The Carbon Roadshow

A Guide to Departmental Greenhouse Gas Inventories for The University of Texas at Austin

2016 School of Architecture Pilot Study
2017 School of Geosciences Pilot Study

PROJECT PARTNERS

The Center for Sustainable Development

The University of Texas at Austin Green Fee

The University of Texas at Austin School of Architecture

The University of Texas at Austin Jackson School of Geosciences

Prepared by Susan Sharp & Elbin Collado, Carbon Roadshow Graduate Research Assistants

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Allan Shearer | Co-Director Center for Sustainable Development and Associate Professor, School of Architecture

Beth Rutter | Interface Manager Team, Central Business Office

Chelsea Cowley | Technology Services Coordinator, School of Architecture

Ethan Rohrer | Graduate Research Assistant, Center for Sustainable Development

Jennifer Hobson | Zero Waste Coordinator, Facilities Services

Jessica Smith | Graduate Coordinator II, Energy and Earth Resources

Jill Parrish | Program Coordinator, Green Fee

Jim Walker | Director, Office of Sustainability

Jonathan A. Batista | Environmental Engineer, Cockrell School of Engineering Alumni

Karen Blaney | Program Coordinator, Office of Sustainability

KatieLea Conley | Senior Administrative Associate for Academic Affairs, School of Architecture

Lauren Crowe | Finance Manager, Biology Instructional Office, College of Natural Sciences

Lee Loden| Director, Travel Management Services

Leora Visotsky | Strategic Grants Coordinator, Center for Sustainable Development

Lindsay Jones | Administrative Associate, Study Abroad

Lucky Mosola |Fleet Administrative Assistant, Department of Geological Sciences

Mark Kaligian | Assistant Directory, University Fleet Operations

Matt McKibben | Travel Coordinator, School of Architecture

Neil Kaufman | Environmental Specialist, Division of Housing and Food Services

Patrick Mazur | Technical Staff Associate, Energy and Water Conservation Program

Patrick Russell | Grants Coordinator, Center for Sustainable Development

Rachel Warburton | Graduate Research Assistant, Center for Sustainable Development

Richard Chuchla | Program Director, Energy and Earth Resources

Robin Dusek | Graduate Program Administrator, School of Architecture

Sarah Gamble | Professional Residency Program, School of Architecture

Sarah Wu | Grants and Project Manager, Center for Sustainable Development

Sean McKeever | Administrative Services Officer, Jackson School of Geosciences

Stephanie Perrone | Project Manager, Energy and Water Conservation Program

Tejas Pevekar | Energy Manager, Utilities and Energy Management

Torrey Kolesar | Graduate Student, McCombs School of Business

Warner Cook | Graduate Student, School of Architecture

Zack Lofton | Graduate Student, School of Architecture

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Introduction

About the Project

This greenhouse gas (GHG) inventory estimates the carbon footprint of The University of Texas at Austin School of Architecture (UTSOA) and the Jackson School of Geosciences (UTJSG) at using established and innovative methods, and was completed as part of the Carbon Roadshow—a Green Fee project housed in the Center for Sustainable Development. The intent of this effort is to not only display the emissions of one of the 18 schools and colleges at the university, but to provide a path forward for other departments that may want to complete greenhouse gas inventories of their own. As such, each source of emissions included in this report presents the greenhouse gases generated by: 1) UTSOA from September 1, 2014 to August 31, 2015 and 2) The Jackson School of Geosciences from June 1 2015 to August 18 2016 as an illustrative exercise. This project also includes several pieces of technical documentation that provide step-by-step instructions for calculating parts of the greenhouse gas inventory.

A major goal of this project is to increase accountability for emissions among the many various departments, colleges, and administrative offices housed within The University of Texas at Austin. While the university has calculated its campus wide carbon emissions in the past, magnitude of the accumulated emissions conveyed a sense of inevitability. Disaggregating this footprint into smaller organizational boundaries could provide a number of advantages, including making mitigation strategies more approachable, uncovering opportunities for emissions reductions masked by aggregate numbers, and increasing accountability for sustainability efforts. In addition, these footprints can serve as baseline consumption metrics, providing an opportunity for comparison and competition against past performance.

