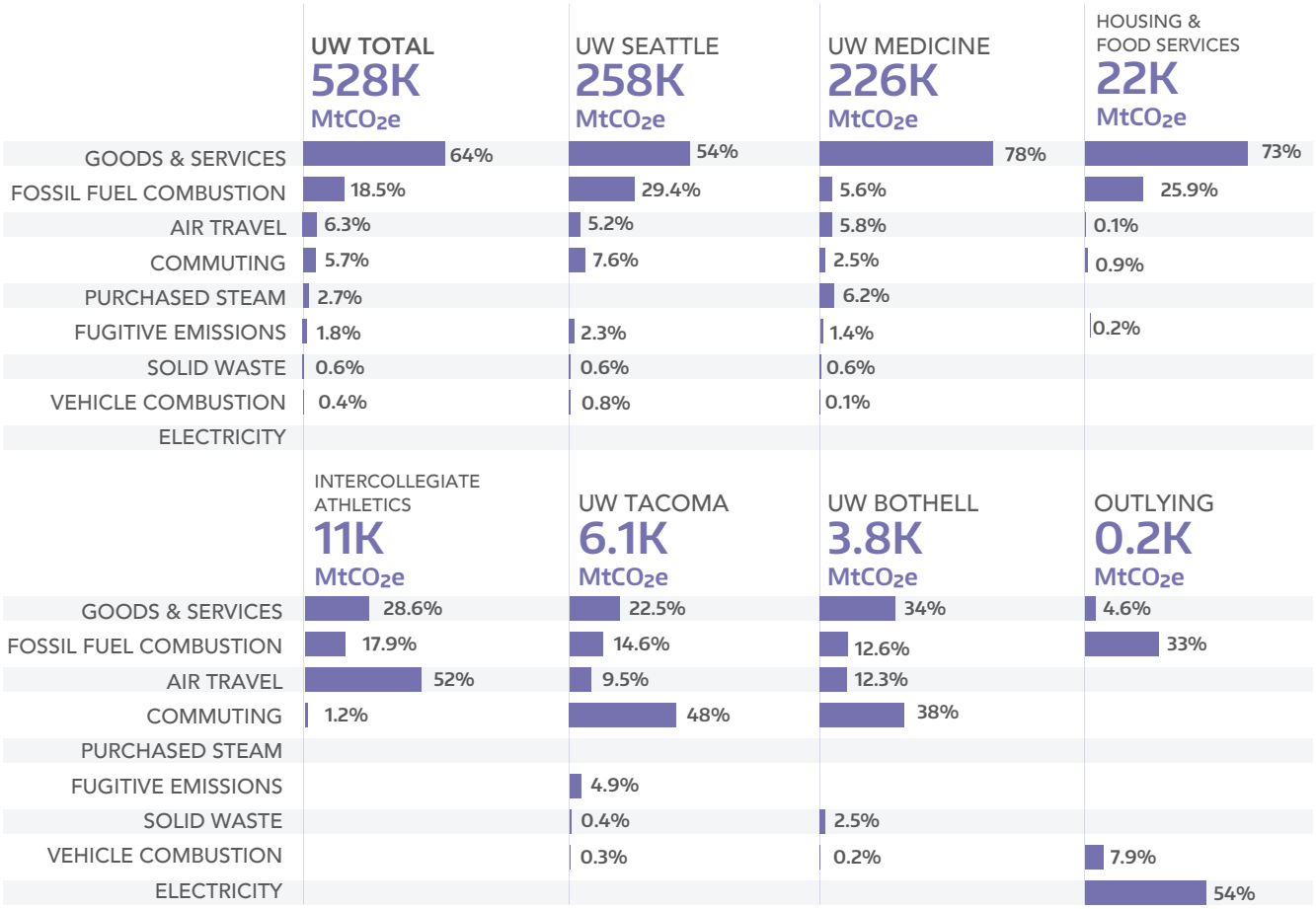


Figure 4. Proportion of emissions across purchase categories (numbers are rounded for graphic simplicity)

SCOPE

YEARS INVENTORIED

This inventory includes data from 2005, 2019 and 2022:

2005 is the baseline year for assessing emission reductions and is the year in which the first GHG inventory for the University of Washington was conducted.[1]

2022 is the most recent year for which comprehensive data was available when the inventory was conducted.

2019 was chosen as an interim year to track trends without the distorting influence of the COVID-19 pandemic.

EMISSION SOURCES INVENTORIED

This inventory is intended to capture all emissions under direct and indirect control of the University of Washington.

BUILDING-RELATED

- **Fossil fuel combustion in buildings**: This category refers to emissions associated with burning fossil fuels such as natural gas and fuel oil on University property. These fuels are burned to generate heat, sterilize equipment, and maintain humidity.
- **Purchased steam consumption**: This category refers to the steam purchased by Harborview Medical Center for heating.
- **Electricity consumption**: This category refers to emissions from generating the electricity the UW consumes. The section on electricity describes how these emissions are calculated under different inventory protocols and how emissions vary between the utility companies that serve UW facilities.

TRAVEL-RELATED

- **Fossil fuel combustion in fleet vehicles**: This category refers to emissions from burning fossil fuels such as gasoline and diesel in fleet vehicles owned by the University of Washington.
- **Air travel**: This category refers to emissions from flights paid for through the University of Washington. It accounts for emissions from burning aviation fuel and the impact of heat-trapping contrails.
- **Commuting**: This category refers to emissions associated with daily travel to and from University of Washington campuses and Medical Centers by students, faculty, and staff.

1 https://sustainability.uw.edu/files/cap/uw_ghg_inventory_2005.pdf

CONSUMPTION-RELATED

• **Purchased goods & services**: This category refers to emissions associated with the creation and transportation of UW purchases. It is typical for this category to be the largest source of an organization's emissions.

• **Solid Waste**: This category refers to emissions generated during recycling, composting or landfilling waste.

FUGITIVE EMISSIONS

This category refers to incidental release of gases that contribute to global warming.

• **Landfill Methane**: This refers to methane produced when the organic material in a landfill breaks down in an anaerobic environment.

• **Refrigerants:** This refers to the release of the liquid used in the refrigeration cycle of a chiller or heat pump. Many refrigerants are potent greenhouse gases.

• **Anesthetic gases**: This refers to the leakage or exhalation of anesthetic gases that have global warming potential.

SEQUESTRATION

• **Forest Sequestration:** This category refers to carbon removed from the air through tree growth. (See Appendix C: Carbon Sequestration for more information).

UW UNITS INVENTORIED

The University of Washington is a large and dispersed organization. The organizational boundary used for this inventory includes the following units:

• **UW Bothell (UWB)**: This refers to UW facilities on the Bothell campus. As several campus buildings are shared with Cascadia College, 66% of emissions from these buildings are attributed to UWB.

• **UW Tacoma (UWT)**: This refers to the UW facilities on the Tacoma campus.

• **UW Seattle inclusive**: This refers to UW facilities within the Seattle area, with the exception of the Metropolitan Tract in downtown Seattle which is owned by the UW, but privately managed.

Where possible, emissions from the "UW Seattle inclusive" umbrella are ascribed to following self-sustaining units:

• **Intercollegiate Athletics (ICA)**: This encompasses the facilities owned and managed by UW Athletics on the Seattle campus.

• **Housing & Food Services (HFS)**: This encompasses the facilities owned and managed by Housing & Food Services in and near the Seattle campus.

• **UW Medicine**: This refers to facilities owned or operated by UW Medicine. This report includes UW Medicine entities that are under UW ownership or direct management, namely the UW Medical Center (including both the Montlake and Northwest campuses) and Harborview Medical Center, which is owned by King County, but managed by UW Medicine. Natural gas and electricity data is included for each of these facilities along with fleet usage data. Commuting data is included for the Montlake campus of UWMC, but is currently unavailable for Harborview MC and the Northwest campus of UWMC (as noted in the

section on commuting). Anesthetic gases are included from Harborview MC only. Refrigerants are included for all three (HMC, UWMC Montlake & NW). Purchasing data is included for all three entities plus a small amount of data from Airlift Northwest. Air Travel data is included for all UW Medicine employees (including School of Medicine employees).

• **Outlying units in Washington**: This refers to University facilities at Friday Harbor Laboratories, the Field Research Station and Conference Center at Pack Forest, and the Olympic Natural Resources Center.

I. EMISSIONS FROM BUILDINGS

Emissions from operating UW buildings come from three sources: on-campus combustion of fossil fuels to generate heat or sterilize equipment or maintain humidity; off-campus combustion of fossil fuels to generate steam used for these purposes at Harborview Medical Center; and off-campus combustion of fossil fuels to generate the electricity that is consumed on campus.

ON-CAMPUS EMISSIONS

In 2022, 18.5% of the University's emissions came from burning fossil fuels primarily to provide heat and hot water to campus buildings. This is a 7.3% increase over the 2005 value (see figure 5). These emissions are calculated by multiplying the volume of fuel consumed by the emission factor for each fuel. The largest source of these emissions (88%) is the steam plant on the Seattle campus which produces steam by burning natural gas. This steam provides heat to many of the Seattle campus buildings include some operated by UW Medicine, Intercollegiate Athletics and Housing & Food Services. The breakdown by unit is shown in figure 6. Some of the differences in emissions per unit can be attributed to whether buildings are heated by fossil fuels or electricity. The heat sources used by various units are shown in Table 1 and described below.

EMISSIONS FROM COMBUSTION ON CAMPUS

Figure 5: Emissions were not separated by sub-unit in 2005. Numbers rounded for graphical simplicity.

ON-CAMPUS EMISSIONS BY UNIT

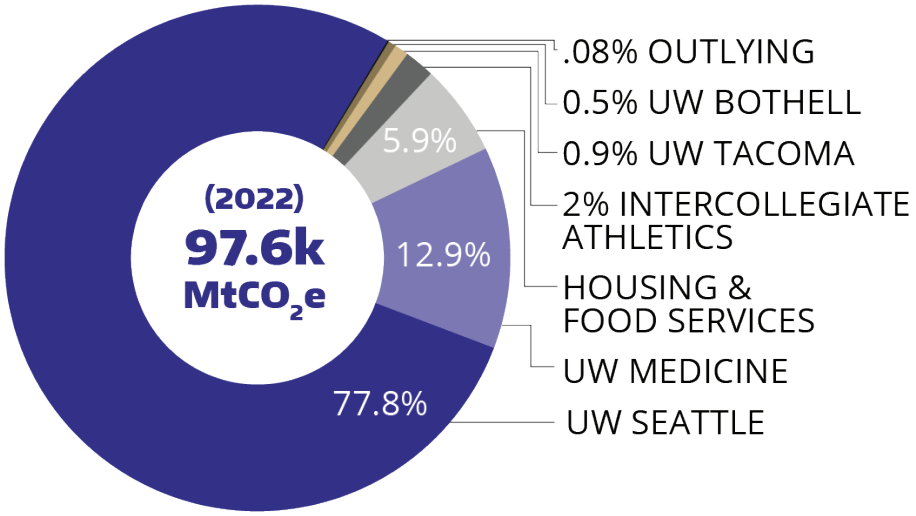


Figure 6: Contributions to on-campus fossil fuel combustion emissions

• **UW Tacoma:** At UW Tacoma, buildings and domestic water are heated with electric water heaters, on-demand water heaters (instant hot), and natural gas-fired boilers. UW Tacoma has a plan to replace the gas-fired boilers with electric heat pumps to fully electrify by 2040. Between 2005 and 2022 UWT emissions increased by 26% as a result of operational changes that include an addition of over 400,000 square feet of buildings space, the addition of gas-fired boilers and water heaters, extended building operation hours for student lab research and study time.

