University of Kentucky
2017-2018 Greenhouse Gas Emissions Reduction Report

January 4, 2019

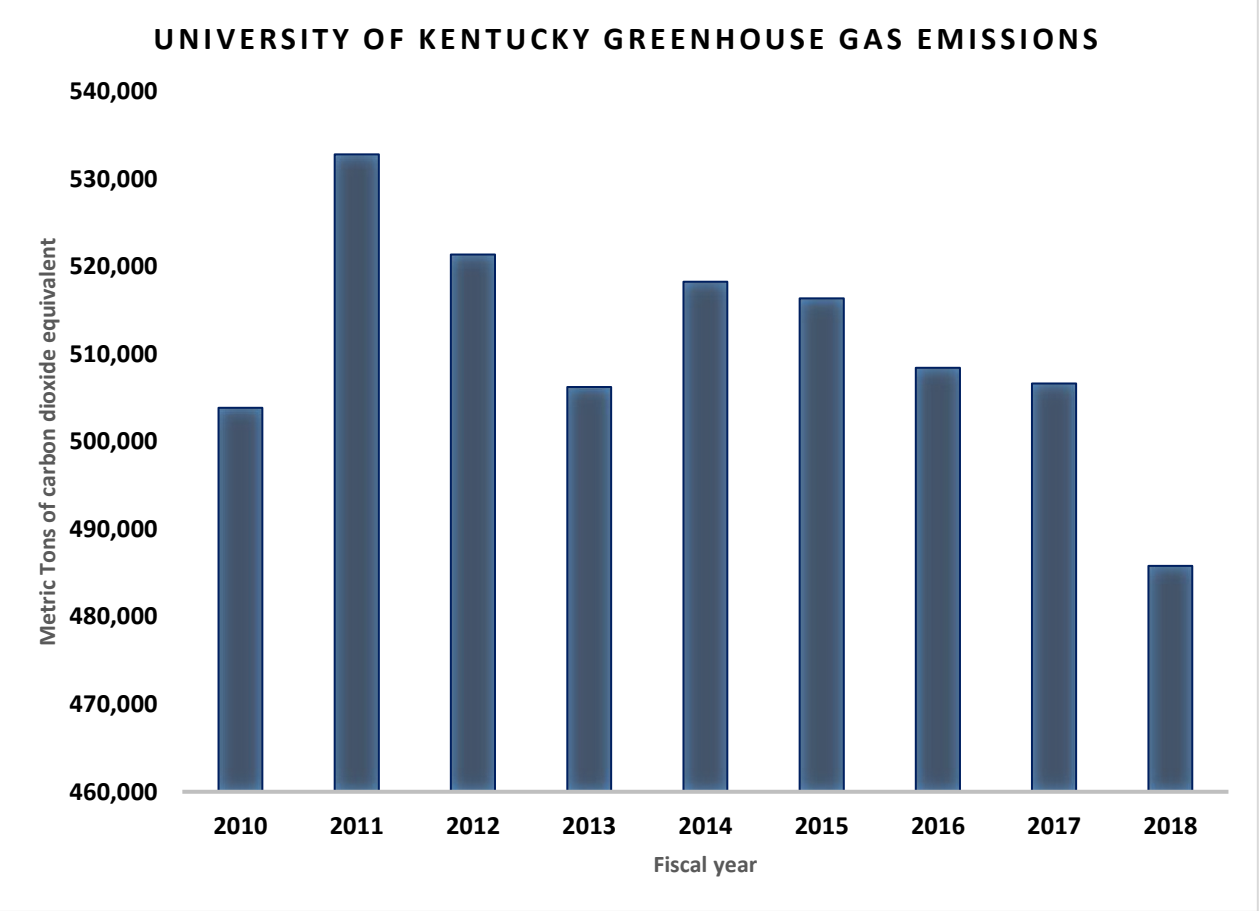
Prepared by the Office of Sustainability and Utilities and Energy Management

Executive Summary

In December of 2016, the University of Kentucky made a commitment to reduce its greenhouse gas emissions by 25% versus a 2010 baseline by 2025. An Emissions Reduction Plan was created in early 2017 to guide our progress toward this goal. Campus emissions for fiscal year (FY) 2010 totaled 505,736 metric tons of carbon dioxide equivalent ($mtCO_2e$) based on the sources and methodologies included in this plan. Achieving an annual emissions total that is 25% below FY2010 total requires that the University reduce annual emissions to 379,302 $mtCO_2e$ or less by FY2025.