Finally, this project's long-term goal is build momentum for university-wide greenhouse gas reduction strategies. With the participation of multiple departments, the

PROJECT GOALS

Short Term

Provide resources and materials for departments at The University of Texas to calculate their carbon footprints. Available here: https://utexas.box.com/v/technicalguides

Long Term

Provide a system for calculating metrics that support emissions reductions strategies across campus.

opportunities for friendly competition and innovation are numerous. Normalized by enrollment and sorted by research type, departmental inventories could provide the basis for climate awards, for instance. In addition, accounting for carbon dioxide fills a gap in the university's current sustainability initiatives, and provides an important layer of depth for other metrics related to energy efficiency and resource consumption. One can imagine how a carbon inventory would complement student initiatives like Longhorn Lights Out, a energy conservation organization, and increase the urgency of alternative transportation efforts that enhance quality of life.

Project Origins

Jim Walker, director of the university's Office of Sustainability, launched the idea for departmental greenhouse inventories after overseeing earlier efforts to calculate the carbon footprint of The University of Texas at Austin. The most recent campus wide greenhouse gas inventory uses data from the 2012-2013 school year (FY12), when the estimated total carbon footprint for the university was 650,000 metric tons of CO2 equivalent. Citing the issue of accountability, the departmental footprints were thought to make carbon emissions more tangible and more connected to actual activity.

Before the inception of the Carbon Roadshow, many students from the Community and Regional Planning Program at the School of Architecture served as interns at Campus Planning and Facilities Management, completing work in the intersection of planning and climate change at the university-scale. This included contributing to the greenhouse gas inventories, assessing climate risks, and enumerating mitigation strategies. This connection between UTSOA and the university's climate change planning was apparent, and the Center for Sustainable Development acquired funding for a Green Fee project to support a student-led effort to increase knowledge of the university's carbon footprint and to complete a departmental greenhouse gas inventory pilot.

University Context

The University of Texas at Austin has prioritized numerous sustainability efforts through official policies and conservation goals, academic programming, and the support of student endeavors. At the institutional level, the 2012 Campus Master Plan Update referenced climate change mitigation and greenhouse gas tracking in its goal to "triangulate sustainability benchmarks against the models set up by AASHE and the American College and University President's Climate Commitment (ACUPCC)" (Sasaki Associates, 2013, p. 195). In addition, the 2011 Natural Resource Conservation Plan prescribes a 20% reduction of building energy by 2020 from a 2009 baseline.

The Energy and Water Conservation Program is on track to meet this goal, having achieved a 15% reduction by 2014 (Dearman, 2014).

The university has also invested in energy efficiency measures for its on-campus power plant. The Carl J. Eckhardt Combined Heating and Power Complex provides all the necessary electricity, steam, and chilled water for the main campus. This natural gas utility has realized an energy efficiency of 88%—a significant achievement given that a typical natural gas power plant is about 40% efficient. Methods that provide these efficiencies include harnessing waste heat to create steam and using chilled water tanks to store thermal energy. Though natural gas is a fossil fuel that releases carbon dioxide when burned, these power plant efficiencies have enabled the university to reach 1970's emissions levels, despite campus expansion and increased demand for power (UT EWC, 2015).