• **UW Bothell:** At UW Bothell buildings and domestic water are heated with natural gas. Between 2005 and 2022, UWB emissions decreased by 22% as a result of energy efficiency and conservation efforts.

• **UW Seattle:** At the Seattle campus, most buildings receive heat in the form of steam from the steam plant. Heat from that steam is transferred to either the air or radiators for circulation throughout the building and to potable water to supply sinks and showers. A major effort is underway to transition the steam plant off fossil fuels and replace the natural gas boilers with electric heat pumps. Between 2005 and 2022 fossil fuel combustion emissions from UW Seattle including UW Medicine, Housing & Food Services & Intercollegiate Athletics increased by 7%. (In 2005, data for UW Medicine, Housing & Food Services, and Intercollegiate Athletics were not separated).

• **UW Medicine:** UW Medicine operates two medical centers (on three campuses). Each campus has a different energy infrastructure. UWMC Montlake receives heat from the Seattle campus steam utility plant described above. UWMC Northwest uses a combination of gas-fired heat pumps, electric resistance heaters, and gas boilers. Harborview

HEATING TECHNOLOGY, BY UNIT

	Natural Gas Boilers	Electric Resistance	Purchased Steam	Gas-fired heat pump	Electric heat pump
UW Tacoma	■	■			
UW Bothell	■				
UW Seattle	■	■			■
Housing & Food Services	■	■			■
Intercollegiate Athletics	■				
UW Medicine: Montlake	■				
UW Medicine: Northwest	■	■		■	
UW Medicine: Harborview			■		

Table 1. Heat Sources

Medical Center purchases heat in the form of steam from a local utility provider. Please note that any change in emissions between 2005 and 2022 is unknown, as UW Seattle emissions data from 2005 was not quantified by unit or department.

• **UW Intercollegiate Athletics:** UW athletic facilities on the Seattle campus are connected to the steam plant described above.

• **UW Housing & Food Services:** On the Seattle campus, HFS operates 12 residence halls, six single student apartment complexes and three family apartment complexes. Ten of the residence halls (Poplar, Elm, Alder, Terry, Lander, Maple, Willow, McCarty, Oak and Madrona) and three of the single student apartment complexes (Mercer, Cedar and Nordheim) have shared gas-fired hot water boilers with electric base board heaters in the residential rooms and variable refrigerant flow (VRF) systems for heating and cooling in building assembly areas. One residence hall (McMahon) and one single student apartment complex (Commodore Duchess) use the central steam plant for heating and hot water and have no cooling. One Residence Hall (Hansee) has an electric plant, which provides domestic hot water and circulated hot water for heating. One single student apartment complex (Stevens Court) uses electric hot water tanks in each apartment for hot water and roof top electric heat pumps for space heating. One single student apartment complex (Stevens Court) uses electric hot water tanks in each apartment and gas furnaces for space heating. The three family apartment complexes (Laurel,

Blakeley and Radford) have electric hot water tanks in each apartment and are heated with either electric base board (Radford) or electric furnaces (Laurel and Blakeley).

OFF-CAMPUS EMISSIONS (PURCHASED STEAM)

Harborview Medical Center purchases steam from a local utility, Centrio. This steam is created by burning natural gas. An 11% increase in Harborview MC's steam consumption between 2019 and 2022 resulted in a 103% increase in emissions in this category because the amount of natural gas burned per unit of steam in 2022 was substantially larger than in 2019.

OFF-CAMPUS EMISSIONS (PURCHASED ELECTRICITY)

In 2022, emissions from electricity consumed by the UW amount to 124 $MtCO_2e$, 0.02% of the total.

The UW follows industry best practice and uses the emission factors for the local utilities to calculate emissions from electricity. These emission factors are determined by multiplying the regional-specific emission factors for fossil-fuel-based generation (coal-, oil-, and natural gas-fired) by the percentage of these generation sources in the fuel mix for the utility. The three UW campuses purchase electricity from utilities which have different forms of generation (different "fuel mixes") shown in figure 7. Seattle City Light (SCL), which serves UW Seattle and Tacoma Power, which servies UW Tacoma, predominantly use carbon-free hydropower for generating electricity. Puget Sound Energy (PSE), which services UW Bothell, includes coal and natural gas in its generation mix so it is more carbon-intensive than the other two utilities. However, PSE offers "Green Direct" electricity which is generated exclusively from wind and solar radiation. UW Bothell began purchasing Green Direct electricity in 2018.

ELECTRICITY FUEL MIX FROM LOCAL UTILITIES

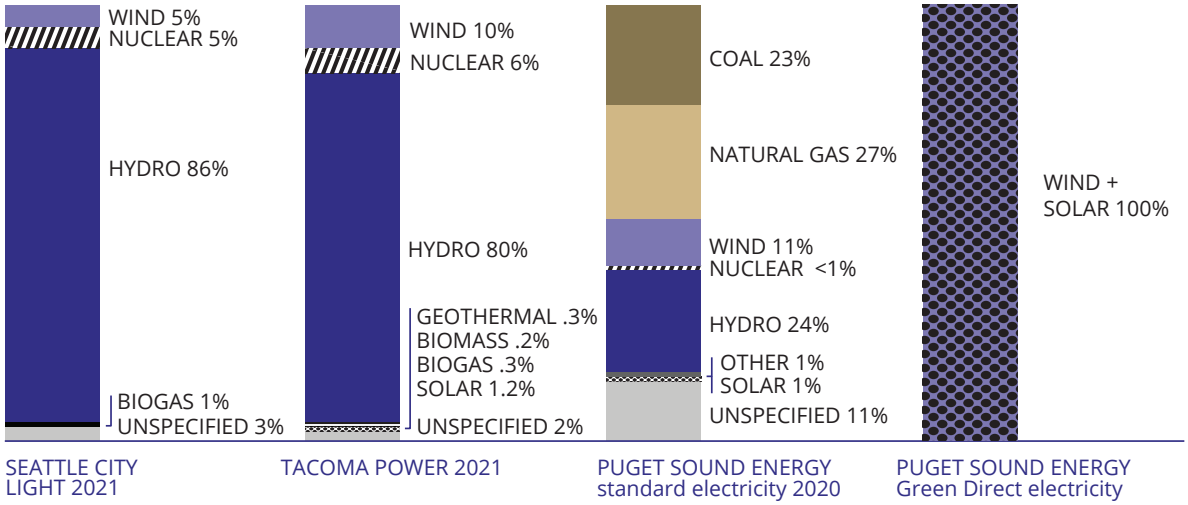


Figure 7: Sources of electricity generated by the utilities that serve the UW campuses

The three utilities that serve the UW transmit the electricity they generate to their customers using a regional grid (the Northwest Power Pool). The fuel mix for the region as a whole is shown in figure 8. The emission reporting protocol used for this inventory calls for reporting the results of emission calculations using the emission factor for the regional grid in addition to the results using the emission factors for the individual utility companies. This accounting method is referred to as "location-based accounting. Using this accounting method, emissions from UW electricity total 131,504 $MtCO_2e$, which is 20% of the entire inventory. Figure 9 shows these emissions.

REGIONAL GRID

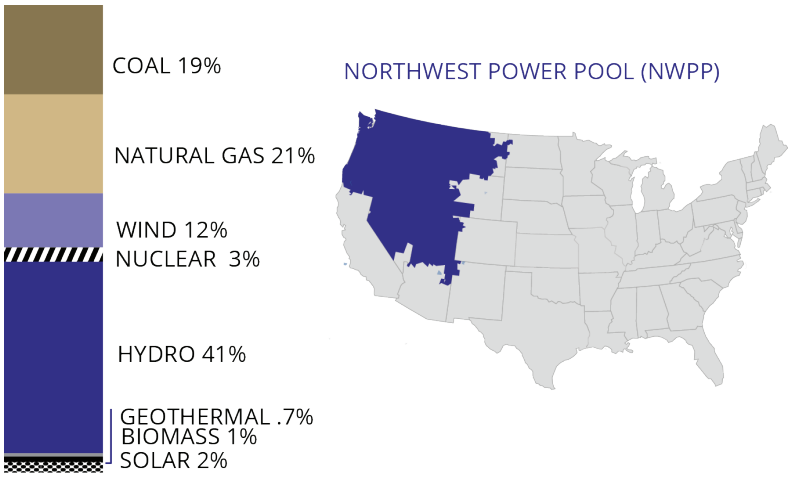


Figure 8: Fuel mix and distribution of the Northwest Power Pool

EMISSIONS FROM PURCHASED ELECTRICITY, ALTERNATE ACCOUNTING

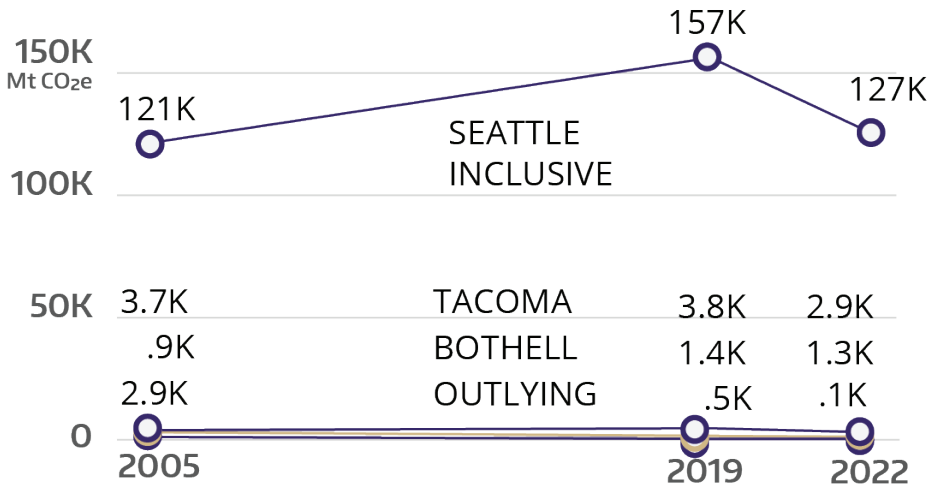


Figure 9: Emissions calculated with Location-based method

II. EMISSIONS FROM TRAVEL

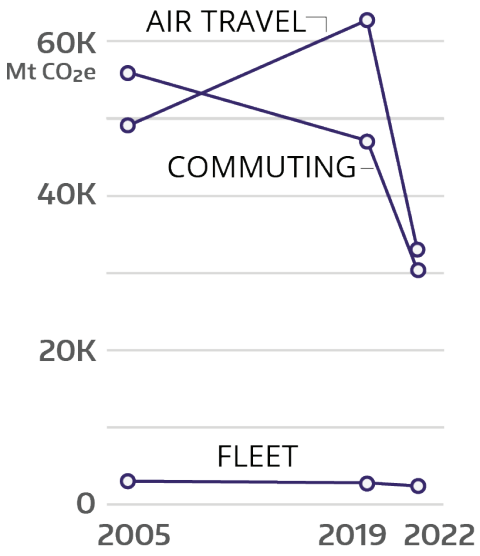


Figure 10. Emissions from travel

The three sources of travel-related emissions for the University of Washington are air travel, commuting, and the UW fleet. As figure 10 shows, emissions from air travel have surpassed emissions from commuting. Emissions from UW fleet vehicles are much lower. They comprise less than 0.5% of UW total emissions.