2017-2018 was the first full year of implementation for UK's plan and significant reductions were achieved. Greenhouse gas emissions for the campus totaled 485,818 $mtCO_2e$, a reduction of more than 18,000 $mtCO_2e$ compared to the FY2010 baseline.

Energy conservation and gains in chilled water production efficiency accounted for the majority of these reductions. Lighting upgrades and steam distribution systems improvements also yielded significant reductions. This report provides details on our progress toward our emissions reduction target.



Scope of this Report

This report includes annual emissions from eight distinct sources of campus emissions. These sources are listed below and **Appendix A** provides the emissions quantification methodology for each source. These eight sources do not include every source of campus emissions; however, they do represent the vast majority of campus carbon footprint. **Table 1** provides the University's inventory of emissions from these sources for fiscal years 2010 through 2018.

This plan uses the emission categories, known as scopes, established by the International Greenhouse Protocol Standard (http://www.ghgprotocol.org/). These standards organize emission sources into three levels based on the degree of control and influence an entity has over the source and quantity of the emissions.

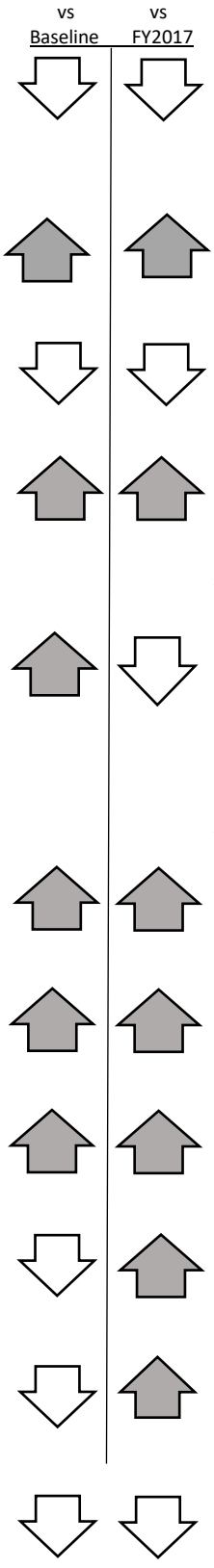
Scope 1 - Entity controls the amount and source of the processes and products producing the emissions

    - Coal and natural gas burned in equipment owned and operated by UK and partners in housing and dining
    - Fuel used in campus-owned vehicles
- Scope 2 - Entity controls the amount but not the source of the processes and products producing the emissions
    - Purchased electricity
- Scope 3 - Entity controls neither the amount nor the source of the processes and products producing the emissions
    - Commuting activities of students, staff, and faculty
    - Student air travel for Education Abroad
    - Directly financed air travel
    - Solid waste sent to landfills
    - Wastewater treatment

This report includes emissions from the sources listed above that originate from the main campus in downtown Lexington, Kentucky. This includes the operations of UK HealthCare, UK Athletics, and the facilities operated by UK's partners in student housing and campus dining services.

