

THE UNIVERSITY OF ARIZONA

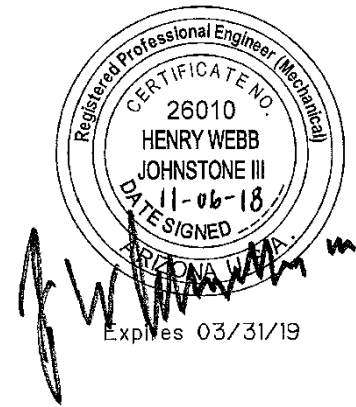
GREENHOUSE GAS EMISSIONS REPORT

FISCAL YEAR 2017

November 06, 2018

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McClelland Park Photovoltaic Installation



UA Bike Sharing Station, 6th Street Parking Garage

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INTRODUCTION

The University of Arizona (UA), located in Tucson, Arizona, has an enrollment of more than 42,000 students in more than 360 academic programs. The campus consists of 207 buildings on Main Campus located on 391 acres in central Tucson. The campus is the oldest continually maintained green space in Arizona. The UA recognizes the need to conserve its natural resources and is committed to creating a sustainable community for its students, employees and the neighboring community.

The UA is a signatory to The American College and University Presidents Climate Commitment (ACUPCC). Climate neutrality is defined as minimizing greenhouse gas (GHG) emissions as much as possible and using carbon offsets, or other measures, to mitigate the remaining emissions. The ACUPCC also requires that a comprehensive inventory of all greenhouse gas emissions be accomplished and updated every other year.

In accordance with its commitment, this report details the UA's GHG emissions for Fiscal Year (FY) 2017. The report is divided into sections according to major sources of emissions. The UA began tracking its environmental impact in FY 2009 and its main sources of measured emissions are purchased utilities, on-site utility related combustion, air travel and commuting. The University is pursuing priorities in purchased utilities categories by improving operational efficiencies within all three Utility Plants as well as the associated utility distribution systems and end use.

METHODOLOGY

Data for calculation and analysis of GHG inventory was collected from several departments on campus including Parking and Transportation Services, Facilities Management (Utilities Services, Motor Pool, Grounds Services, Custodial Service, Recycling and Business Services) and the UA Office of Sustainability. Emissions are reported as CO₂ with all emissions given in metric tons of CO₂ equivalent (MtCO₂e). The UA's FY 2017 greenhouse gas report includes emissions from the Main Campus' electricity use, natural gas use, refrigerant use, fleet fuel use, shuttle bus fuel use, employee air travel, fertilizer use and solid waste disposal. Also included in the report are estimated CO₂ emissions due to faculty, staff and student commuting.

Data supplied for this report covers FY 2017 for the Main UA Campus. This report does not include satellite locations or Biosphere 2.

In previous years the greenhouse gas emissions were calculated using the Microsoft Excel based program Campus Carbon Calculator developed by the University of New Hampshire Sustainability Institute. This calculator is no longer being supported and has been replaced by the University of New Hampshire with the on-line calculator Sustainability Indicator Management and Analysis Program (SIMAP). SIMAP was used to generate the FY 2017 greenhouse gas emissions values.

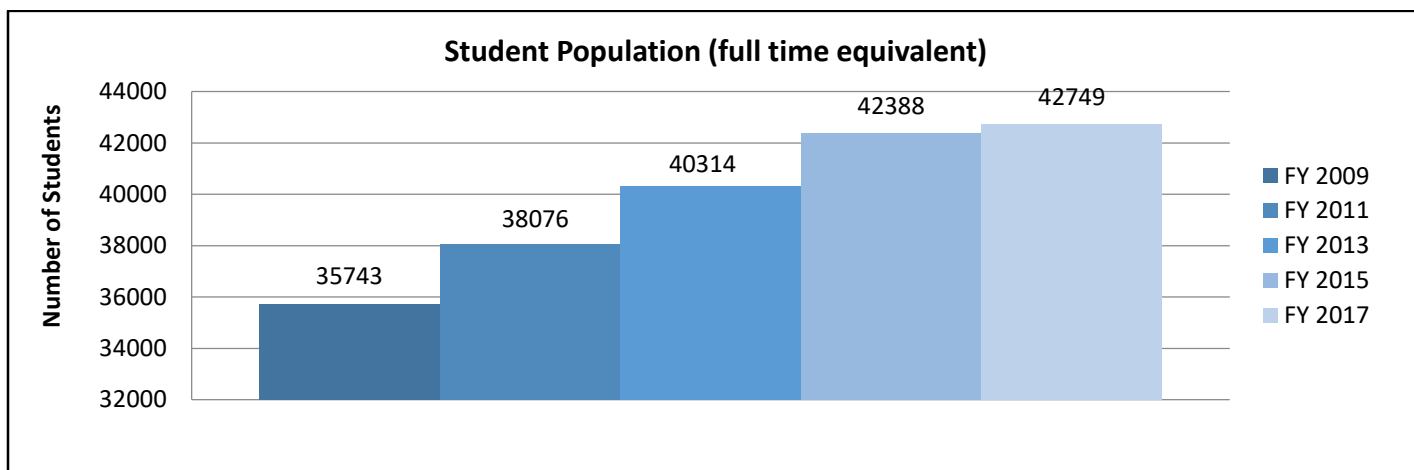
CAMPUS GROWTH

Since the fiscal year 2009 benchmark, the student population and physical campus has continued to grow. Fall 2017 records record a full time equivalent student population of 42,749, comprised of 34,841 undergraduate students and 7,908 graduate students. In addition, there were a total of 821 full time equivalent medical students enrolled in the 2017 fiscal school year. From 2009 to 2015 the student population increased at an average rate of 5.8% every 2 years. For the past 2 years from 2015 to 2017 the student population increased only 0.9%.

In fiscal year 2017 the University employed 15,056 total faculty and staff with a full time equivalent employee count of 11,919. These totals have decreased 3.5% and 4.5% respectively from fiscal year 2015.

The Main Campus size is 391 acres with a count of 207 buildings.

Graph 1: University Student Population Growth



UTILITY OPERATIONS

Data for FY 2017 indicates that approximately 57.1% of the overall campus greenhouse gas emissions are attributed to purchased utilities, compared to 73% in FY 2015. The main function of these utilities is to directly support building functions such as lighting, plug loads, cooling, heating, emergency generators, etc. The recognized decrease in utility-based emissions is attributed to the University's ongoing proactive efforts to reduce the energy usage of new buildings constructed on campus, combined with continuous investment in energy-saving projects for existing facilities and utility systems. All new buildings require, at a minimum, LEED Silver certification. The use of solar energy for heating water and photovoltaic systems for generating electricity is highly encouraged in all new building projects.