FLEET

In 2022, just 0.43% of the University's emissions came from burning fossil fuels such as gasoline and diesel in vehicles owned by the University of Washington.

The UW Fleet consists of approximately 750 vehicles, which are maintained by UW Facilities. These vehicles are used for campus operations and supporting the work of the University at large. For example, fleet vehicles are used to transport medical lab specimens for rapid test results, to haul materials for recycling, to carry maintenance crews and their equipment, and to travel to local academic conferences. Some vehicles are assigned to specific departments or uses, and others are available through the UCAR system for hourly rentals by faculty, staff and students for official university business. Fleet emissions are calculated by multiplying EPA emission factors for

FLEET EMISSIONS

CAMPUS/UNIT	2019 $MtCO_2e$	2022 $MtCO_2e$	CHANGE
UW Seattle	2,538	2,038	-20%
UW Bothell	14	9	-36%
UW Tacoma	27	16	-42%
UW Medicine	122	115	-5%
Athletics	2	4	+90%
HFS	70	47	-33%

Table 2. Fleet emissions trends by unit (values rounded)

different fuel and vehicle types by the number of miles traveled and gallons of fuel consumed by each vehicle.
Fleet emissions decreased 4% between 2005 and 2019 and another 22% between 2019 and 2022. The significant decrease in emissions between 2019 and 2022 can be attributed to a combination of a reduction in fleet usage and replacement of retired internal combustion vehicles with electric vehicles. Electric and hybrid vehicles make up approximately 29% of the fleet as of 2023, and this number is expected to approach 100% by 2035 as internal combustion engine vehicles are retired and more electric vehicle models become available.

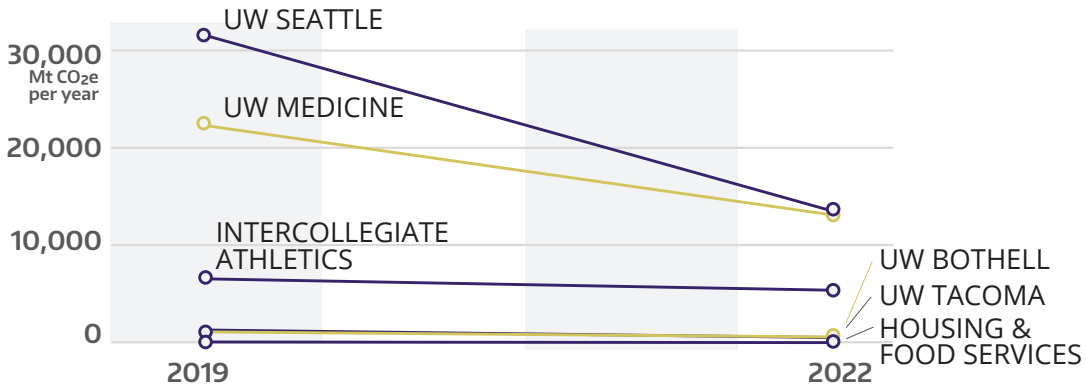
See Table 2 for a breakdown of fleet emissions by unit, including the magnitude of change from 2019 to 2022.

AIR TRAVEL

In 2022, 6.29% of the University's emissions came from flights paid for through the University of Washington's purchase system, and flights paid for by students to participate in Study Abroad programs.

Air travel data is gathered from reimbursement data, travel account data, Study Abroad data and chartered flight data. (Note: flights by Airlift Northwest, an air ambulance service operated by UW Medicine, are not included).

AIR TRAVEL: EMISSIONS IN 2019 & 2022



AIR TRAVEL: FLIGHTS PER MONTH 2019-2022

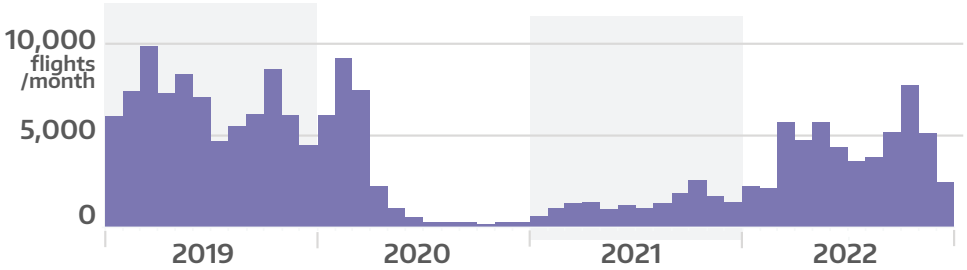


Figure 11: Emissions and number of flights in parallel, showing impact of COVID-19 restrictions

COMMUTE EMISSIONS BY CAMPUS

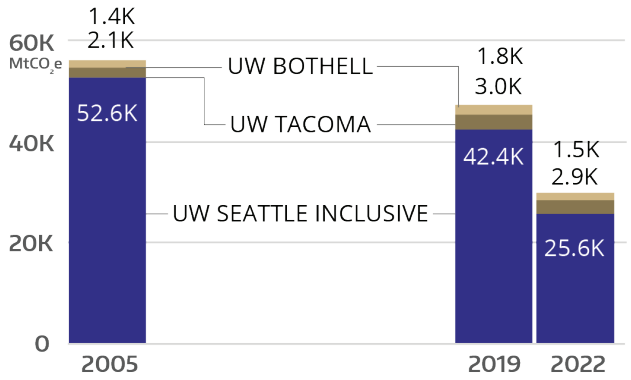


Figure 12: Trends in emissions from commuting per campus

Emissions are calculated by multiplying the number of miles flown by an emission factor developed by the EPA which accounts for differences in emission intensity for short-, medium- and long-haul flights. This value is then multiplied by a "radiative forcing" factor to account for the global warming impact of contrails.

As shown in figure 11, the number of flights and the volume of emissions from air travel decreased substantially as a result of COVID-19 pandemic travel restrictions. Preliminary data from 2023 suggest that air travel has since returned to 2019 levels.

COMMUTING

In 2022, 5.68% of the University's emissions came from with daily travel to and from University of Washington sites by UW students, faculty, and staff. (NOTE: Commuting data from 2005, 2019 and 2022 is unavailable for off-campus sites such as Harborview and Northwest Medical Centers but will be included in future inventories when it becomes available.)

The three campuses track commuting data separately. All are required to survey employees about drive-alone trips and distance every two years to fulfill requirements of Washington State's Commute Trip Reduction (CTR) law. For UW Bothell and UW Tacoma, reports from this survey, which includes GHG emissions, are the source of data for this inventory. UW Seattle conducts a more in-depth survey annually. This survey includes non-employee students as well as employees and asks for more detailed information about commute distance and commute mode. Emission calculations are based on average commute distance and average gallons of fuel consumed per mile per passenger for each mode.

Since 2005, emissions from commuting have decreased by 46.5% (over 26,000 $MtCO_2e$). Figure 12 shows the contribution to this reduction from the three campuses. This reduction is primarily the result of shifts in commuting modes as shown in figure 13: drive-alone rates have decreased by 12% and telecommuting increased by 14% between 2005 and 2022 (telecommuting rates were not reported in 2005, but without a formal program, the assumption is that they were equal to, or lower than in 2019). Emissions were also influenced by changes in the efficiency of vehicles. The federal Corporate Average Fuel Economy (CAFE) Standards required

new vehicles to achieve an average of 27.5 miles per gallon (MPG) in 2000 and 48.2 MPG in 2022.

The UW continually works to support low impact modes of commuting to increase health, reduce pollution and reduce traffic congestion. The UW is a leader in this regard with impactful actions, including providing transit passes to students in 1991, providing transit passes to staff in 2022, and supporting telework during and after the COVID-19 pandemic.

COMMUTE MODE TRENDS, UW SEATTLE

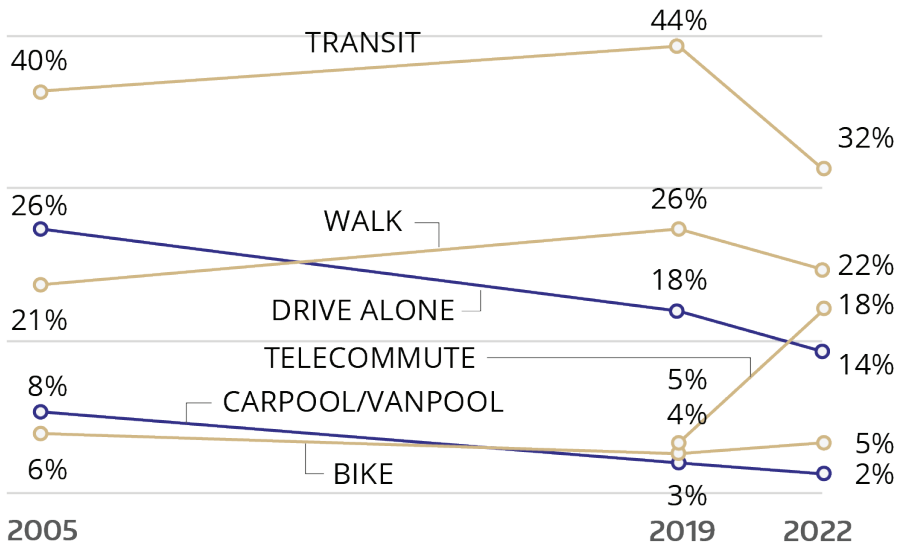


Figure 13: Mode split trends for Seattle (this data is not available for Bothell & Tacoma)

III. FUGITIVE EMISSIONS

In 2022, 1.79% of the University's emissions came from the unintended or incidental release of gases that have substantial global warming potential. At the UW, this includes refrigerants, anesthetic gases, and methane from the covered landfill near Husky Stadium at the Seattle campus.

REFRIGERANTS

Refrigerants are chemicals used in mechanical heating and cooling equipment. Many of these chemicals are potent greenhouse gases. As shown in Figure 14, emissions from refrigerants decreased (24%) between 2019 and 2022. Data is not available for 2005 so emissions for that year were estimated based on the difference in emissions from natural gas over the same time period.

Emissions from refrigerants are calculated by multiplying an emission factor specific to each chemical by the amount of refrigerant purchased to replace refrigerant lost to leakage. For the inventory, the year the refrigerant was purchased is treated as the year the emissions were released. UW's emissions from refrigerants are expected to continue to decrease as refrigerants with high global warming potential are phased out through regulations at both the federal and state level.

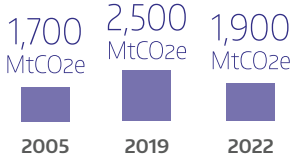


Figure 14. Emissions from refrigerants

ANESTHETIC GASES

The anesthetic gases nitrous oxide, sevoflurane, isoflurane and desflurane become greenhouse gases when released to the atmosphere either through leakage or by being exhaled by the individual being anesthetized. This the first time that UW has included anesthetic gases in its GHG inventory. As of 2023 data was available only for Harborview Medical Center. As Figure15 shows, emissions from anesthetic gases at Harborview Medical Center increased by 62% between 2019 and 2022. This increase may be due to a combination of improvements in data tracking and a

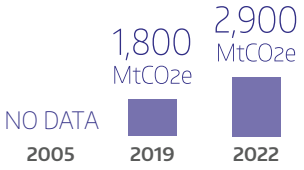


Figure 15. Emissions from anesthetic gases at Harborview Medical Center

temporary rise in medical procedures to fill a backlog created by COVID restrictions.

