SAS Carbon Inventory

Fiscal Year '16 (July 2015 - June 2016)

Penn SUSTAINABILITY
Arts & Sciences

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Intro & Mission

As Penn's oldest school and home of the Earth and Environmental Sciences, as well as numerous energy research centers, Arts & Sciences Sustainability has a strong drive to lead by example in many areas of sustainability, foremost energy and carbon reduction. In early 2017, SAS Sustainability undertook the task of creating the School's first Carbon Inventory. A University-wide carbon inventory was undertaken with the writing of Penn's initial Climate Action Plan in 2009, but no individual school has undertaken a carbon inventory up until this point. Much like the University-wide carbon inventory, SAS' intent was to determine the sources of the School's carbon emissions and inform decisions on ways to reduce those emissions that would ultimately contribute to the University's goal of carbon reduction to the point of neutrality.

Advances in metering technology and deployment in all university buildings enabled SAS to have reliable data for baseline building emissions. The successful implementation of several Century Bond energy reduction projects in SAS buildings created a need to look beyond the "low hanging fruit" of energy reduction and determine more difficult to address sources of energy consumption and carbon emissions. What resulted was a year-long exercise into methodology, data compilation and interpretation, and ultimately this report.

Scopes & Types of Energy Included

The carbon inventory of the School of Arts and Sciences includes emissions from scope 1 (direct), scope 2 (indirect), and scope 3 (indirect) sources. The scope categorization was determined based off Penn's main campus carbon inventory to maintain consistency with wider University reporting. The scopes in both the SAS and University carbon inventory follow the EPA's gudeilines for defining scope[1]. Scopes were included in the SAS Carbon Inventory when they had a significant carbon impact at the School level and when reliable data was available from which to calculate accurate metrics.

The SAS Carbon Inventory examines institutional greenhouse gas (GHG) emissions from three specific categories within the emission scopes: van fleet, building, and air travel.

Scope 1 (direct emissions)

Van fleet emissions: This includes sources of emissions that are released through gasoline consumption for SAS-owned vehicles that are part of the School's van fleet. In FY '16 the SAS van fleet had a total of 6 vehicles. These vehicles are used both on and off campus for facility-related work and academic or research-related trips.

Scope 2 (indirect emissions)

Building emissions: This includes all sources of emissions that are released through electric, steam and chilled water usage for University-owned, SAS campus buildings. The School's building portfolio can be divided into three main types: laboratory, classroom/ office and historical buildings. (See Appendix A)

Scope 3 (indirect emissions)

Air travel emissions: This includes sources of emissions that are released through fuel usage for institutionally sponsored air travel at the School. The air travel emissions in this inventory include precise data from Penn's online travel booking system, World Travel Booking, as well as reimbursements submitted through Concur, to fully capture the School's emissions from this scope

Emission conversion factors from Penn's Center for Environmental Building & Design were used when calculating these emissions to stay consistent with the University's carbon reporting methodology. Each form of energy consumed by the School was converted and recorded in the standard emissions unit of Metric Tons of Carbon Dioxide Equivalent (MTCDE) to provide a metric for comparable analysis at the School and University level.

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[1] United States Environmental Protection Agency. "Greenhouse Gases at EPA," Sept. 6, 2017, https://www.epa.gov/greeningepa/greenhouse-gases-epa

Method

Baseline year and how it was determined

The SAS Carbon Inventory was developed to analyze the School's carbon footprint and to determine a baseline from which to monitor progress. The baseline year was selected as Fiscal Year 2016 (July 2015 – June 2016) as this was the earliest year that reliable data was available for calculating accurate carbon emissions for the carbon emission scopes.

SUMMARY: FY16 BUILDING, VAN FLEET, AIR TRAVEL EMISSIONS

Summary of Emissions (MTCDE):

Scope 1 Emissions	41.2 (0.001%)
Scope 2 Emissions	25,188.96 (75%)
Scope 3 Emissions	8,467.01 (25%)

Scope 1 Emissions (MTCDE)

Van Fleet	41.2 (0.001%)

Scope 2 Emissions (MTCDE)