Fuel consumption for utility operations consists of natural gas used in turbines, utility plant boilers, building loads (such as stand-alone heating systems), emergency generators, lab use, and purchased electricity to the campus grid. Combined, these sources accounted for greenhouse gas emissions equating to 113,860 MtCO₂e in FY 2017, compared to 170,413 MtCO₂e in FY 2015. The reduction in utility-based emissions can be attributed to reductions in both natural gas usage and purchased electricity over the past two years, despite ongoing campus growth. Also contributing to the reduction in emissions attributed to purchased electricity is the updated electricity emissions factors in the new SIMAP calculation which were adjusted from 0.53 to 0.38 kg CO₂/kWh.

The purchased utility breakdown for electricity and natural gas are shown in Table 1, including the percent change between FY 2015 and FY 2017. The campus operates (2) gas fired turbines to generate electricity to feed the campus electric grid. In FY 2017 the turbine utilization increased to generate more electricity which in turn reduced the amount of purchased electricity required.

Table 2: Purchased Utilities – Comparison

| | FY 2015 | FY 2017 | % Change |
|---|----------------|----------------|-----------------|
| Purchased Electricity (kWh) | 165,063,041 | 151,948,429 | -7.9% |
| Purchased Turbine Natural Gas (mmbtu) | 1,021,724 | 1,113,383 | +8.9% |
| Purchased Boiler Natural Gas (mmbtu) | 409,697 | 389,283 | -4.9% |
| Purchased Building Natural Gas (mmbtu) | 27,233 | 28,059 | +3.0% |

Below are descriptions of significant projects undertaken by UA Facilities Management and UA Planning, Design and Construction to date from FY 2009. It is anticipated that these projects will reduce the University of Arizona Main Campus greenhouse gas emissions.

Steam and Chilled Water Tunnel Improvements

A significant amount of tunnel steam and chilled water distribution piping were assessed and repairs were made to leaking valves, steam traps and expansion joints. In addition, all missing or compromised piping insulation was replaced. This effort is considered ongoing and further lengths of utility tunnels are expected to undergo similar improvements in the near term.

It is anticipated that these repairs will significantly reduce system losses attributable to utility transportation and thermal energy losses. This more efficient transportation system will reflect on the generation capacity required at the utility plants. The steam (and chilled water to a lesser degree) generation requirements will decrease, thus reducing University of Arizona greenhouse gas emissions.

Un-Islanding of 4.5 MW Turbine

The AHSC turbine, a 4.5 MW combined cycle unit, was previously islanded to specific equipment located within the refrigeration plant. This precluded the turbine from consistently being able to produce power and steam at maximum output and realize the full benefit of this cogeneration system. The turbine was recently un-islanded and now provides power to the campus electrical grid. This modification in operations now allows the turbine to operate at full power and steam output.

With this change, a corresponding decrease in campus greenhouse gas emissions should result. The University's use of the natural gas turbine in lieu of the local electrical utility, which predominately utilizes coal based production units, is one more step towards reducing the campus carbon footprint.

Active Energy Management System and Utilities Metering Upgrade Program

A comprehensive program has been instituted to measure all utilities and auxiliary equipment at the utility plants and at end-use facilities. This measure will enable Facilities Management to analyze its production and distribution systems continually and respond to changes in data indicating possible maintenance issues. All generating equipment (chillers and boilers) are measured for input and output. Additions to the metering system include the pumps and fans associated with production and energy/flow data for the newly installed high efficiency chillers and boilers. Efforts are currently underway to achieve complete optimization on energy and resource metering, including plant make-up water, sewer system discharge, and flow/energy for chilled water and steam.

Metering will allow the plant operators to determine plant efficiencies for steam and chilled water production and respond to changes in real time. The ability to conveniently ascertain dynamic system discrepancies and inefficiencies will allow facilities personnel to respond to issues immediately and maximize operational efficiencies, allowing for a greater overall usage of energy and yield an associated reduction in overall environmental impact.

High Efficiency Chillers and Boilers Installation

Several new chillers and boilers were installed at the utility plants. The new chillers are energy efficient and will be used for base loading the existing chiller fleet to minimize overall plant kw/ton. The new boilers are modular, high efficient, condensing type, able to quickly respond to changing loads and thus mitigating the requirement for larger, less efficient boilers to maintain standby status.

These measures are expected to reduce source energy requirements, both electrical and natural gas, helping to further reduce the greenhouse gas emissions at the University of Arizona.

Over the past couple of years, the university has upgraded their energy management control system for the chilled water plants. These upgrades will allow the operators to utilize better instrumentation and streamline the operational sequences to optimize chilled water system performance.

North Campus Building Controls Audit

The North Campus, considered the portion of campus immediately north of Speedway Blvd., has completed a utility energy usage audit focused on building control systems. A similar audit is ongoing to include the main campus. As campus buildings continue to grow and adapt to the needs of their occupants, the breadth and function of the building control systems need to adapt as well. Current efforts are underway to conduct audits of the existing control systems to pinpoint outdated functions and equipment and update these systems appropriately in order to optimize heating, cooling, and lighting usage and minimize overall building and, subsequently, campus energy usage.

Steam Trap Replacement Initiative

In addition to the general utility tunnel improvements projects for specific lengths of the tunnel system, a new initiative is kicking off to address issues with steam traps on a global scale. A full campus steam distribution system steam trap audit is scheduled to commence this year with the intent of locating and replacing all steam traps found to have symptoms of leaking or clogging. Leaking steam traps are a very common inevitability with any steam distribution system and, upon sufficient accumulation, can result in a significant and continuous loss of energy, indiscriminant of weather or system usage. By effecting this plan, the university expects to better secure distributional steam losses and reduce the amount of fired fossil fuels utilized in the steam production process.

Renewable Energy

The university is continuing to invest in renewable energy on campus in the form of photovoltaics. There are over a half dozen installations currently installed, with planning for additional installations underway. Current installations include McClelland Hall, 2nd Street Parking Garage, McClelland Park, Likins Hall, Arbol de la Vida, Student Recreation and Highland District Housing.

FLEET OPERATIONS

Sources of greenhouse gas emissions from fleet operations consist of the on campus shuttle service operated by UA Parking and Transportation Services and the Motor Pool operated by UA Facilities Management. Fuel consumption is tracked using beginning and end of year inventory data and is therefore an accurate representation of the fuel used in the campus vehicles and the Cat Tran campus shuttle service.