Emissions from these gases are calculated by multiplying the amount purchased by the emission factor for each anesthetic. The UW is taking steps to eliminate leakage and switch to equally effective anesthetics that have lower global warming potential. Harborview Medical Center plans to launch a work group focused on discontinuing the use of a central supply of nitrous oxide to eliminate leaks in distribution pipes. Other UW Medical Centers will learn from and follow this lead.

LANDFILL METHANE

Methane emissions from the Montlake Landfill on the Seattle campus (which was closed in 1971) are calculated using historic records of the volume of material buried in the landfill, the anaerobic conditions of the landfill and known rates of decomposition under these conditions (see figure 16). Each year, the volume decreases as the organic matter breaks down. The methodology for calculating these emissions is described in the 2005 inventory report[1].

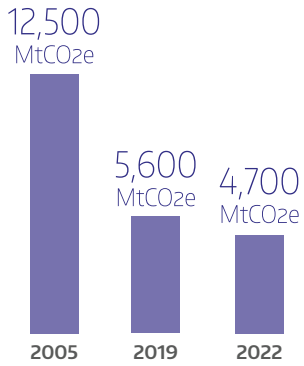


Figure 16. Emissions from methane leaks

1 2005 Inventory of Greenhouse Gas Emissions Ascribable to the University of Washington, October 2007 by Roel Hammerschlag and Matthew Van Sickle (available at https://sustainability.uw.edu/files/cap/uw_ghg_inventory_2005.pdf)

IV. EMISSIONS FROM WASTE

In 2022, 0.57% of the University's emissions came from recycling, composting or landfilling waste. These emissions consisted of:

- **CO_2** from degradation of both fossil and biogenic carbon contained in waste.
- **CH_4** principally from decomposition of biogenic materials in landfills.
- **HFCs** from the disposal of refrigeration and air conditioning units.

The EPA Emission Factor Hub provides emission factors for combined waste streams and individual waste streams defined by the type of material such as paper, food waste, mixed plastics, and the disposal strategy such as composting, recycling or landfilling. Figure 17 shows the emissions for all three campuses and UW Medicine (the data does not clearly separate waste from Intercollegiate Athletics and Housing and Food Services so they are included within the number for UW Seattle). A detailed breakdown of the waste streams is available for UW Seattle and UW Medicine so those numbers are more precise than the numbers for UW Bothell and UW Tacoma which are based upon average-data emission factors and bin size rather than measured weight.

EMISSIONS FROM WASTE DISPOSAL

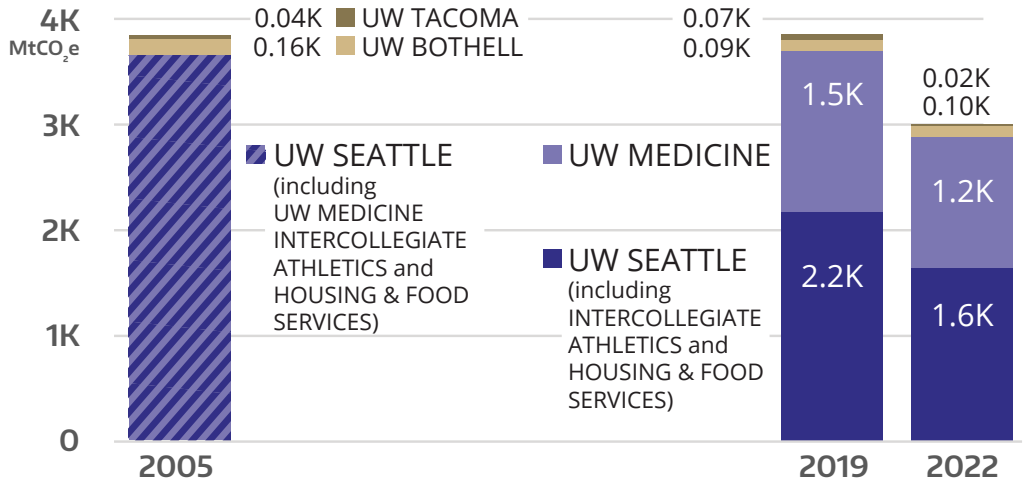


Figure 17: Waste emissions. UW Medicine was not separated in 2005. numbers rounded for graphic simplicity)

V. EMISSIONS FROM PURCHASES

The University of Washington spent more than $2.8 billion on goods and services in 2022. The creation and delivery of those goods and services resulted in approximately 338,000 $MtCO_2e$ which is 64% of the university's total emissions.

This is the UW's first inventory of emissions from goods & services purchased. UW made a deliberate decision to include emissions from purchases in this 2022 Inventory in order to gauge their magnitude and to develop strategies to address them in the Sustainability Action Plan Update. Emissions associated with goods and services were calculated using 2019 & 2022 procurement data provided by Procurement Services, Housing and Food Services, and UW Medicine (procurement data for 2005 was backcast based on campus growth and trends in the emission-intensity of goods and services). To translate purchase dollar amounts into emissions, EcoDataLab matched the codes for purchase categories in UW's procurement system with the North American Industry Classification System (NAICS) purchase codes and identified the most important categories

UW EMISSIONS FROM PURCHASES

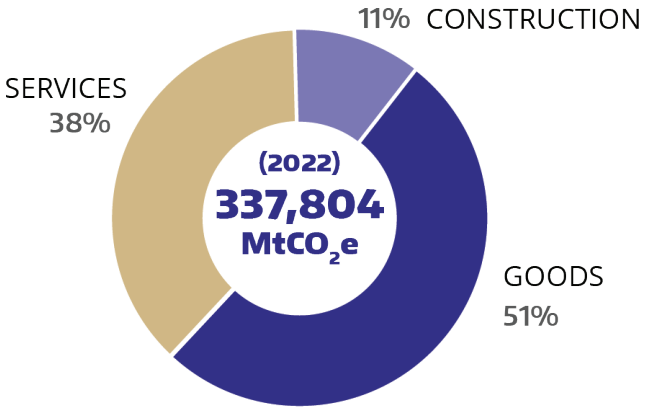


Figure 18. Consumption-based emission sources

of UW goods/services that contribute to emissions. The purchase amounts were then converted to GHG emissions using EPA's US Environmentally-Extended Input-Output (USEEIO) emission factors, incorporating an annual scaling adjustment factor since the emission factors are in 2021 dollars. These emission factors provide national average estimates of life-cycle emissions by category of goods and services (such as "computers", "fruits & vegetables", etc.) This current state-of-the art methodology is inherently imprecise but provides a sense of the magnitude of the GHG impact of purchases and points to areas for examination to find

opportunities to make lower-impact purchases. UW plans to do a subsequent and more detailed emissions inventory in the future, with the intent of getting more data on emissions from suppliers through our university procurement processes.

SOURCE OF EMISSIONS

Of the total emissions associated with goods and services, 'goods' are responsible for half of these emissions, while 'services' comprises roughly 38%, and 'construction' comprises approximately 11% (see Figure 18).

Figure 19 shows the proportion of emissions in each NAICS category across units (note: brief descriptions of each category are available at the end of this section). These profiles reveal significant variability. For example, more than 75% of UW Medicine's purchase emissions are associated with four categories that are almost entirely absent in the other units: manufacturing, specifically prostheses; surgical supplies, drugs & pharmaceuticals; retail trade, specifically pharmacy; and transportation and warehousing, specifically flight costs of equipment return. In contrast, more than 90% of Housing & Food Service's purchase emissions are associated with food purchases. Intercollegiate Athletics purchase emissions are dominated by contractual and professional services (41%), food (29%), and equipment purchase and rental (18%). UW Seattle's profile is unique because of the impact of construction-related emissions which include construction itself (27%) and construction-related professional services (more than 14%). UW Bothell and UW Tacoma profiles are similar to each other: for both, the primary sources of emissions are Professional Services consisting of software purchases, contracted maintenance and repair, and "non-capitalized" equipment (equipment purchased by units as opposed to equipment purchased at the university level for things like land and buildings). The one notable difference between UW Bothell and UW Tacoma is that Bothell has substantial emissions associated with construction.

(Note: the data for this diagram does not include upstream emissions from the purchased fossil fuels which are calculated separately and don't use the NAICS designations).

NAICS CATEGORIES

The descriptions below apply provide more context for the data in figure 19:

a**: Professional, Scientific, and Technical Services** (legal, accounting, architectural, engineering; computer services; photographic services, etc.)

b**: Manufacturing - Metals, Machinery, Electronics, Misc** (mechanical, physical, or chemical transformation of materials, substances, or components into new products)

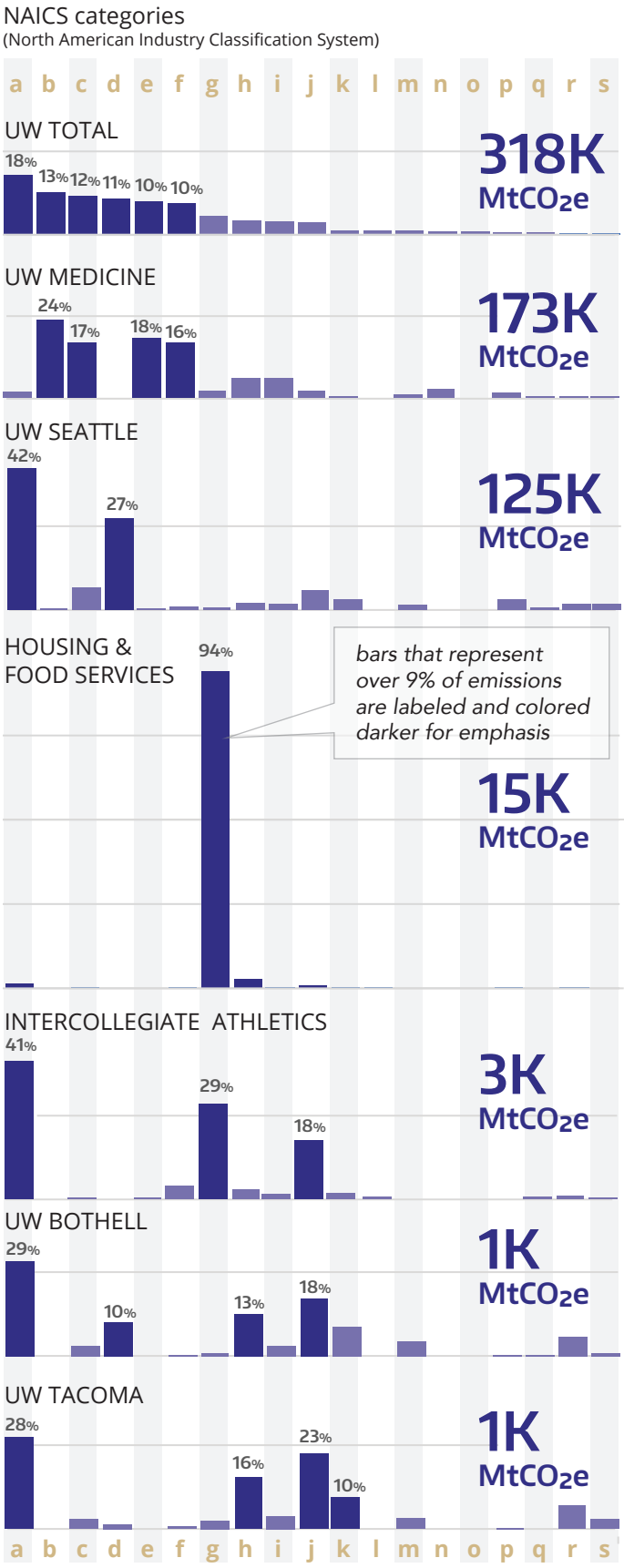
c**: Manufacturing - Wood, Paper, Petroleum, Chemicals** (mechanical, physical, or chemical transformation of materials, substances, or components into new products)

d**: Construction** (of buildings or engineering projects such as highways and utility systems)

e**: Retail Trade** (retailing merchandise, generally without transformation, and rendering services incidental to the sale of merchandise.)

f**: Transportation and Warehousing** (transportation of passengers and cargo, warehousing and storage for goods, etc.)