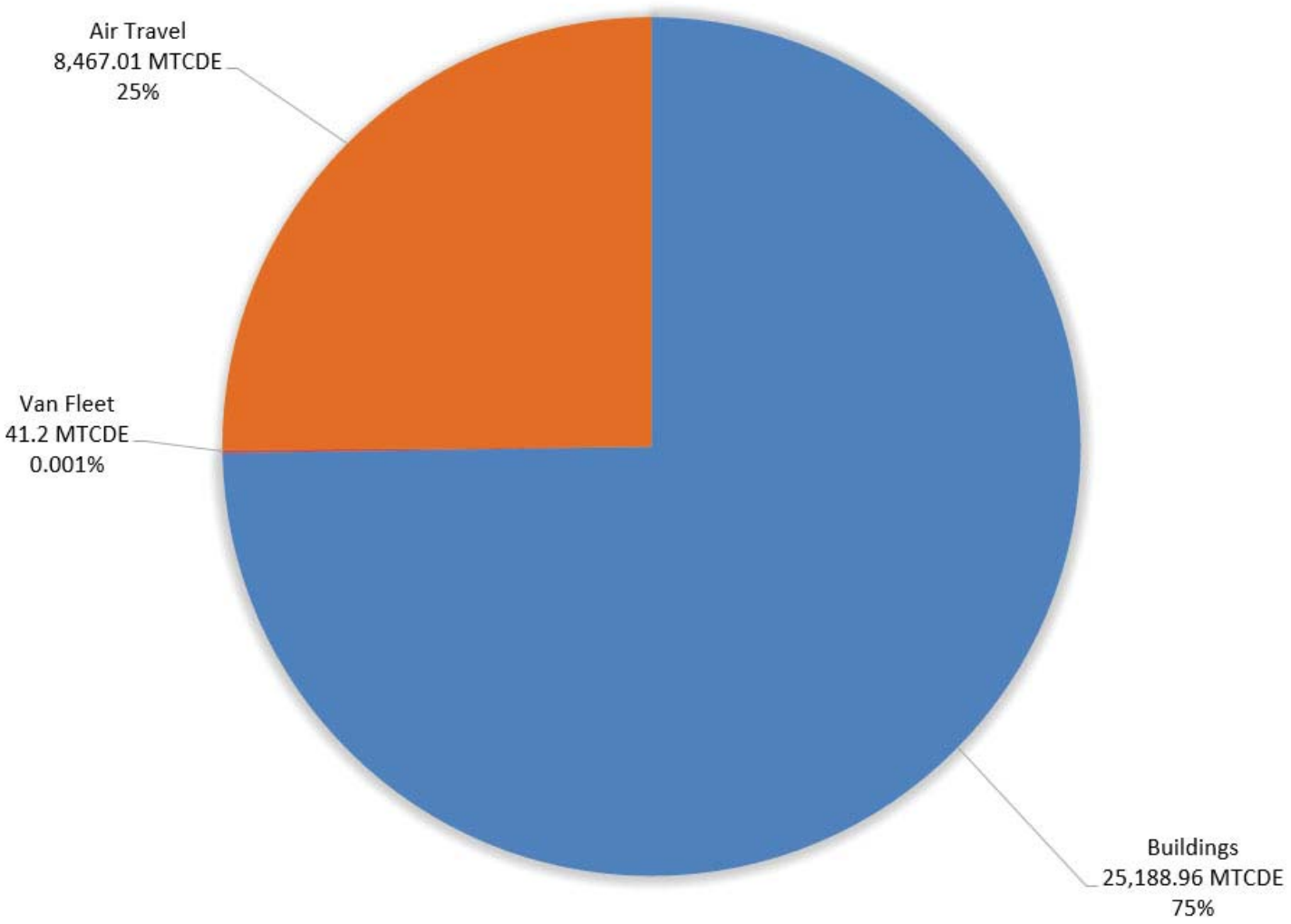
Buildings	25,188.96 (75%)

Scope 3 Emissions (MTCDE)

Air Travel	8,467.01 (25%)

FY16 at a glance

- Building energy metered data was available for 19 SAS buildings
- Over 4,500 academic-related trips were taken nationally & internationally
- The SAS Van Fleet had 6 vehicles
- 2016 was recorded as the warmest year on earth in 137 years, after 2015 which was recorded as the second warmest year[2]



[2] Glenn Shwartz, "Glenn's Blog: State of the Climate - 2016,"*NBC Philadelphia*, Aug. 10, 2017, https://www.nbcphiladelphia.com/weather/stories/Glenns-Blog-State-of-the-Climate---2016-43977