UA's fleet operations generated 2,756 MtCO₂e, a 10% increase compared to 2,493 MtCO₂e in FY 2015.

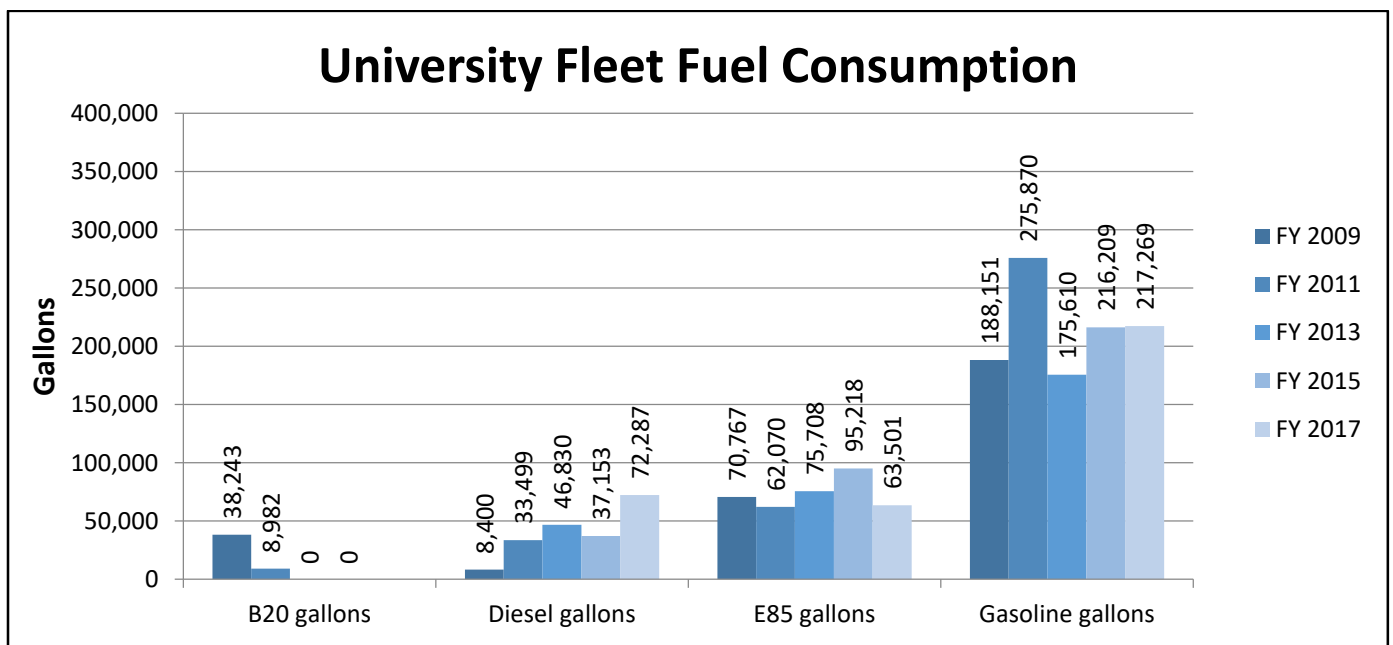
UNIVERSITY FLEET

Fleet vehicles use gasoline and Ethanol 85 as of FY 2013. The biodiesel fuel used in past years has been eliminated as a fuel source. Correspondingly, Ethanol 85 fuel use continued to increase from FY 2011 to FY 2015. This trend has since declined in FY 2017 where Ethanol 85 fuel consumption dropped by 33% from FY 2015. Unleaded gasoline consumption had no significant change between FY 2015 and FY 2017. University fleet fuel also includes propane and diesel, which is provided to the small engine shop for equipment such as forklifts, street sweepers, welders, and mowers.

CAT TRAN SHUTTLE FLEET

The Cat Tran shuttle traveled 195,546 miles and transported 248,399 passengers during FY 2017. The shuttle fleet utilizes ultra-low sulfur diesel in its buses, having completely transitioned from the use of biodiesel fuel. Diesel fuel use has increased by 95% since the FY 2015 reporting period. Increase in fuel usage emissions could be correlated to the increase in student population and campus square footage in recent years.

Graph 2: University Fleet Fuel Consumption:



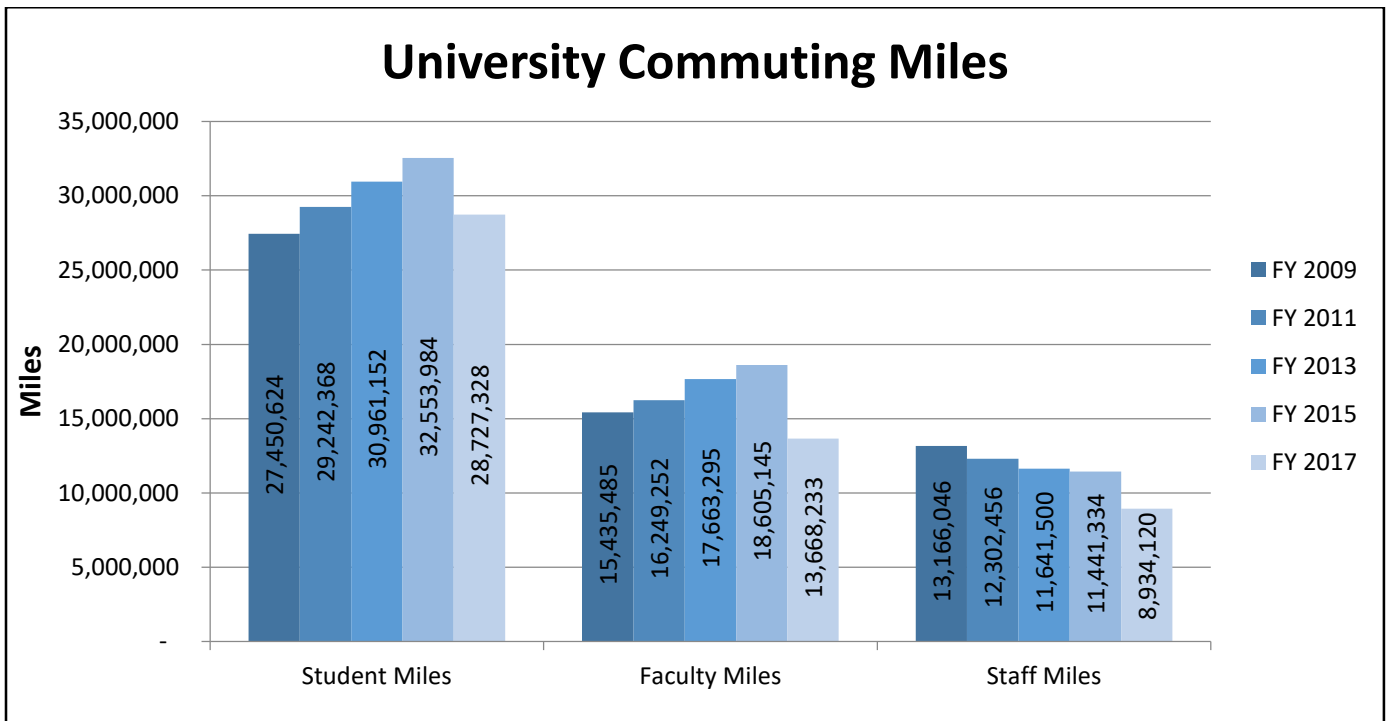
COMMUTING AND AIR TRAVEL

The University of Arizona Parking and Transportation department completed commuting surveys for FY 2017 to both staff/faculty and students. The survey results included the following data: Average distance traveled, average number of trips per week, and a breakdown of different modes of transportation. Modes of transportation include drive alone, carpool, public transportation, bike, and walking. Results are tabulated in Table 2 below.

Table 1: Commuting Statistics

| Student Commuting Statistics | | | | | |
|------------------------------------|------|------|-------|---------|------------------|
| | Bike | Walk | Drive | Carpool | Public Transport |
| %Trips By Mode | 25% | 25% | 36% | 9% | 6% |
| One Way Miles | 2 | 2 | 10 | 10 | 3 |
| Faculty/Staff Commuting Statistics | | | | | |
| | Bike | Walk | Drive | Carpool | Public Transport |
| %Trips By Mode | 10% | 9% | 68% | 9% | 5% |
| One Way Miles | 5 | 1 | 10 | 10 | 3.5 |

Graph 3: University Commuting Miles



In previous years, data from outdated surveys was used to calculate commuting miles which did not include the effects of Parking and Transportation initiatives such as bike sharing programs, shuttle services, ride share programs. These programs coupled with newer data shows reductions in emissions associated with campus commuting. As graph 3 shows the total carbon producing miles traveled reduced 18% from previous years.

AIR TRAVEL

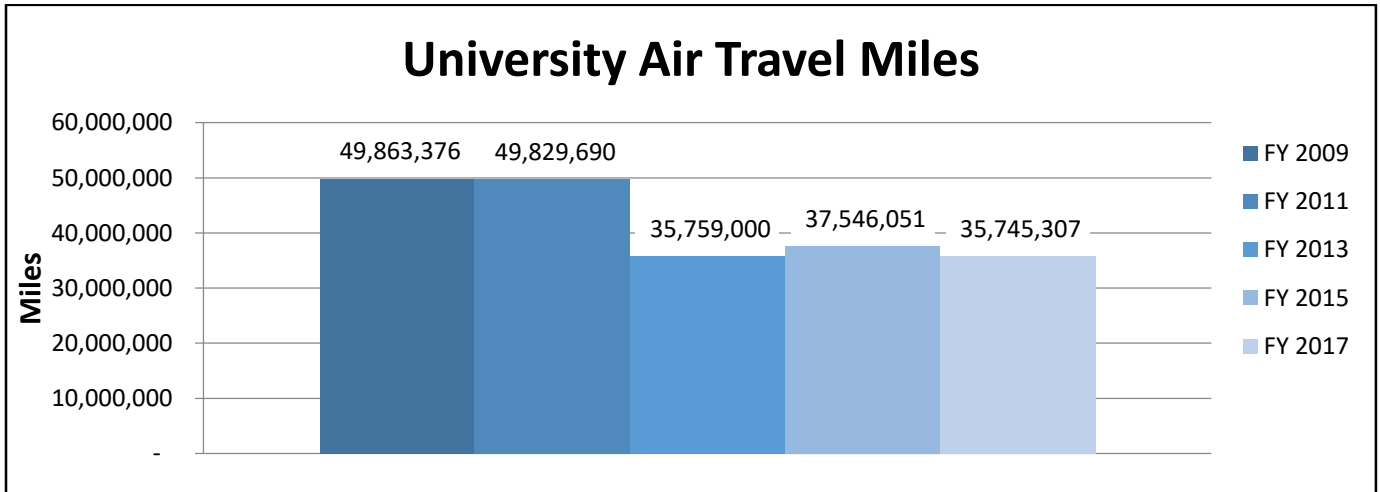
Air travel information was obtained from UA Procurement and Contracting Services Department (Purchasing Card (P-Card) Program). P-Cards are a direct method of charging air travel to the UA Financial Services Office (FSO). Utilizing P-Card usage data, the UA College of Engineering compiled a database with travel dates and origination and destination airport designations to calculate the total annual mileage data.

Another avenue for funding air travel is via direct reimbursement from UA FSO. UA FSO was able to provide the total number of trips reimbursed. Air travel mileage was not available. The average trip length from the P-Card data set was used as a multiplier to determine a reasonable total air travel mileage where evaluating the direct reimbursement data.

FY 2017 total miles traveled has decreased 4.8% from FY 2015. The confidence level in existing air travel data is less than desired due to averages, extrapolations, and assumptions that are necessary in order to derive the final data, specifically for direct reimbursement flights.

For improvement to future data collection methods, the University is exploring various coordination strategies by which the Financial Services Office and/or Procurement and Contracting Services can develop custom computer queries to extract the required mileage data for all air travel by UA faculty and staff. Consideration will also be given with respect to implementing an alternate means of logging air travel miles at the time of ticket purchasing/reimbursing.