	Table 1: Campus Emissions Inventory by fiscal year								
Calculated Emissions ($mtCO_2e$)	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018
Emissions for Scope 1: Direct Emissions									
Coal for UK Heating Plants	77,373	82,627	61,996	39,152	24,694	25,306	21,858	21,125	13,777
Natural Gas for UK Campus	38,807	44,440	48,927	68,916	79,802	79,343	72,314	70,518	77,665
Gasoline for Fleet Transportation	1,783	1,811	1,772	1,781	1,777	1,773	1,693	1,791	1,871
Diesel for Fleet Transportation	733	739	762	790	777	727	656	564	477
Emissions for Scope 2: Purchased Utilities									
Electricity for UK Campus	323,494	338,369	348,210	337,400	352,147	348,743	362,387	372,538	349,297
Emissions for Scope 3: Indirect Emissions									
Air Travel: Business	3,549	3,809	3,837	4,080	4,323	4,566	4,781	5,534	5,959
Air Travel: Education Abroad	485	987	1,373	1,341	1,704	1,811	1,762	1,973	2,076
Campus Commuting: Employees	21,800	23,064	22,978	23,348	23,479	24,587	23,591	25,681	26,983
Campus Commuting: Students	5,154	5,318	4,887	4,921	4,838	4,417	3,951	4,116	4,504
Landfill Waste	30,430	31,388	26,387	24,276	24,475	24,881	15,200.08	2,582	3,015
Wastewater	235	245	222	230	231	214	215	225	194
Total Scope 1	118,696	129,616	113,457	110,639	107,049	107,149	96,521	93,999	93,790
Total Scope 2	323,494	338,369	348,210	337,400	352,147	348,743	362,387	372,538	349,297
Total Scope 3	61,653	64,810	59,683	58,196	59,051	60,477	49,500	40,111	42,730
Total Emissions	**503,843**	**532,796**	**521,350**	**506,235**	**518,247**	**516,368**	**508,408**	**506,647**	**485,818**

Summary of FY2018 Greenhouse Gas Emissions by Scope versus baseline and previous year



Direct Emissions/On Campus Combustion (Scope 1) – 19.3% of total emissions

Coal for heating plants – Emissions from the combustion of coal in campus boilers were calculated to be 13,777 $mtCO_2e$ in 2017-2018 or 2.8% of total emissions. This represents an 82% decrease versus the baseline and a 35% reduction versus FY2017. Decreases driven by increased reliance on natural gas.

Natural gas for heating plants – Emissions from burning natural gas on campus were calculated to be 77,665 $mtCO_2e$ in 2017-2018 or 16% of total emissions. This represents a 100% increase versus the baseline and a 10% increase versus FY2017. Increases driven by increased reliance on natural gas.

Gasoline for fleet vehicles – Emissions from gasoline burned in university-owned vehicles were calculated to be 1,871 $mtCO_2e$ or 0.1% of total emissions. This represents a 35% decrease versus the baseline and a 15% decrease versus FY2017.

Diesel for fleet vehicles– Emissions from diesel burned in university- owned vehicles were calculated to be 478 $mtCO_2e$ or 0.4% of total emissions. This represents a 5% increase versus the baseline and a 4% increase versus FY2017.

Purchased utilities (Scope 2) – 71.9% of total emissions

Electricity – The emissions from the electricity purchased from Kentucky Utilities to power the campus were calculated to be 349,297 $mtCO_2e$ or 72% of total emissions. This represents an 8% increase versus the baseline **but a 4% decrease** versus FY2017. Increase over baseline driven by growth of campus. Decrease versus previous year driven by conservation and efficiency efforts and investments.

Indirect Emissions (Scope 3) – 8.8% of total emissions

Business Air Travel – Emissions from employee air travel were calculated to be 5,959 $mtCO_2e$ in 2017-2018 or 1.2% of total emissions. This represents a 68% increase versus the baseline and an 8% increase versus FY2017.

Education Abroad Air Travel – Emissions from student education abroad air travel were calculated to be 2,076 $mtCO_2e$ in 2017-2018 or 0.4 % of total emissions. This represents a 328% increase versus the baseline and a 5% increase versus FY2017.

Employee Commuting – Emissions from employee commuting were calculated to be 26,983 $mtCO_2e$ in 2017-2018 or 5.6% of total emissions. This represents a 24% increase versus the baseline and a 5% increase versus FY2017.

Student Commuting – Emissions from student commuting were calculated to be 4,504 $mtCO_2e$ in 2017-2018 or 0.9% of total emissions. This represents a 13% decrease versus the baseline **but a 9% increase** versus FY2017.

Landfilled Waste – Emissions from landfilled waste were calculated to be 3,015 $mtCO_2e$ in 2017-2018 or 0.6% of total emissions. This represents a 90% decrease versus the baseline **but a 17% increase** versus FY2017.

Wastewater Treatment – Emissions from wastewater treatment were calculated to be 194 $mtCO_2e$ in 2017-2018 or 0.04 % of total emissions. This represents an 18% decrease versus the baseline and a 14% decrease versus FY2017.