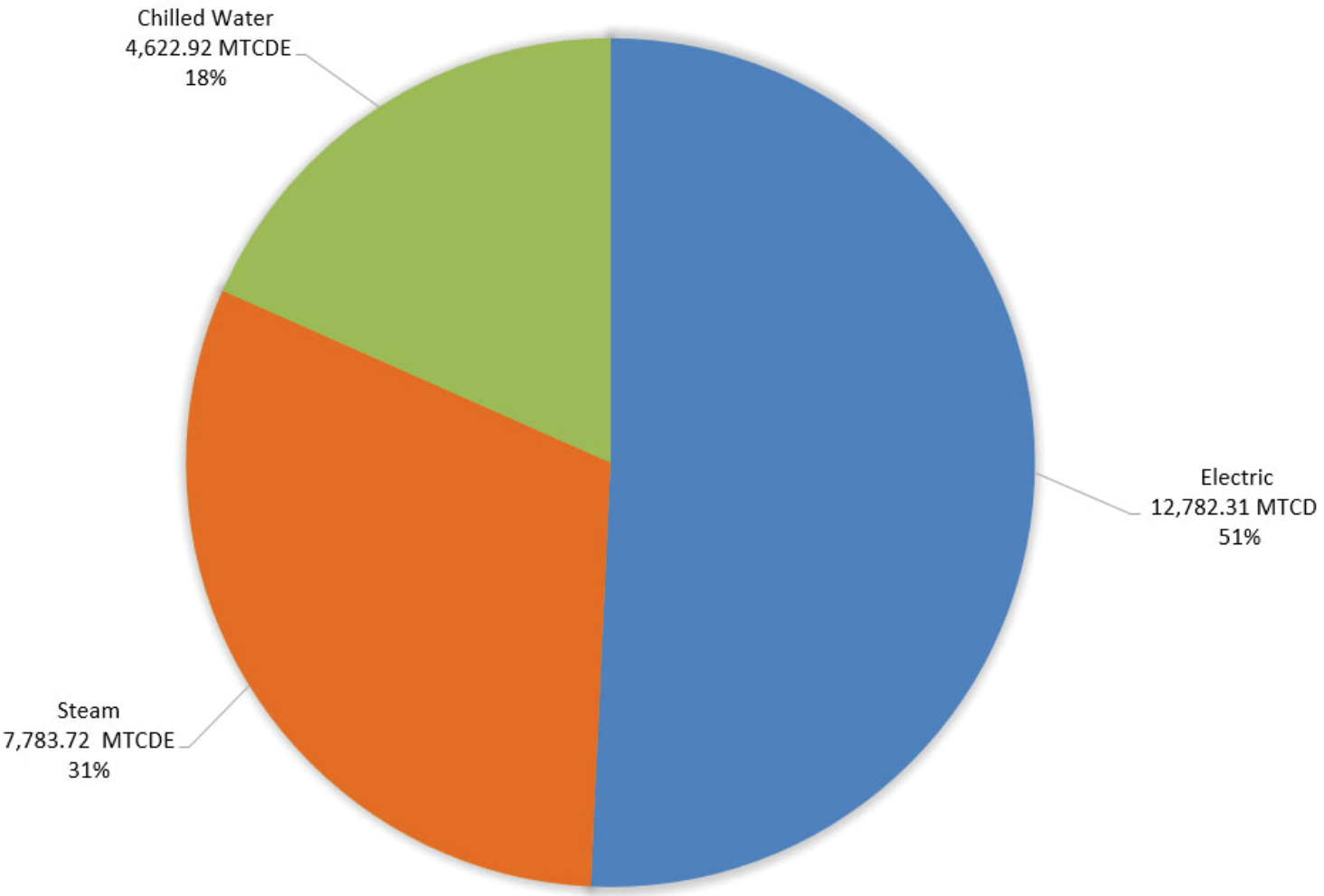
SUMMARY: FY16 BUILDING EMISSIONS BY ENERGY TYPE

Summary of Emissions (MTCDE):

Electric	12,782.31 (51%)
Steam	7,783.72 (31%)
Chilled Water	4,622.92 (18%)

FY 16 at a glance

- The Stephen A. Levin Building was completed as a LEED project
- The Chemistry 1973 Century Bond project was completed in September 2014. This makes FY16 the first full FY the building was in operation with its comprehensive mechanical and lighting system upgrades
- (Building infrastructure project)
- (Building infrastructure project)