Graph 4: University Air Travel Miles



WASTE MANAGEMENT

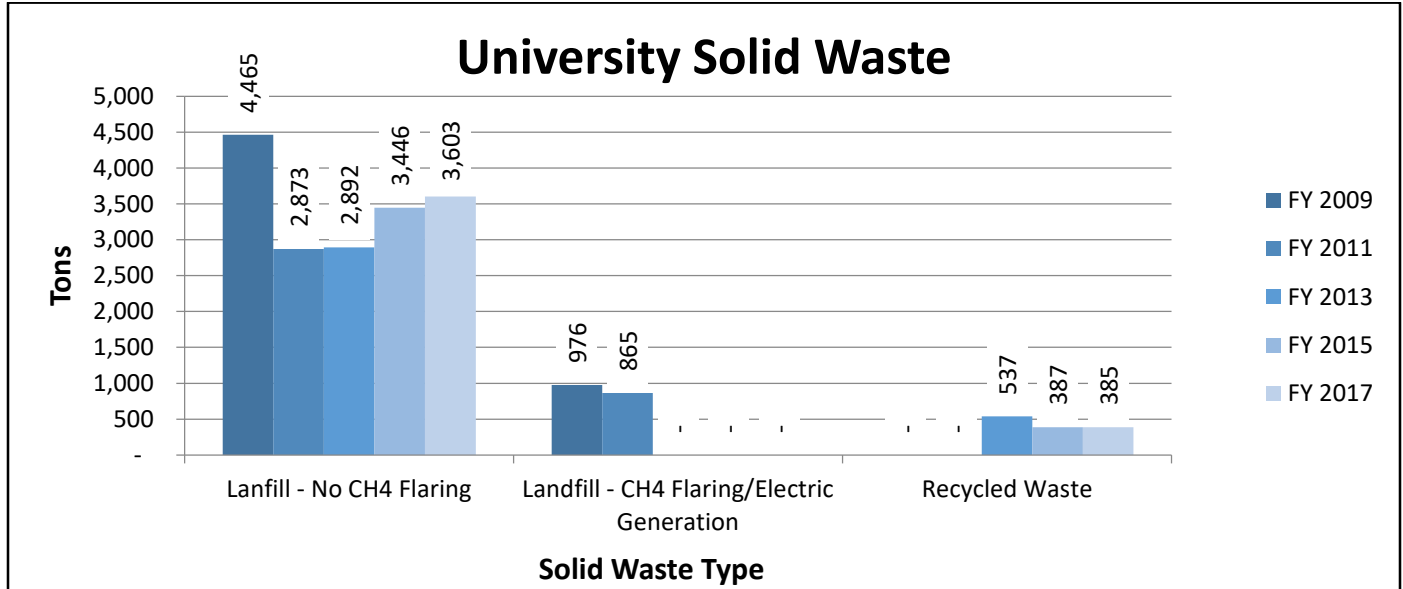
In FY 2017, the UA sent approximately 3,603 tons of commercial, roll-off and owner-hauled waste to landfill, and recycled 385 tons of paper and baled old corrugated cardboard (OCC). The recycle values only account for paper products and does not include any off campus contributions. Overall, University solid waste generation increased by 4.6% from FY 2015. This is due to increased number of events on campus that produce waste. Events such as the book festival and spring fling.

Waste removal from campus is either by UA hauling to a local landfill or the contracted waste disposal service (Waste Management (WM)) hauling both commercial and roll off waste to a local landfill. UA-hauled waste is transported to the Ina Road Land Reclamation Facility, which only accepts clean inert or clean green waste and does not perform CH4 recovery.

Waste removed by WM is taken to the Marana Regional Landfill. CH4 recovery is not accomplished at this facility.

The University employs a composting operation (Compost Cats) at San Xavier Mission, aiding in campus carbon offsetting. According to the UA Office of Sustainability, a total of 4,500,000 lbs of wet organic compost was produced this fiscal year for an additional offset amount of 622 MtCO₂e.