Emissions Reduction Strategies

The University will pursue the 25 percent reduction target with a two-phased approach that includes nine reduction strategies for Phase 1 (FY2018-FY2021). These nine strategies, listed below, focus on energy conservation and efficiency, waste reduction, and transportation. **Table 2** details the progress made in year one in each of these areas.

Phase 1 Strategies (FY2018-2021)

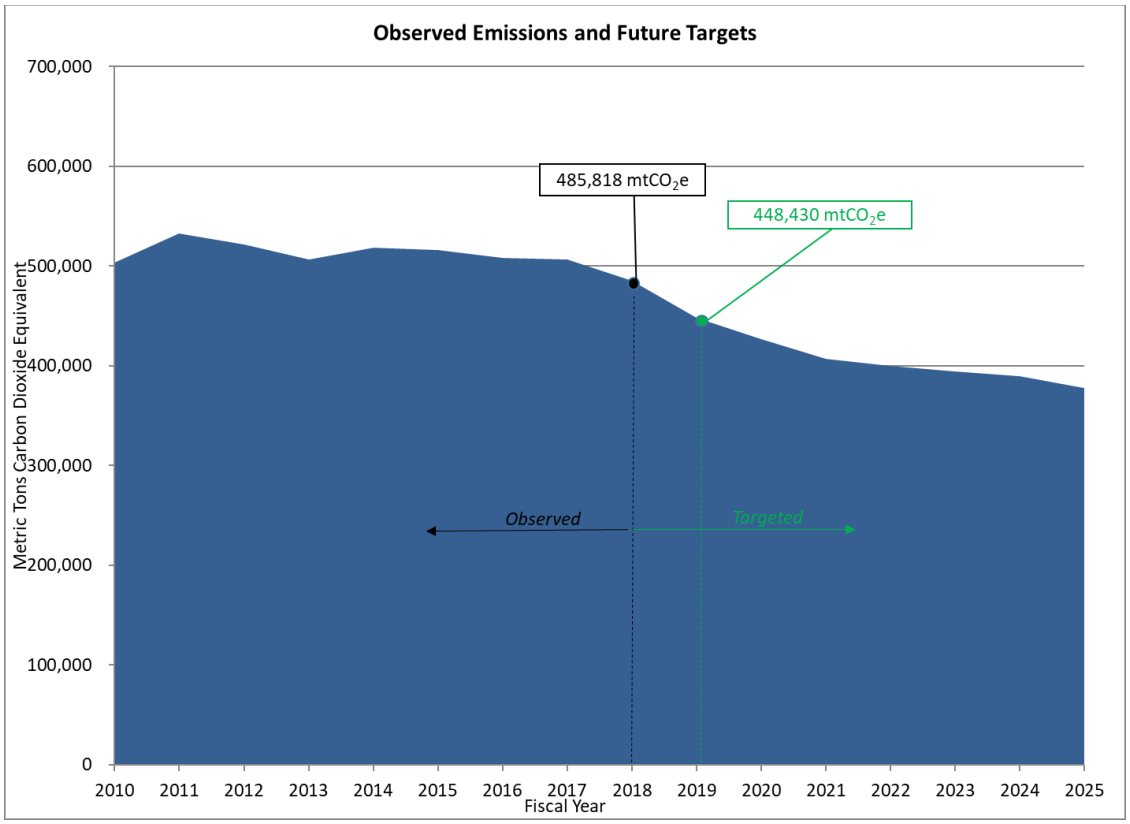
1. **Energy Conservation and Efficiency**
   - 1.1 Optimize building performance for energy efficiency
   - 1.2 Renovate and upgrade buildings for energy efficiency
   - 1.3 Optimize electricity used for lighting through equipment upgrades
   - 1.4 Improve the efficiency of baseload chilled water production
   - 1.5 Optimize steam distribution systems
2. **Waste Reduction**
   - 2.1 Increase campus waste diversion rate to 50 percent
3. **Transportation**
   - 3.1 Launch and promote alternative transportation programs and policies
   - 3.2 Work with campus and community partners to develop a service learning-focused effort to offset 50 percent of the annual emissions associated with Education Abroad air miles by 2025
   - 3.3 Work with campus and community partners to develop a service learning-focused effort to offset 25 percent of the annual emissions associated with University business air miles by 2025