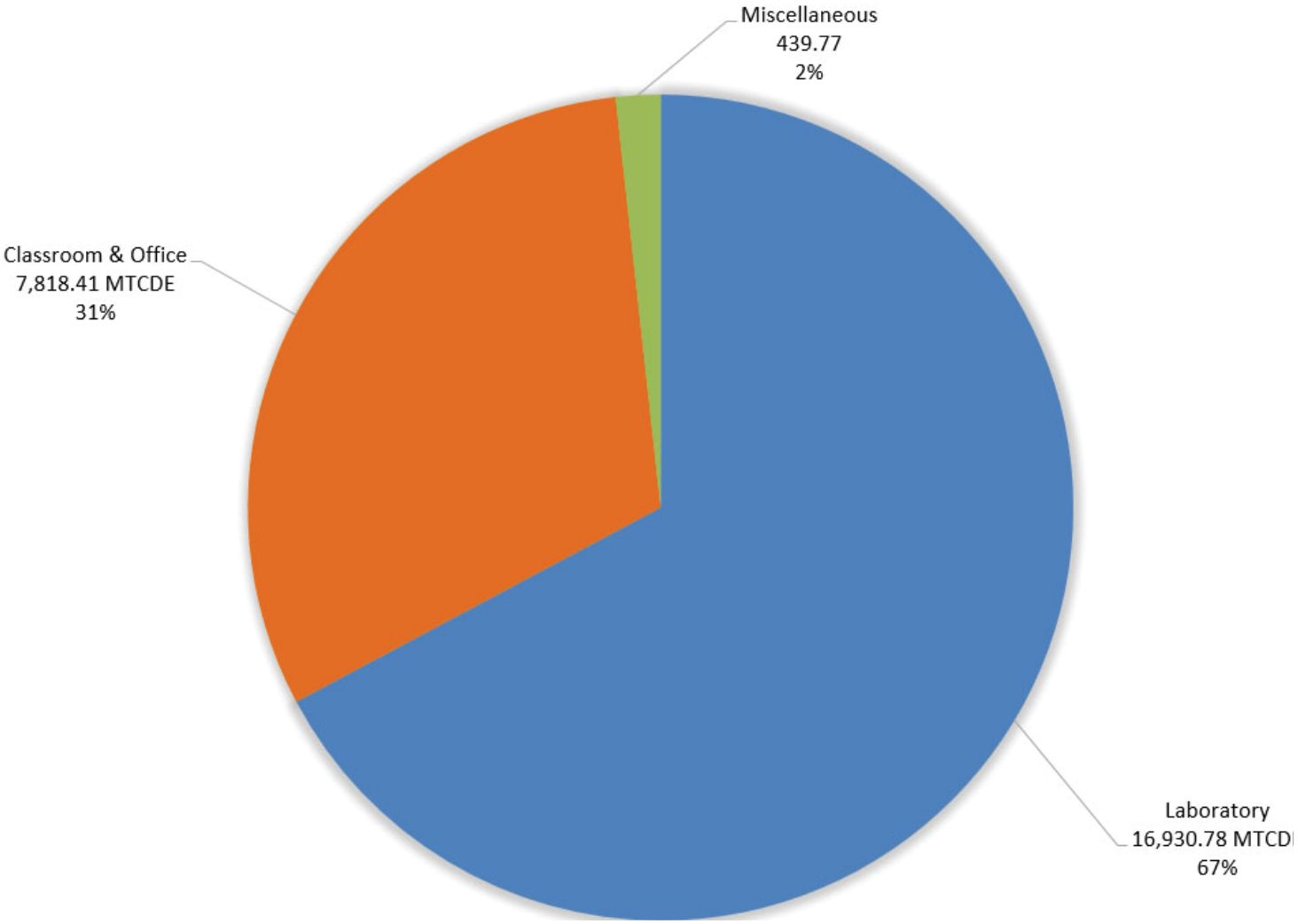
SUMMARY: FY16 BUILDING EMISSIONS BY BUILDING TYPE

Summary of Emissions (MTCDE):

Laboratory	16,930.78 (67%)
Classroom & Office	7,818.41 (31%)
Miscellaneous	439.77(2%)

Definition of Building Type

- Laboratory: buildings whose primary use is research-related laboratory work. These buildings are composed primarily of wet laboratories but also include energy-intensive dry laboratories, such as a laser labs
- Classroom & offices: buildings whose primary use is for classroom and office space. This includes Central Pool classrooms, seminar rooms and faculty, staff & and student offices
- Miscellaneous: small historic residential buildings that have been converted to office or classroom space.