EMISSION PROFILES



g: Accommodation and Food Services (providing customers with lodging and/or preparing meals, snacks, and beverages for immediate consumption)

h: Other Services except Public Administration (grant-making, advocacy, laundry services, personal care services, photofinishing services, etc)

i: Administrative and Support and Waste Management and Remediation Services (office administration, hiring and placing of personnel, document preparation and similar clerical services, solicitation, collection, security and surveillance services, cleaning, and waste disposal services)

j: Real Estate and Rental and Leasing (renting, leasing, or otherwise allowing the use of tangible or intangible assets)

k: Information (producing and distributing information and cultural products; the means to transmit or distribute these products as well as data or communications, and processing data)

l: Wholesale Trade (wholesaling merchandise)

m: Utilities (electric power, natural gas, steam supply, water supply, and sewage treatment and disposal)

n: Agriculture, Forestry, Fishing and Hunting (growing crops, raising animals, harvesting timber, and harvesting fish and other animals)

o: Health Care and Social Assistance (health care and social assistance for individuals by trained professionals)

p: Arts, Entertainment, and Recreation (services to meet varied cultural, entertainment, and recreational interests of their patrons)

q: Educational Services (instruction and training)

r: Government

s: Manufacturing - Food, Textiles, Apparel, Leather (mechanical, physical, or chemical transformation of materials, substances, or components into new products)

t: Finance and Insurance (raising funds, pooling of risk, specialized financial services facilitating)

Figure 19. Purchasing profiles by unit. Explanations of categories (labeled with gold letters) can be found in the text. Note: These charts do not include embodied emissions from fossil fuels, which are calculated separately
(2/26/2024)

VI. EMISSIONS FROM FOOD PURCHASES

Food purchases are included in the consumption-based data and analyzed in more detail here because this is a particularly high-impact purchase category. Figure 20 shows emissions relative to cost for food purchases made by UW Housing and Food Services in 2022. It reveals that "protein" (primarily meat) and dairy are considerably more emission-intensive dollar-for-dollar than other food categories. Table 3 provides the breakdown of expenditures and emissions by category, while Table 4 provides this breakdown by percentage.

Future food analyses will benefit even more by separating different kinds of protein (beef, chicken, lamb, pork, processed meat, etc). There is a wide range of emissions between different animal products, e.g., 3.30 kg CO2/$ for beef vs 1.17 kg CO2e/$ for chicken in the EPA model. Note that these emission factors are on a dollar basis. If chicken is cheaper per pound than beef then the emission per pound would be even lower for chicken in comparison.

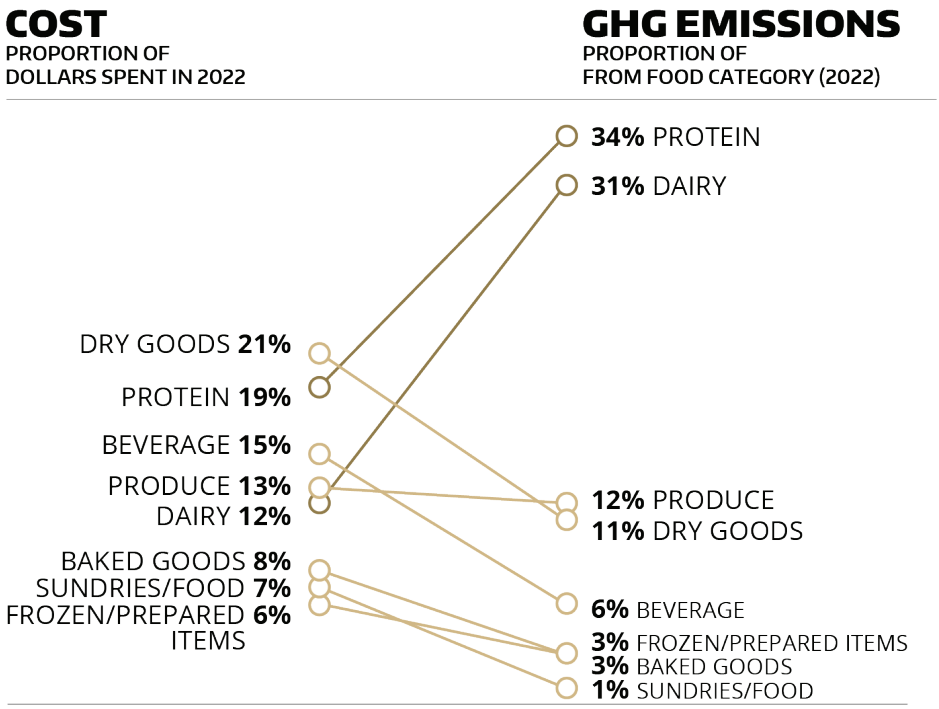


Figure 20. Cost-to-emissions ratio for each food category

FOOD CATEGORY	EXPENDITURES (2019)	EXPENDITURES (2022)	$MtCO_2e$ (2019)	$MTCO_2e$ (2022)
Protein	$3,145,291	$2,962,543	5,994	4,811
Dairy	$1,994,128	$1,905,342	5,428	4,420
Produce	$2,400,827	$2,121,925	2,191	1,650
Dry Goods	$3,409,259	$3,322,251	1,888	1,568
Beverage	$3,019,824	$2,373,462	1,205	807
Frozen/ Prepared Items	$1,054,068	$889,162	671	482
Baked Goods	$1,815,921	$1,295,904	602	366
Sundries/Food	$911,404	$1,044,103	126	123
Coffee	$55,687	$18,400	32	9
Total	**$17,806,409**	**$15,933,092**	**18,137**	**14,236**

Table 3. : Total UW expenditures and associated emissions by food category

FOOD CATEGORY	PERCENT OF EXPENDITURES (2019 / 2022)	PERCENT CO_2e (2019 / 2022)	$kgCO_2e$/$ IN 2019	$kgCO_2e$/$ IN 2022
Protein	18% / 19%	33% / 34%	1.91	1.62
Dairy	11% / 12%	30% / 31%	2.72	2.32
Produce	13% / 13%	12% / 12%	0.91	0.78
Dry Goods	19% / 21%	10% / 11%	0.55	0.47
Beverage	17% / 15%	7% / 6%	0.40	0.34
Frozen/Prepared Items	6% / 6%	4% / 3%	0.64	0.54
Baked Goods	10% / 8%	3% / 3%	0.33	0.28
Sundries/Food	5% / 7%	1% / 1%	0.14	0.12
Coffee	<1% / <1%	<1% / <1%	0.57	0.49
Total	**100%**	**100%**	**1.02**	**0.89**

Table 4. Proportion of cost and emissions per food category

FORECAST

REDUCTION SCENARIOS

Future emissions trends are projected to 2050 based upon the results of the 2022 GHG inventory, planned emission reduction strategies and anticipated impact of state legislation.

The resulting "wedge analysis" forecast model shows three trajectories:

1) "Business-as-usual" (BAU) trajectory: This trajectory shows where emissions are headed if the campus continues to grow as expected and neither the UW nor the State take action to reduce emissions.

2) Adjusted BAU (ABAU) trajectory: This trajectory shows the influence of existing state policies:

a) WA Clean Energy Transformation Act (CETA) applies to all electric utilities serving retail customers in Washington and sets specific milestones: By 2025, utilities must eliminate coal-fired electricity from their state portfolios; By 2030, utilities must be greenhouse gas neutral, with flexibility to use limited amounts of electricity from natural gas if it is offset by other actions; By 2045, utilities must supply Washington customers with electricity that is 100% renewable or non-emitting, with no provision for offsets. The impact of CETA is that all electricity will be GHG neutral (electricity emissions factor equals zero) in 2030 and beyond with a straight-line emissions factor reduction from 2022 to 2030. This action impacts electricity emissions factors (reduces emissions per unit of energy consumed).

b) WA Clean Fuel Standard requires a 20% reduction in the carbon intensity of transportation fuels by 2038, compared to a 2017 baseline level. Reductions in carbon intensity may be achieved through cleaner fuels or by purchasing clean fuel credits from cleaner producers such as those providing electricity as fuel. Boats, trains, aircraft, and military vehicles & equipment are excluded.

For this model, the assumption is that the split of clean fuel/EV will be close to 35%/65% by 2038.

c) WA Climate Commitment Act (known as Cap and Invest) places an economy-wide cap on carbon to meet state GHG reduction targets and remain consistent with best available science, while minimizing the use of offsets to meet those targets. Every polluting

facility covered under the program needs to hold one State "allowance" for every ton of greenhouse gas that it emits.

For this model, the assumption is that this legislation will lower the emission factors for transportation fuels and for the natural gas the UW consumes by adding low-emission fuels to the fuel mix.

d) Global decarbonization of goods and services is anticipated in the future, and will be influenced by technology and policies focused on supply chains, packaging, shipping, and other initiatives.

3) Expected Trajectory: This trajectory shows where emissions are headed as a result of both the state policies and planned UW actions:

a) Decarbonizing building operation by transitioning away from fossil fuels and introducing energy efficiency improvements.

b) Decarbonizing commute trips through transition to cleaner vehicles and switching to non-SOV (single occupancy vehicle) commuting modes such as telecommuting or walking.

c) Transition to an electric vehicle fleet.

d) Reduction in air travel through efforts to provide alternatives to air travel and mitigate emissions through emission reductions in other sectors.

e) Improved refrigerant management through reduced leakage and transition to more environmentally friendly refrigerants.

f) Purchase of lower-emissions products and services. This includes guidelines for construction embedded in the new UW Green Building Standard.

Table 5 shows the projected reductions in 2030, 2040 and 2050 from each of these strategies.