Graph 5: University Solid Waste

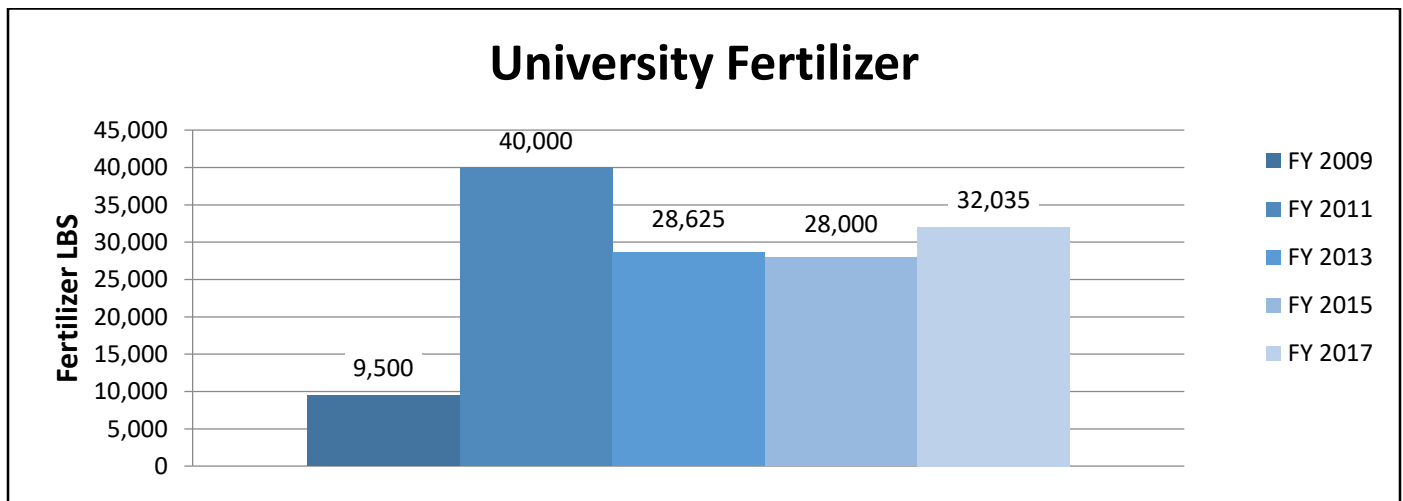


GROUNDS MANAGEMENT

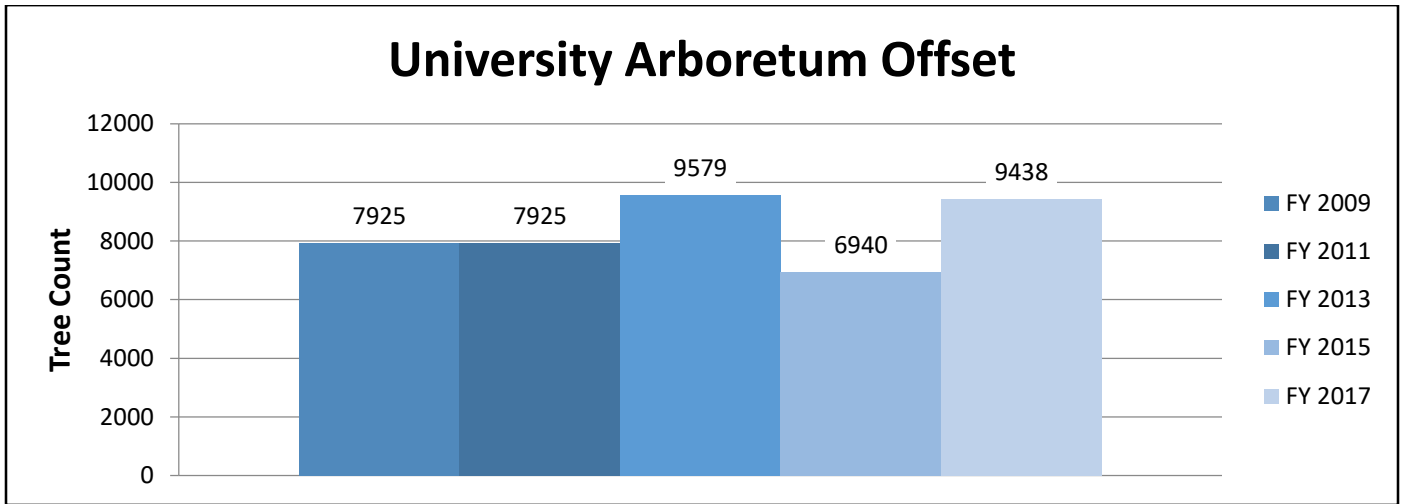
The University of Arizona has over 390 acres of mostly landscaped land. During FY 2017, the campus increased its dependency on synthetic fertilizer in lieu of utilizing organic fertilizer. The amount of synthetic fertilizer used in FY 2017 increased by 15.4% from FY 2015. The amount of organic fertilizer used in FY 2017 decreased by 16.7% from FY 2015.

Tree data is used as an offset to the University of Arizona's greenhouse gas emissions. Total tree count for FY 2017 is 9,438. Data compilation for this report identified an error in the FY 2015 tree count data, apparently due to discrepancies in the campus GIS (geographical information system). These errors have since been corrected.

Graph 6: University Fertilizer Use



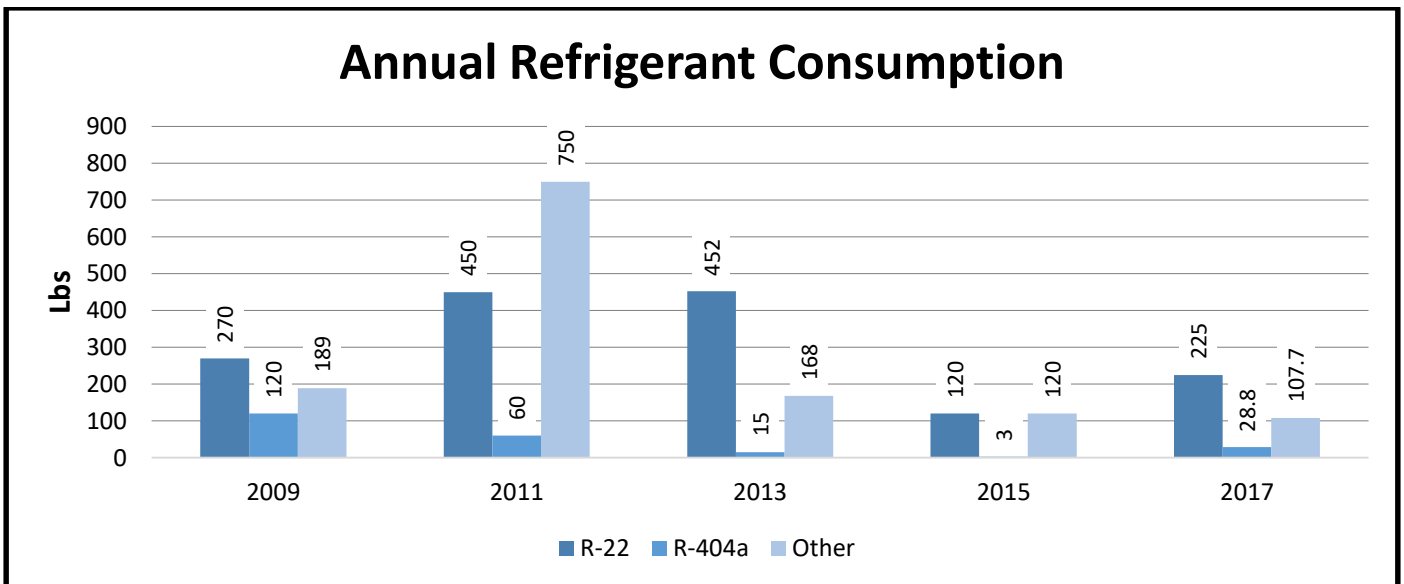
Graph 7: University Arboretum Offset



REFRIGERANTS

The university has a variety of mechanical equipment that require refrigerants. The central plants around campus house chillers that produce chilled water for building cooling. There are some spaces that are cooled via smaller packaged HVAC units. The student unions and residence life buildings are set up in the same fashion. Over the years there have been fluctuations in the recorded data. This is because refrigerant purchases were being tracked rather than actual usage. Furthermore, recycled refrigerant was not being tracked and recorded. These factors have been taken into account for FY17 and additional improvements will be made to the data collecting procedures for FY18 and beyond.

Graph 8: Refrigerants



FISCAL YEAR 2017 GREENHOUSE GAS EMISSIONS FINDINGS

According to available data, the University of Arizona produced a net total emissions count of 202,047 MtCO₂e in FY 2017 as compared to 231,824 MtCO₂e in FY 2015. This represents a 12.8% decrease in overall CO₂ equivalent emissions in the past two years. The largest contributors to greenhouse gas emissions are listed below, in descending order of contribution (greatest to least, not including transmission/distribution losses or offsets):

1. Purchased natural gas and propane - stationary combustion
2. Purchased electricity
3. Commuting
4. Air Travel
5. Waste Management
6. University fleet operations – mobile combustion
7. Fugitive emissions – refrigerants, chemicals, fertilizer
8. Paper Purchasing