Table 2 - Emissions Reductions by strategy

Reduction Strategies	FY2018 Emissions Reductions ($mtCO_2e$)
Optimize buildings for energy efficiency and conservation	13,250
Renovate and upgrade buildings for efficiency	0
Indoor and outdoor lighting equipment upgrades	314
Increase efficiency of baseload chilled water production	7,064
Optimize steam distribution systems	201
Increase campus waste diversion rate to 50%	No documented reductions versus previous year
Reduce commuter miles traveled	No documented reductions versus previous year
Education Abroad air miles emissions offset	Not yet implemented
Business air miles emissions offset	Not yet implemented
Employee Commuter Emissions Offset	Not yet implemented

Next Steps

The greenhouse gas emissions target for FY2019 is 448,430 $mtCO_2e$. We are pursuing this target through expanded energy conservation efforts, renovating and upgrading for energy efficiency, additional improvements to baseload chilled water production, lighting upgrades, optimization of steam distribution, and reducing the vehicle miles traveled by campus commuter.



Appendix A: Methodology for calculating campus emissions

There are several heat-trapping gases that are by-products of the activities of the University included in this plan. Each of these has been converted to a carbon dioxide equivalent for the purposes of this report. Metric tons of carbon dioxide equivalent ($mtCO_2e$) is the standard unit of measure for campus emissions.

Stationary Combustion for Steam Production

The University owns and operates 14 primary boilers that produce the steam needed to heat campus facilities and meet campus hot water needs. Ten of the boilers are fueled by natural gas and four are fueled by coal. The University operates these 14 boilers in compliance with regulations and permits provided by the Kentucky Division of Air Quality and the United States Environmental Protection Agency (USEPA). The emissions factors for these two fuels are:

- Coal combustion is tracked by the number of short tons (2000 lbs.) burned. Each short ton of coal burned releases 2.47664 $mtCO_2e$.
- Natural gas combustion is tracked by British thermal units (Btu) and one million BTUS (MMBtu) releases .054431643 $mtCO_2e$.

University-Owned Vehicles

The University owns and operates a large fleet of automobiles, service vehicles, buses, heavy equipment, and golf service carts. These vehicles run on a variety of fuels including gasoline, diesel, bio-diesel, and electric batteries. The emissions factors provided by the University of New Hampshire's Sustainability Indicator Management and Analysis Platform (SIMAP) are used to convert the fuel use of these vehicles to $mtCO_2e$.

Purchased Electricity

Purchased electricity is the largest single source of UK's GHG emissions. UK purchases all of its electricity from Kentucky Utilities (KU). The resulting emissions are considered Scope 2 because UK has control over the amount consumed, but not over the method used to produce the electricity.

KU has a current grid mix composed of 94.62 percent coal, 5.01 percent natural gas, and 0.37 percent renewable sources. The average heat rate is approximately 10,270 British thermal units (Btu) per kilowatt hour (kWh) for Kentucky power generation and grid loss is approximately 5.82 percent. The USEPA has established CO_2e emission rates of 210 pounds of CO_2e per million Btu (MMBtu) produced for coal and 120 lb./MMBtu for natural gas. Based on those rates and using the calculations below, the emissions factor for the electricity purchased by UK is 0.001007 $mtCO_2e$/kWh.

- Coal: 10,270 Btu/kWh x 210 lb./MMBtu x 0.9462 ÷ 1,000,000 = 2.04 lb. CO_2e/kWh plus
- Natural gas: 10,270 Btu/kWh x 120 lb./MMBtu x 0.0501 ÷ 1,000,000 = 0.06 lb. CO_2e/kWh
- Subtotal: 2.10 lb. CO_2e/kWh or 0.00095255 $mtCO_2e$ /kWh
- Grid loss: 5.82 percent of 2.10 lb. CO_2e/kWh = 0.12 lb./kWh
- Total: 2.10 lb./kWh + 0.12 lb./kWh = 2.22 lb. CO_2e/kWh or 0.001007 $mtCO_2e$ /kWh

Directly Financed Air Travel and Education Abroad Travel

The total air miles traveled by the UK community for business and Education Abroad purposes is tracked by two offices. The UK Education Abroad Office tracks the student air miles traveled for education abroad opportunities and UK Travel Services tracks all university-funded travel for staff and faculty. This report uses the emissions factors developed by the USEPA for short-, medium- and long-haul flights to convert the air miles traveled into emissions equivalents (https://www.epa.gov/sites/production/files/2015-07/documents/emission-factors_2014.pdf).