UW STRATEGIES	$MtCO_2e$ reduction in 2030	$MtCO_2e$ reduction in 2040	$MtCO_2e$ reduction in 2050
Commute Emission Reduction	4,470	9,227	17,107
Fleet Electrification	1,349	1,893	2,140
Air Travel Emission Reduction	10,708	25,058	45,705
Building Decarbonization (electrification)	21,402	87,656	141,476
Building Decarbonization (waste elimination)	72,766	37,567	-
Refrigerants (% reduction in emissions from 2022)	74	740	1,375
Low Carbon Purchasing (% reduction in goods/ service emissions)	42,441	113,133	183,255

Table 5. Anticipated emission reductions from UW actions

FORECAST (EXCLUDING PURCHASED GOODS & SERVICES)

Accounting for upstream emissions from the purchase of goods and services is a relatively new practice. Thus, strategies and management practices to reduce purchasing emissions are still in development. In response, the following sections present scenario findings both with and without inclusion of the purchased goods & services emissions sector.

If emissions from purchased goods and services are excluded, we estimate (as shown in the top chart of figure 21), that business-as-usual UW GHG emissions will increase 4% and 41% by 2030 and 2050, respectively, compared to 2005 baseline levels. This increase is driven by an anticipated increase in student and faculty populations.

Modeling suggests that existing policies under the ABAU scenario will limit BAU increase to only 26% by 2050, primarily driven by reductions from the WA Climate Commitment Act (CCA).

Under the university strategy scenario listed in Table 5 (but excluding sustainable purchasing), modeling suggests that the university can reduce emissions by 64% and 84% by 2030 and 2050, respectively, compared to 2005 baseline levels. Significant contributors to these reductions include building decarbonization, commute trip reduction, and addressing emissions from air travel.

FORECAST (INCLUDING PURCHASED GOODS & SERVICES)

Under a business-as-usual scenario (bottom chart of figure 21), we estimate that UW GHG emissions will increase 21% and 61% by 2030 and 2050, respectively, compared to 2005 baseline levels. This increase is driven by an anticipated increase in student and faculty populations.

Modeling suggests that existing policies under the ABAU scenario will limit emissions increases to 11% and 30% by 2050. Much of this reduction is due to anticipated decarbonization of goods and services.

Under the university strategy scenario listed in Table 5, modeling suggests that the university can reduce emissions by 23% and 56% by 2030 and 2050, respectively, compared to 2005 baseline levels. Significant contributors to these reductions include sustainable purchasing, building decarbonization, and commute trip reduction.

KEY

BAU (Business as usual) ----------

Anticipated trajectory of emissions without intervention under anticipated growth conditions.

ABAU (Adjusted business as usual)

Anticipated trajectory of emissions under the influence of state policies, without UW intervention.

- Clean Energy Transformation Act *(barely visible)*
- Clean Fuel Standard *(barely visible)*
- Climate Commitment Act

Expected ----------

Showing the cumulative impact of state policies and UW actions:

- Commuting emission reductions
- Fleet electrification
- Air travel reduction
- UW seattle power plant electrification
- Energy efficiency (completed by 2050)
- Refrigerant management *(barely visible)*
- Goods & Service

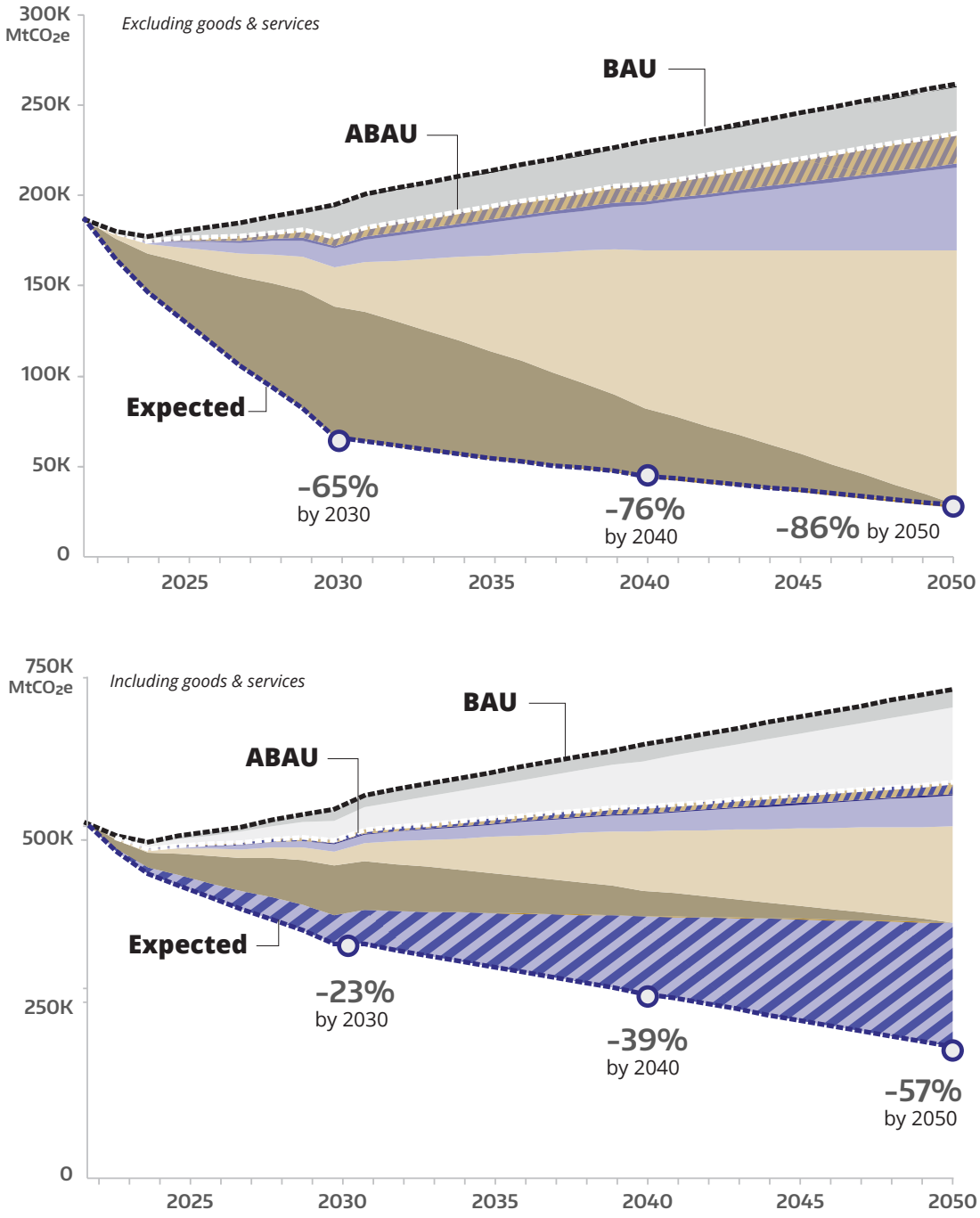


Figure 21. University reduction strategy modeling (including or excluding consumption-based emissions)

RECOMMENDATIONS

This analysis provides the most comprehensive picture to date of the university's past, current, and future greenhouse gas emissions. Its findings provide key insights into how the university is progressing and what more is needed to meet its short- and long-term emission reduction goals.

KEY TAKEAWAYS

Key takeaways from the analysis are presented below:

- **Major emissions sources consistently include purchasing, natural gas consumption, commuting, and air travel.**
- **The UW is trending in the right direction**, including achieving significant emission reductions between 2019 and 2022 due to teleworking, reduced air travel, and increased efficiency in our facilities.
- **More accelerated progress will be needed** to meet state requirements and emission reduction goals.

RECOMMENDATIONS

Given these trends, the following priority actions are recommended for the University of Washington:

- **Transition off natural gas consumption at the Seattle campus** through targeted decarbonization efforts.
- **Continue to explore opportunities to include requirements or provisions for lower-impact professional services, construction, and food service contracts.** For example, introducing requirements for using lower-carbon concrete mixes in major construction contracts.
- **Reduce emissions associated with UW air travel** through multi-pronged approach, such as: providing education and resources to the UW community to fly less, institute an internal carbon mitigation fee to help reduce direct emissions across UW facilities, and purchase flights from airlines that use sustainable aviation fuels.
- **Continue to advocate for and incentivize lower-carbon commuting alternatives.**
- **Examine ways to shift to lower-impact refrigerants and anesthetics**.

These recommendations reflect the highest-emitting sectors for the

university and/or those with the largest perceived potential for reduction. Much of this work has already begun by the university—including the Energy Transformation Program which will substantially reduce emissions from the Seattle Central Power Plant; the Green Building Standard revision which will impact both embodied and operational emissions; and the formation of a university-wide initiative to reduce air travel emissions. These recommendations represent opportunities to continue and expand upon those activities into areas such as goods and services purchased.

APPENDIX A:
METHODOLOGY & SOURCES

The inventory followed the World Resources Institute's Greenhouse Gas Protocol—the leading standard for organizational inventories in the United States.

Inventory data collection and analysis were performed in Microsoft Excel based on workbooks utilized for previous University of Washington inventories. Data was provided by various departments within the University of Washington as listed in table 4 as well as from relevant local utilities. Emission factors (emissions per unit activity, such as $MtCO_2e/kWh$) were derived from local sources, where possible. All emissions calculations underwent an internal quality control / quality assurance (QAQC) process and were reviewed to ensure compliance with current approaches and standards. The following sections describe the methodology for individual components of the inventory in more detail.

sector	*emission factor(s)*	*data sources*
PURCHASES		
Purchases	"USEEIO Supply Chain Greenhouse Gas Emission Factors v1.2 by NAICS-6" (https://catalog.data.gov/dataset/supply-chain-greenhouse-gas-emission-factors-v1-2-by-naics-6)	Category and spend data for all UW units acquired through UW Central Purchasing and UW Medicine Purchasing. More granular food purchasing data acquired from contacts at HFS, UW Medicine and ICA.
TRAVEL & TRANSPORTATION		
Vehicle fleet	diesel fuel: 10.150 $kgCO_2$/gal 0.04488 gCH_4/gal 0.04224 gN_20/gal gasoline: 8.810 $kgCO_2$/gal 0.25434 gCH_4/gal 0.16362 gN_20/gal E85 (flex fuel): 4.46 $kgCO_2$/gal *Source: World Resources Institute, "Emission_Factors_from_Cross_Sector_Tools_March_2017.Xlsx," Microsoft Excel (World Resources Institute (WRI), March 2017) https://ghgprotocol.org/sites/default/files/Emission_Factors_from_Cross_Sector_Tools_March_2017.xlsx*	Gallons of fuel (diesel, gasoline, E85 and propane) vehicle type, and miles traveled provided by UW Transportation (which serves all three campuses).