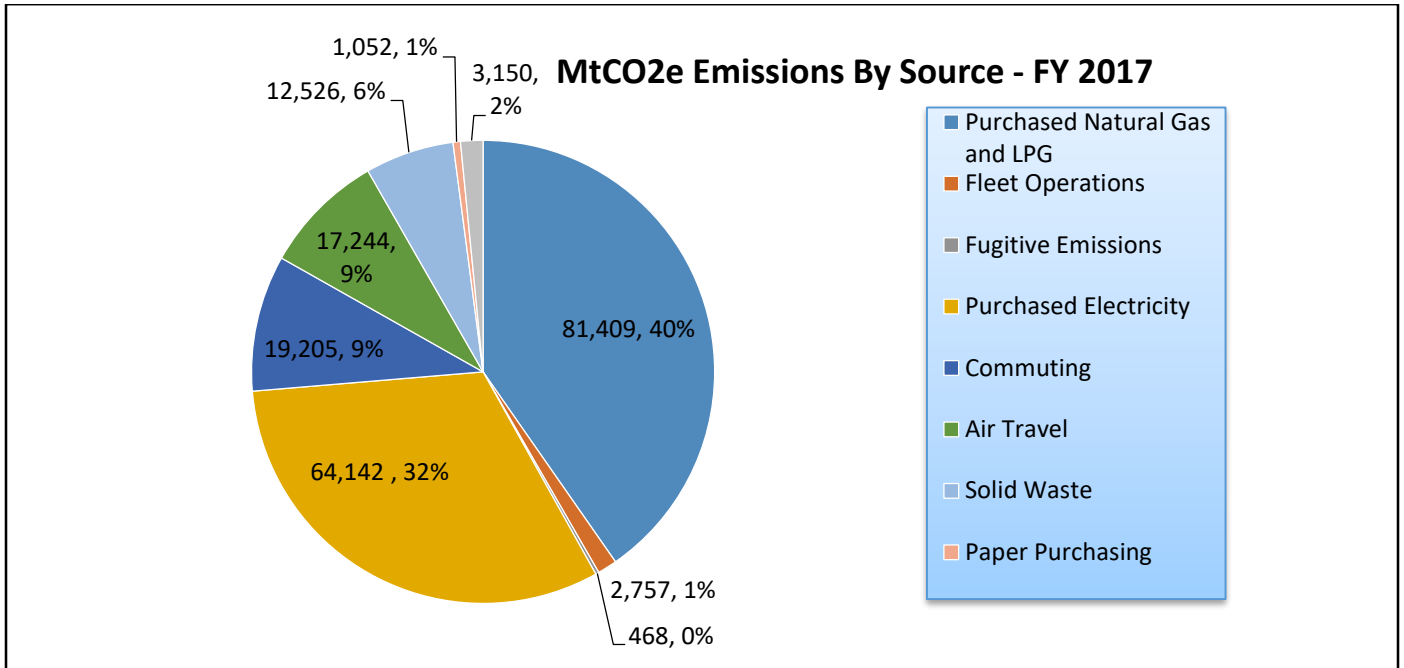
A significant factor contributing to total emissions reductions is the ongoing separation of Banner Health facilities from the university's utility grid. This will affect electricity and gas systems that provide chilled water, steam, and electricity to the Banner Health facilities. The chilled water and steam energy associated with Banner Health Facilities have been included in this year's greenhouse gas emissions calculations since the university's plants still supply these utilities to Banner Health. The electricity utilities have not been included since these were taken off the university's utility grid before FY 2017.

The following tables and graphs present data of general interest regarding the University of Arizona greenhouse gas emissions for fiscal year 2017.

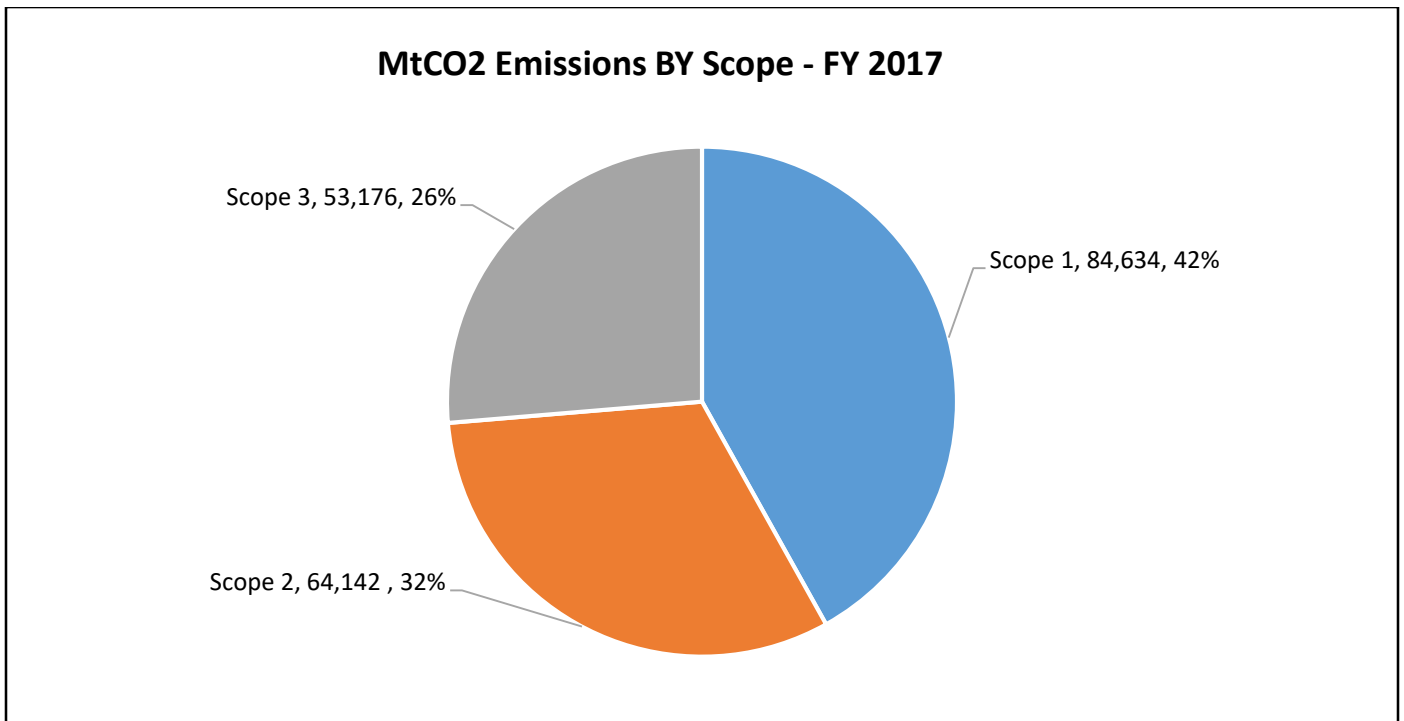
Table 3: Metric Tons of CO2 Equivalent (MtCO2e)