Next Steps

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Arts & Sciences undertook this inventory as an exercise to support Penn's Climate Action Plan and carbon reduction goal of 18% by 2042, and in the hopes of helping the University exceed that goal. Having a better idea of where The School's emissions come from will help target a variety of initiatives to reduce emissions at the source. For example, after seeing our building electric use SAS has undertaken the GIT (Green IT) green initiative to reduce energy use in School computers. This project implements automatic power settings on staff and faculty desktop machines that reduce power use on evenings and weekends. The energy reduction from this project is enough to offset the entire SAS van fleet's emissions!

Previously, air travel emissions at the University level have been estimated based on available records. SAS took a deeper dive into an updated data set and subsequently determined that air travel emissions are a greater percentage of The School's footprint than previously thought. This raises a question not just for SAS but for the wider University about how to mitigate the environmental impact of air travel, which is a core function of the educational mission of the institution. This conversation is just beginning and will involve input from multiple stakeholders. While these methodologies are being developed, here are some tips for sustainable travel:

Fly less and More Sustainably

- Will a train do? Use alternative modes of transportation whenever possible
- Fly nonstop. The majority of a plane's carbon emissions come from takeoffs and landings, and more fuel is required for a one-stop or two-stop trip. You will get there faster and reduce both emissions and fuel consumption. Keep an eye on the price, to make sure the nonstop is a good value versus the multiple stop options.
- Plan wisely - schedule trips back to back. You will save time and resources not flying home in-between business trips.
- Use electronic tickets to save paper
- Pack light. Heavy luggage requires more energy to get where it needs to go. In addition to saving the environment, packing light can save you time (no waiting at baggage claim), stress (no worry about losing your bags), and money (no overweight luggage fees).
- Bring a reusable water bottle. Carry it empty through security, and fill it before getting on the plane. Keep it with you throughout your travels, refilling it often.

Choose Ground Transportation Smartly:

- Try to walk as much as possible instead of taking cabs or renting a car.
- Take public transportation. In most metropolitan areas, taking the subway or metro is often faster than a taxi navigating through traffic. (Added benefit - it is usually cheaper!)
- Share transportation. If you are traveling with co-workers, schedule your travel at the same time so you can share taxi rides or rental cars. Alternatively, take the ho-

tel van or airport shuttle service to reduce the number of vehicles on the road.
- Opt for eco cabs. Most major cities now have hybrid taxis and eco cabs. Research before you travel to see if this is available at your destination.
- Choose a green car rental. Renting a hybrid car might be slightly more, but you'll balance it out by saving money on gas, and you'll also reduce the pollutants put into the air.

SAS will continue to troubleshoot buildings and identify energy-consuming mechanical issues. This includes recommissioning of high energy use buildings on campus in an effort to reduce their carbon footprint. The School will continue to raise awareness among its faculty, staff and student population though participation in University-wide campaigns such as Red Days and Power Down Challenge, and through publicizing the research of the School's various energy research projects. The School also supports a cluster of interdisciplinary faculty who conduct research on a wide variety of energy issues, including energy capture, catalysts, and fuel cells.

The School of Arts and Sciences is proud of its commitment to environmental sustainability, and will continue its efforts of carbon reduction through a multi-pronged approach of targeted projects, raising awareness and creating behavior change on campus. With these efforts, SAS hopes to lead the way and support Penn's CAP and carbon reduction goals.

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Appendix A

Buildings included in the SAS carbon inventory:

Laboratory Buildings:
Chemistry Laboratories - Cret Wing
Chemistry Laboratories - 1958 Wing
Chemistry Laboratories - 1973 Wing
Vagelos Laboratories
Carolyn Hoff Lynch Biology Lab
Leidy Laboratories of Biology
David Rittenhouse Laboratory

Classroom & Office Buildings:
Fisher Bennett Hall
Goddard Laboratories
McNeil Center for Early American Studies
Claudia Cohen Hall
McNeil Building
Lerner Center
Solomon Laboratories
David Rittenhouse Laboratory
Stiteler Hall
Williams Hall

Miscellaneous Buildings:
Fels Center of Government
Jaffe History of Art Building