sector	*emission factor(s)*	*data sources*
Commuting	Average fuel economy per vehicle in 2019: 28.3 Average fuel economy per vehicle in 2020: 28.6 (this value was used for 2022 because it was the most current value available during the time of this calculation). Average Fuel Intensity of motorcycles: .0189 gallons per passenger mile (From table 4.1 and 2.13 in the Transportation Energy Book, Edition 40 produced by the Oak Ridge National Laboratory: https://tedb.ornl.gov/data/) Metro Transit: 0.206 gallons of fuel per passenger mile (calculated based on passenger miles and fuel consumed data). This is assumed to be representative of all transit used by UW commuters.	Bothell & Tacoma: Emissions from Washington State Trip Reduction Reports provided by UW staff. Seattle: Commute distance, frequency, and modes from annual commute survey. (Harborview Medical Center, Northwest Hospital & Outlying facility commuting data was not available).
Air travel	Short-haul flights (<300 miles) 0.206 $kgCO_2$/passenger mile 0.0071 gCH_4/passenger mile 0.0065 gN_20/passenger mile Medium-haul flights (>=300, <2300 miles) 0.131 $kgCO_2$/passenger mile 0.0006 gCH_4/passenger mile 0.0042 gN_20/passenger mile Long-haul flights (>=2300 miles) 0.161 $kgCO_2$/passenger mile 0.0006 gCH_4/passenger mile 0.0051 gN_20/passenger mile *Source: EPA: Emission Factors for Greenhouse Gas Inventories (Last Modified: 15 September 2021), Table 10 "Scope 3 Category 6: Business Travel and Category 7: Employee Commuting"*	Flight reimbursement data (with dates, origin and destination cities) comes from the purchasing database (via UW Travel Office and from UW Finance DATAGroup for flights paid for via a Central Travel Account). This data covers all flights paid for through funds managed by the University include travel by self-sustaining units such as Intercollegiate Athletics. Emissions were calculated based on distance between origin and destination locations and adjusted for short- medium- and long-range flights (following the model set by Stanford University).
FOSSIL FUEL COMBUSTION		
Electricity	Seattle City Light emission factor: 0.0 tCO2e/MWh Tacoma Power emission factor: 0.0 tCO2e/MWh Puget Sound Energy Green Direct emission factor: 0.0 tCO2e/MWh Other local utilities (same as regional grid factor below) *Source: Washington Department of Commerce Annual Fuel Mix Report (for 2019 & 2021)* Regional (Location-based) emission factor: 634.599 lb CO2equivalent/MWh *Source: EPA Emissions & Generation Resource Integrated Database (eGRID), file eGRID_Data.xls, January 30, 2023, tab "SRL21" cell V:14*	Bothell: Data from Puget Sound Energy (PSE). Tacoma: Data from Tacoma Power. Seattle: Data from Seattle City Light. Seattle Self-Sustaining Units (ICA, UWM & HFS): Recharge data from UW Facilities (UWF provides electricity to self-sustaining units on the Seattle campus and meters this data). UW Medicine-Harborview: Data from Harborview Medical Center. Outlying units: UW contacts.

sector	*emission factor(s)*	*data sources*
Natural gas	53.06 $kgCO_2$/mmBtu 1.0 gCH_4/mmBtu 0.10 gN_20/mmBtu Code of Federal Regulations: Table C-1 to Subpart C of Part 98, Title 40 https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98/subpart-C/appendix-Table%20C-1%20to%20Subpart%20C%20of%20Part%2098	UW Seattle, Bothell & Tacoma: Consumption data from Puget Sound Energy (PSE).
Fuel oil	10.21 $kgCO_2$/gal 0.41 gCH_4/gal 0.08 gN_20/gal *(Reference source same as for Natural Gas)*	UW Seattle data from operator of central power plant.
Propane	5.68 $kgCO_2$/gal 0.28 gCH_4/gal 0.06 gN_20/gal *(Reference source same as for Natural Gas)*	Outlying units: Data from UW contacts at these facilities.
Steam	2019 = 0.01332 therms/lbs 2022 = 0.013706 therms/lbs *(communications with Chief Sustainability Officer Centrio, May, 2023)*	Harborview Medical Center (data came from the steam provider Centrio.)
FUGITIVE EMISSIONS		
Historic landfill on UW property	*2005 Inventory of Greenhouse Gas Emissions Ascribable to the University of Washington, by Roel Hammerschlag and Matthew Van Sickle (2007).* *https://sustainability.uw.edu/files/cap/uw_ghg_inventory_2005.pdf*	Calculated using data and algorithms devised for original (2005) UW GHG emission inventory.
Refrigerants	Refrigerants and global warming potential R-12 10900 tCO2e/t R-134A 1430 tCO2e/t R-22 1810 tCO2e/t R-23 14800 tCO2e/t R-401A 1182.48 tCO2e/t R-401B 1288.26 tCO2e/t R-404A 3921.6 tCO2e/t R-407C 1773.85 tCO2e/t R-409A 1584.75 tCO2e/t R-410A 2087.5 tCO2e/t R-422B 2525.75 tCO2e/t R-422D 2729.12 tCO2e/t R-449A 1396.29 tCO2e/t R-508B 13396 tCO2e/t *Source: California Air Resources Board, High-GWP Refrigerants https://ww2.arb.ca.gov/resources/documents/high-gwp-refrigerants*	Seattle: Refrigerants purchased for Seattle campus acquired from UW Stores & UW Medicine. Bothell: UW staff. Tacoma: UW staff.
Anesthetic gases	Anesthetic gases Sevoflurane 130 tCO2e/t Isoflurane 510 tCO2e/t Desflurane 2540 tCO2e/t source: Andersen, Mads P. Sulbaek, et al. "Assessing the impact on global climate from general anesthetic gases." Anesthesia & Analgesia 114.5 (2012): 1081-1085. (Table 1)	Anesthetic gas data from Harborview Medical Center and UW Medicine.

sector	*emission factor(s)*	*data sources*
Solid waste generation & disposal	For each of 61 categories of waste (e.g. "newspaper", "grains", "PET plastic") the EPA WARM model tool provides emission factors per ton of material "source reduced", recycled, landfilled, combusted, composted or anaerobically digested. *source: EPA WARM v. 14, tab "Analysis Results (MTCO2E)"*	Waste data sources are described under "Solid waste generation and disposal." Landfill information acquired from the service provider websites and calls to providers.
Solid waste generation & disposal	EPA Emissions Factor Hub Table 9: Scope 3 Category 5: Waste Generated in Operations and Category 12: End-of-Life Treatment of Sold Products. *(https://www.epa.gov/system/files/documents/2023-03/ghg_emission_factors_hub.pdf)*	Bothell and Tacoma data was extracted from bills and consists of number and size of waste receptacles rather than weight of disposed material. Seattle waste data is provided by UW Recycling and Harborview Medical Center, and is broken down as indicated below

Waste sent to landfills
• Tons of medical waste (treated sharps and biowaste)
• Tons of general waste (further broken down into the categories below based on results of a waste characterization study conducted in 2018.)
• Corrugated Containers [plain OCC/kraft and waxed OCC/kraft)
• Magazines/Third-class Mail (Low-grade paper)
• Newspaper
• Office Paper (High-Grade Paper)
• Textbooks (Hardcover books)
• Mixed Paper (general) Non-compostable single-use food service paper products, polycoated/aseptic packaging, compostable/soiled paper, non-recoverable & composite paper
• Food Waste
• Yard Trimmings (grass/leaves/prunings, other untreated wood)
• HDPE
• PET containers
• PS (expanded polystyrene)
• Mixed Plastics
• Bioplastics (Compostable single use food service plastics and compostable liners/bags)
• Mixed Electronics
• Aluminum cans
• Aluminum (other)
• Mixed Metals
• Glass
• Carpet
• Asphalt Concrete
• Asphalt shingles
• Dimensional lumber (pallets/crates wood, dimensional lumber)
• Fiberglass insulation
• Tires
• Mixed MSW (all non-recoverable materials not counted in the rest of the waste sort categories)

Waste sent to be recycled
• Tons Cardboard Corrugated Containers Recycled
• Tons Mixed Paper (general + shredded paper + hardbound books) recycled
• Tons Mixed Metals Recycled
Tons Mixed Recyclables Recycled
• Tons Mixed Electronics Recycled (electronic media, batteries, electronics, cell phones)
• Tons light bulbs/tubs recycled
• Tons PS Plastic (Styrofoam) Recycled
• Tons appliances/white goods recycled
• Tons mixed construction & demolition recycled (does not include contractors/large building demos)
• Tons Tires Recycled
• Tons Asphalt Concrete recycled
• Tons textiles recycled
• Tons mixed plastics recycled (plastic film)
• Tons cooking oil recycled to fuel

Waste sent to be composted:
• Tons Dimensional Lumber Composted
• Tons Yard Trimmings Composted
• Tons Leaves Composted
• Tons Mixed Organics (food, paper, PLA) Composted
• Tons Coffee Grounds Composted

Material reused:
• Tons Dimensional Lumber Reused (estimate for pallets reused on campus)
• Tons Donated to local charities from Res Halls (food, toiletries, clothing, household goods, school/art supplies)
• Tons food donated (Food lifeline, meal matchup)
• Tons Surplus Resold/Reuse

APPENDIX B:

SUMMARY TABLES

2005								
	Outlying	Bothell	Tacoma	Athletics	HFS	UW Medicine	Seattle	Grand Total
goods & services	8	453	665	2,265	12,137	132,575	105,079	253,182
fossil fuel combustion	227	626	704				89,411	90,968
commuting		1,356	2,067				52,618	56,041
air travel		383	494	5,201	54	17,862	25,266	49,260
fugitive emissions		-	259			181	13,703	14,143
electricity	925	3,023	236				-	4,184
solid waste		158	36				3,652	3,846
vehicle combustion	152	60	11				2,666	2,889
TOTAL	**1,312**	**6,060**	**4,472**	**7,466**	**12,191**	**150,618**	**292,395**	**474,513**

2019

	Outlying	Bothell	Tacoma	Athletics	HFS	UW Medicine	Seattle	Grand Total
goods & services	23	1,978	1,610	2,602	19,701	134,969	140,170	301,053
fossil fuel combustion	45	568	806	1,971	5,761	12,216	80,052	101,417
air travel		1,245	1,092	6,503	68	22,334	31,592	62,834
commuting		1,825	2,984	289	490	11,166	30,438	47,192
fugitive emissions		-	-			2,030	7,845	9,874
purchased steam						12,301		6,931
solid waste	-	92	69			1,522	2,183	3,866
vehicle combustion	3	14	27	2	70	122	2,538	2,777
electricity	447	-	10	-	-	-	-	456
TOTAL	**519**	**5,722**	**6,598**	**11,368**	**26,089**	**191,288**	**294,817**	**536,400**

2022

	Outlying	Bothell	Tacoma	Athletics	HFS	UW Medicine	Seattle	Grand Total
goods & services	11	1,328	1,369	3,011	16,136	176,253	139,698	337,805
fossil fuel combustion	76	488	887	1,883	5,728	12,581	75,990	97,634
air travel		478	580	5,515	26	13,108	13,455	33,162
commuting		1,489	2,914	123	209	5,730	19,514	29,980
purchased steam						14,088		14,088
fugitive emissions		-	296			3,251	5,919	9,467
solid waste	-	97	22			1,245	1,640	3,005
vehicle combustion	18	9	16	4	47	115	2,038	2,247
electricity	124	-	-	-	-	-	-	124
TOTAL	**229**	**3,888**	**6,084**	**10,537**	**22,146**	**226,372**	**258,254**	**527,510**