Commuting Activities of Students, Faculty, and Staff

Travel to, from, and around campus for daily activities generates a tremendous number of vehicle miles traveled (VMT) with corresponding emissions impacts, congestion, air quality issues, and safety concerns. Calculating the emissions that result from the vehicles driven to, from and around campus by employees and students is challenging due to the number of variables at play.

Employee commuter emissions are calculated using these figures, assumptions, and estimates:

- The number of employee permits sold for a given fiscal year
- The average employee makes five, round-trip commutes between home and campus per week
- The average employee works 48 weeks per year
- The average round-trip commute distance is estimated to be 15.9 miles based on survey data collected by UK Transportation Services from 2,604 employees
- All of these trips are made in vehicles that use unleaded gasoline and that the average fuel economy for these vehicles is 20.79 miles per gallon based on National Highway Traffic Safety Administration (NHTSA) data
- An emissions factor of 0.009795 $mtCO_2e$ /gallon of gasoline from USEPA data (https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references).

Employee emissions calculation ($mtCO_2e$) = {[Permits sold x 5 (trips) x 48 (weeks) x 15.9 (miles)]/20.79 (mpg)} x .009795 ($mtCO_2e$ per gallon)

Student commuter emissions are calculated using the following figures, assumptions, and estimates:

- The number of commuter permits (C permit) sold for a given fiscal year
- The assumption that the average student makes four round trip commutes between home and campus per week
- The assumption that the average student is on campus 34 weeks per year
- The average round-trip commute distance is estimated to be 7.66 miles based survey data collected by UK Transportation Services from 1,010 students
- The assumption that all of these trips are made in vehicles that use unleaded gasoline and that the average fuel economy for these vehicles is 20.79 miles per gallon based on NHTSA data for model years 1982-2011
- An emissions factor of 0.009795 $mtCO_2e$ /gallon of gasoline from USEPA data (https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references).

Student commute emissions calculation: {[Permits sold x 4 (trips) x 34 (weeks) x 7.66 (miles)]/20.79 (mpg)} x .009795 ($mtCO_2e$ per gallon) = $mtCO_2e$ per year.

Landfilled Waste

When placed in a landfill municipal solid waste (MSW) generates methane, a very potent greenhouse gas. There are also greenhouse gas emissions associated with the transport of the waste. This report uses the methodology developed for the University of New Hampshire's Sustainability Indicator Management and Analysis Platform (SIMAP) to convert tons of landfilled waste to carbon dioxide equivalent. Emissions factors for landfilled MSW vary widely depending on the presence and/or type of landfill gas recovery system in use at the landfill in question.

The landfill receiving the University's solid waste had very limited, if any, methane recovery or flaring until late 2015. In late 2015, a system for recovering landfill gas for power generation was activated in partnership with Toyota Motor Manufacturing of Kentucky. This significantly impacted the emissions associated with the University's solid waste. For FY2010-FY2015, this document uses the emissions factor of 3.1 mtCO2e /short ton of MSW based on the SIMAP emissions factor for solid waste with no methane recovery or flaring. For FY2016, this document uses the factor above for half the year and the SIMAP emissions factor for solid waste with methane recovery and flaring of 0.31 mtCO2e /short ton of MSW for the other half. Starting in FY2017 and projecting forward, this document uses the 0.31 mtCO2e/short ton of MSW. Additional information is available at https://sustainableunh.unh.edu/calculator.

Wastewater

Lexington's wastewater treatment process generates methane as a by-product. Due to methane capture and storage technologies installed at the treatment plant, the emissions from wastewater are quite low relative to the volume of water processed. The methodology from the University of New Hampshire's Sustainability Indicator Management and Analysis Platform (SIMAP) is used to convert the gallons of wastewater to carbon dioxide equivalent.