| Category | FY 2013 | FY 2015 | FY 2017 | FY 2017 to 2015 Change | Contribution to Total |
|--|----------------|----------------|----------------|------------------------|-----------------------|
| Utility Operations | | | | | |
| Purchased Electricity | 94,493 | 92,837 | 64,142 | -30.9% | 31.6% |
| Purchased Natural Gas and LPG | 85,622 | 77,576 | 81,409 | +4.9% | 40.0% |
| | | | | | |
| Commuting | 22,663 | 23,540 | 19,204 | -18.4% | 9.5% |
| | | | | | |
| Air Travel | 17,251 | 18,113 | 17,244 | -4.8% | 8.6% |
| | | | | | |
| Waste Management | 8,965 | 10,683 | 12,526 | +17.2% | 6.2% |
| | | | | | |
| University Fleet Operations | 2,173 | 2,493 | 2,756 | +10.5% | 1.4% |
| | | | | | |
| Paper Purchasing | 1,307 | 941 | 1,052 | +11.8% | 0.5% |
| | | | | | |
| Fugitive Emissions | | | | | |
| Refrigerants and Fertilizers | 442 | 199 | 468 | +135.0% | 0.2% |
| | | | | | |
| Transmissions and Distribution Losses | 6,224 | 6,115 | 3,141 | -48.6% | 1.6% |
| | | | | | |
| Offsets | | | | | |
| Arboretum Tree Count | -201 | -116 | -198 | -70.7% | 0.1% |
| Organic Composting | N/A | -557 | -622 | -11.7% | 0.3% |
| | | | | | |
| TOTAL | 238,939 | 231,824 | 201,133 | -13.2% | 100% |

Graph 9: Emissions by Source



Graph 10: Emissions by Scope



Scope 1 Emissions (Direct emissions for fuels burned on campus)

Scope 2 Emissions (Emissions from the consumption of purchased energy)

Scope 3 Emissions (Emissions that are consequences of operations but are not directly owned by the university)

Graph 11: Metric Tons of CO2 Equivalent (MtCO2e) by Fiscal Year

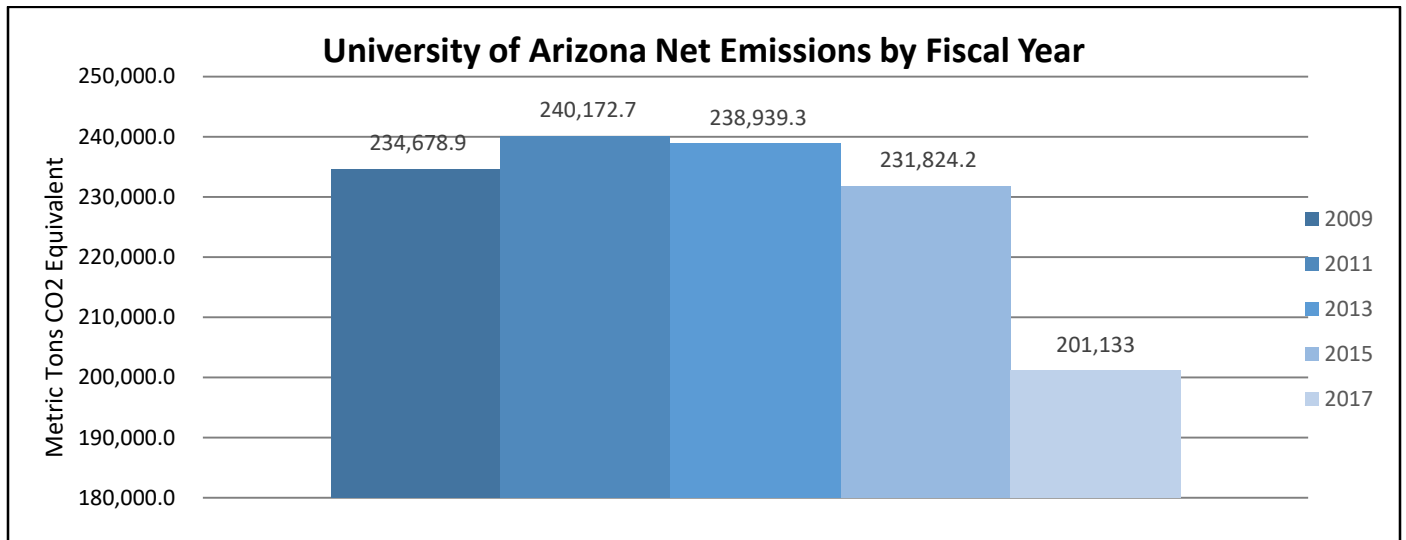


Table 4: Normalization Data for MtCO2 Emissions

| Fiscal Year | MtCO ₂ /SF | MtCO ₂ /Student | MtCO ₂ /Total Population* |
|-------------|-----------------------|----------------------------|--------------------------------------|
| 2009 | .0251 | 6.5734 | 4.9375 |
| 2011 | .0244 | 6.3063 | 4.8109 |
| 2013 | .0239 | 5.9250 | 4.5516 |
| 2015 | .0215 | 5.4691 | 4.2252 |
| 2017 | .0199 | 4.7049 | 3.6791 |

*Total Population (FTE) = Student + Staff + Faculty

INSTITUTIONAL DATA FY 2017

| | | | |
|------------------------|-----------------|--|----------|
| Population | | | |
| FTE students | 42,749 | | (note 1) |
| Full time staff | 4,600 | | (note 2) |
| Part time staff | not available | | |
| Full time faculty | 7,319 | | (note 3) |
| Part time faculty | not available | | |
| | | | |
| Budget | | | |
| Total Operating budget | \$2,359,127,600 | | (note 4) |
| Research budget | \$606,219,000 | | (note 5) |
| | | | |
| Physical Space Data | | | |
| Total Space GSF | 10,088,259 | | (note 6) |

SOURCES: 2016-2017 FACT BOOK DATA

Note 1: Students/FTE

<http://factbook.arizona.edu/2016-17/students/fte>

Note 2: Employees (use FTE value for classified staff and Administrator)

<http://factbook.arizona.edu/2016-17/employees>

Note 3: Employees (use FTE value for Faculty, Other appointed, and GA and Associates)

<http://factbook.arizona.edu/2016-17/employees>

Note 4: Total Operating Budget (use total funds)

<http://factbook.arizona.edu/2016-17/finances>

Note 5: Research Budget (use Total R&D)

<http://factbook.arizona.edu/2016-17/finances/research>

Note 6: Total Space GSF, Residential, permanent and non-permanent, and Parking Structures (use Main Campus)

<http://factbook.arizona.edu/2016-17/facilities>