2019	Housing & Food Services		Intercollegiate Athletics		UW Bothell		UW Medicine		UW Seattle		UW Tacoma	
Purchase categories	$MTCO_2e$	Cost	$MTCO_2e$	Cost	MCO_2e	Cost	$MTCO_2e$	Cost	MTCO2e	Cost	MTCO2e	Cost
Accommodation and Food Services	17,740	$17,416,887	412	1808179.55	93	566916.93	1,799	10947642.91	2,502	14782214.15	60	348784.77
Administrative and Support and Waste Management and Remediation Services	15	$118,829	43	339020.32	74	684845.36	1,496	33546040.44	3,026	24050463.91	70	1033682.73
Agriculture, Forestry, Fishing and Hunting									3,899	2685682.31	0	69.19
Arts, Entertainment, and Recreation	26	$82,707	18	61860.45	113	374740.33	314	953648.39	3,073	10438488.92	115	370295.44
Construction					67	258911.61	2	7887.56	30,972	119720712.4	24	92573.24
Educational Services	1	$6,041	2	15671.16	30	211893.89	99	632129.43	2,526	15296260.53	52	377782.07
Finance and Insurance			4	103592.71	0	263.12	152	4231373.48	413	11473219.41	0	51.64
Government	4	$27,787	5	37285.37	5	34942.86	3	19009.29	1,247	8685874.4	9	63534.48
Health Care and Social Assistance			17	188227.87	3	34022.03	1,845	12590132.87	1,009	11103260.05	1	12052.11
Information	84	$589,112	67	471910.31	32	231410.78	490	4685513.4	5,285	37762157.92	122	905426.89
Manufacturing - Food, Textiles, Apparel, Leather							291	1623718.051				
Manufacturing - Metals, Machinery, Electronics, Misc							30,788	169905129.7	62	334754.19		
Manufacturing - Wood, Paper, Petroleum, Chemicals	1	$1,963	1	94291.67	1	70575.76	26,762	210493464.4	11,012	29136763.16	36	152482.43
Other Services (except Public Administration)	366	$2,443,132	106	725770.68	262	1775710.63	9,583	63698213.45	2,991	20422872.83	255	1737286.77
Professional, Scientific, and Technical Services	227	$2,383,927	1,103	13671804.61	268	3036476.73	5,754	60882998.85	42,914	460592718.9	241	2862974.91
Real Estate and Rental and Leasing	296	$1,996,484	434	2835247.98	108	516487.85	4,252	23701425.61	8,300	55073043.66	248	1655167.35
Retail Trade							21,406	133606670.2	1,068	6204350.12		
Transportation and Warehousing	11	$76,670	42	1727211.53	2	362011.33	16,752	17570197.7	1,042	25252891.24	9	368371.73
Utilities	0	$381,679			0	930429.39	4,352	10342727.02	0	30765141.88	0	1024357.01
Wholesale Trade	33	$154,977	19	167626.19	1	5914.47	4,639	29055867.78	781	4314327.15	16	79376.09
Unable to categorize	0	$5,011,148	0	17710739.5	0	9144.24	0	102895445.9	0	163126662.2	0	50855.81
Grand Total	**18,803**	**$30,691,343**	**2,273**	**39958439.9**	**1,061**	**9104697.31**	**130,780**	**891389236.4**	**122,121**	**1051221859**	**1,258**	**11135124.66**

2022	Housing & Food Services		Intercollegiate Athletics		UW Bothell		UW Medicine		UW Seattle		UW Tacoma	
Purchase categories	$MTCO_2e$	Cost	$MTCO_2e$	Cost	MCO_2e	Cost	$MTCO_2e$	Cost	MTCO2e	Cost	MTCO2e	Cost
Accommodation and Food Services	14,376	$16,090,624	782	$4,120,023	47	$327,005	2,028	$12,489,529	1,482	$10,180,959	33	$219,841.32
Administrative and Support and Waste Management and Remediation Services	3	$28,635	36	$327,313	35	$534,179	10,734	$279,987,905	1,982	$21,745,229	39	$648,910.28
Agriculture, Forestry, Fishing and Hunting					1	$547			3,768	$3,046,835	0	$358.53
Arts, Entertainment, and Recreation	14	$50,653	26	$95,952	64	$253,591	203	$722,266	2,230	$8,965,563	73	$269,070.60
Construction					108	$489,401			34,177	$155,087,930	15	$66,379.77
Educational Services			2	$12,273	13	$108,967	127	$979,669	2,200	$15,753,357	28	$238,181.79
Finance and Insurance	0	$131	2	$65,076			0	$12,000	456	$14,902,188	0	$3,073.83
Government	4	$30,147	3	$28,073	13	$105,865	2	$18,766	651	$5,322,235	7	$57,688.29
Health Care and Social Assistance			16	$207,968	1	$17,019	2,524	$17,084,080	716	$9,201,577		
Information	46	$375,227	47	$408,098	91	$778,265	555	$4,954,191	3,815	$32,107,081	101	$873,147.87
Manufacturing - Food, Textiles, Apparel, Leather							460	$1,936,036				
Manufacturing - Metals, Machinery, Electronics, Misc							40,714	$227,287,841	17	$103,459		
Manufacturing - Wood, Paper, Petroleum, Chemicals	19	$36,934	8	$125,961	35	$195,797	29,250	$238,733,562	8,217	$28,543,941	30	$183,592.58
Other Services (except Public Administration)	466	$3,696,653	79	$633,962	134	$1,074,159	10,816	$77,269,806	2,653	$21,210,990	166	$1,324,299.82
Professional, Scientific, and Technical Services	223	$2,838,035	1,128	$16,450,161	299	$4,162,435	3,269	$40,080,597	52,729	$653,654,481	293	$4,043,114.43
Real Estate and Rental and Leasing	123	$975,887	482	$3,779,124	182	$1,325,196	3,856	$27,750,225	7,545	$57,473,977	238	$1,809,660.25
Retail Trade			0	$2,299			31,748	$200,546,917	426	$2,902,756		
Transportation and Warehousing	15	$101,882	104	$1,693,442	2	$169,045	28,945	$30,544,981	1,114	$20,143,490	9	$243,407.64
Utilities	0	$391,245			0	$875,550	4,237	$6,202,330	0	$39,353,519	0	$1,117,962.84
Wholesale Trade	22	$113,433	15	$159,911	13	$85,450	3,763	$23,187,152	556	$3,590,610	25	$176,689.21
Unable to categorize	0	$6,239,332	0	$13,495,828	0	$1,614,223	0	$123,152,163	0	$306,970,912	0	$23,470.23
Grand Total	**15,312**	**$30,968,820**	**2,730**	**$41,605,463**	**1,038**	**$12,116,694**	**173,231**	**$1,312,940,016**	**124,735**	**$1,410,261,089**	**1,056**	**$11,298,849.28**

GHG Emissions (MTCO2e)	2005	2019	2022
FOSSIL FUEL COMBUSTION	90,968	101,417	97,634
Athletics		1,971	1,883
Bothell	626	568	488
HFS		5,761	5,728
Outlying	227	45	76
Seattle	89,411	80,052	75,990
Tacoma	704	806	887
UW Medicine		12,216	12,581
VEHICLE COMBUSTION	2,889	2,777	2,247
Athletics		2	4
Bothell	60	14	9
HFS		70	47
Outlying	152	3	18
Seattle	2,666	2,538	2,038
Tacoma	11	27	16
UW Medicine		122	115
ELECTRICITY	4,184	448	124
Athletics		-	-
Bothell	3,023	-	-
HFS		-	-
Outlying	925	447	124
Seattle	-	-	-
Tacoma	236	10	-
UW Medicine		-	-

APPENDIX C:

CARBON SEQUESTRATION

While a GHG emissions inventory accounts for emissions sources from the university, there are also university activities that result in the removal of GHG emissions from the atmosphere—also referred to as "carbon sequestration." Standard GHG accounting protocols do not advise including carbon sequestration within the GHG emissions inventory accounting, but quantification of carbon sequestration can be considered for informational purposes. The primary source of carbon sequestration at University of Washington is forest lands. Proper management of university-managed forest lands can result in removals of carbon dioxide from the atmosphere. Pack Forest sequesters an estimated 76,604 $MtCO_2e$ each year.

APPENDIX D:

EMISSIONS BY SCOPE

The World Resources Institute (WRI) Greenhouse Gas Protocol categorizes emissions into three scopes based on relative level of control/ownership:

- **Scope 1 emissions** include direct emissions from sources owned or controlled by UW within the organizational boundary. It covers emissions from activities such as natural gas boilers, fuel consumed by fleet vehicles, and fugitive emissions.
- **Scope 2 emissions** include indirect emissions resulting from the purchased electricity consumed by UW.
- **Scope 3 emissions** include upstream and downstream emissions for which UW does not have direct operational control. It includes emissions from air travel, commuting; and goods and services procurement. It also includes fossil fuel combustion and purchased steam for Harborview Medical Center since the building is owned by King County and therefore not under full UW control.

Figure 23 shows a breakdown of 2022 UW GHG emissions by these scope categories.

EMISSIONS BY SCOPE

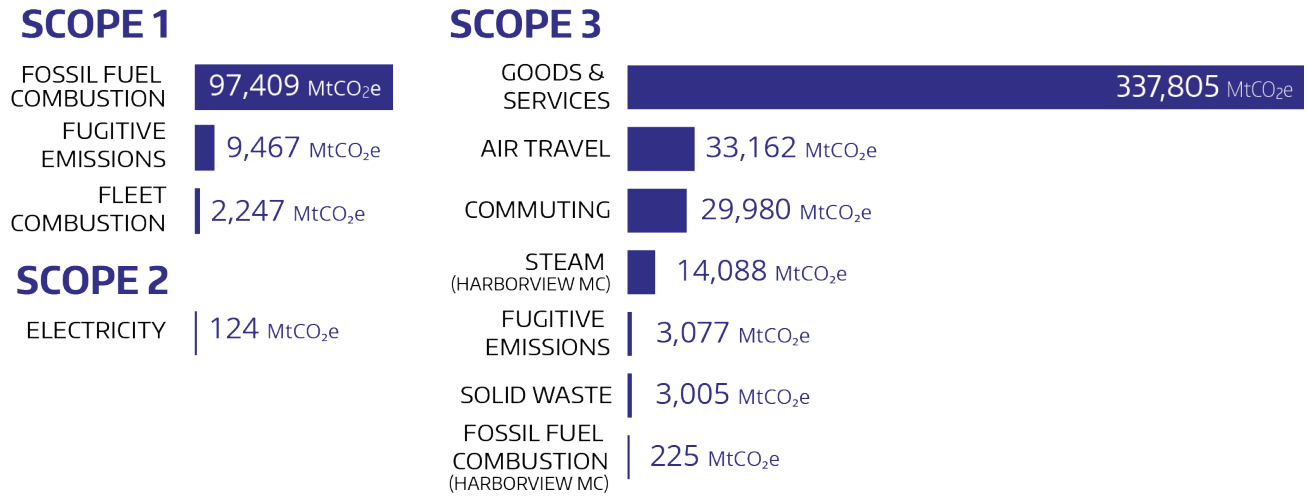


Figure 22. Overall University of Washington 2022 GHG emissions, by scope and category. Harborview MC is managed by UW, but owned by King County so purchased steam and fossil fuel combustion at Harborview MC are categorized as Scope 3 for UW.

APPENDIX E:

GUIDE TO SUPPLEMENTARY FILES

Inventory Files

1 file for each year (2005, 2019, 2022)
These files include the original data and their conversion to $MtCO_2e$
These files also include pointers to raw data files and reference sources

Summary File: An excel file in which the $MTCO_2e$ data is compiled on a single excel sheet

Wedge Analysis (excel file). Includes the model assumptions, data and charts