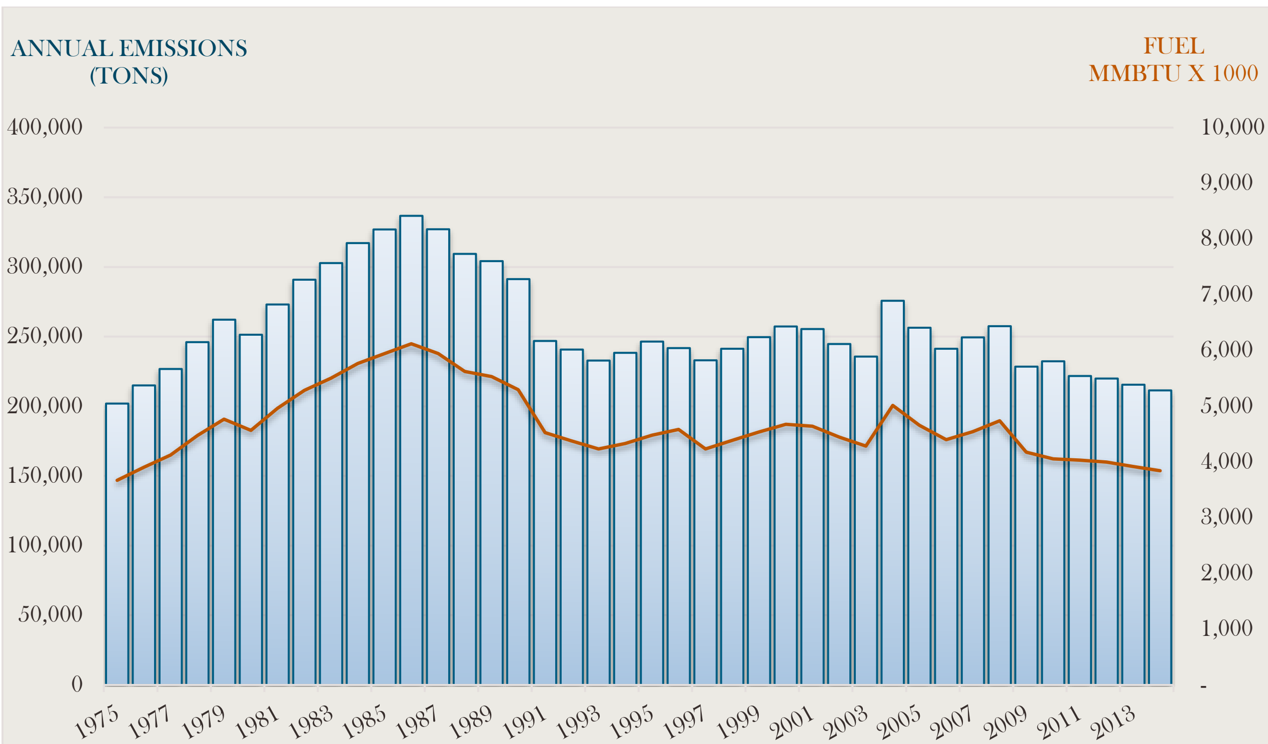


FIGURE 1: CO2 EMISSIONS FROM THE CARL J. ECKHARDT HEATING AND POWER COMPLEX

Despite the successful implementation of these conservation, sustainability, and efficiency strategies, campus expansion continues. With the opening of the Dell Medical Complex, the Engineering Education and Research Center (EERC) and the implementation of graduate housing and other improvement in East Campus, the energy needs of the university will continue to grow.

As such, continued innovation as well as vigilant resource consumption is necessary if we are to surpass current sustainability achievements.

Climate Projections for the City of Austin

Climate projections provided by the City of Austin Office of Sustainability indicate that the city will experience several shifts in climate and weather patterns. Using data collected by the Camp Mabry weather station about 3.5 miles northwest of campus, climatologist Katherine Hayhoe provides insights into what changes we might expect. These include hotter summers—both in terms of average temperature and the occurrence of days over 100 and 110°F—as well precipitation changes. Rain events will likely be more extreme while summer droughts may increase in frequency, essential resulting in a concentration of annual precipitation to fewer days (City of Austin, 2014).

FIGURE 2: FOSSIL FREE TEXAS CLIMATE MARCH, PHOTO BY GABRIEL LOPEZ OF THE DAILY TEXAN

Student Interest

In the past few years, climate change has come to the forefront of sustainability conversations, especially at the collegiate level. Students at The University of Texas at Austin demonstrate their interest in climate change through their involvement in a number of groups and in community action. Fossil Free Texas, the university's fossil fuel divestment group, has shown action and involvement on campus through climate demonstrations, workshop facilitation, coordination with 350.org, and participation in citywide climate marches (Zighelboim, 2015a, 2015b). Interest in a talk given by climate activist and author Naomi Klein in November 2015 led to a full auditorium with standing room only (Zein, 2015).

Inventory Overview

Timeframe

This greenhouse gas inventory estimates the School of Architecture's greenhouse gas emissions emitted from September 1, 2014 to August 31, 2015, or over fiscal year 2015 (FY2015) and the Jackson School of Geosciences from September 1, 2015 to August 31, 2016 or over fiscal year 2016 (FY2016). The delay of about one calendar year for analysis occurs because the data analyzed must first be compiled by internal sources at the university. This includes information from the power plant, purchasing, and waste collection, among other items.

Sources of Emissions

This inventory considers the three major emissions scopes used in conventional carbon accounting practices. Scope 1 emissions include those that derive from fuel combusted directly on university property, or those from the power plant and those from vehicles operated by the department. Scope 2 emissions covers all indirect emissions stemming from fuel combustion for electricity and climate control. For departments at The University of Texas, these would include those generated by the city's power source, Austin Energy. Scope 3 emissions incorporate those indirect emissions not derived from electrical power. These include emissions stemming from commuting, travel, landfill waste, and upstream emissions from the supply chain. These source components are discussed in detail in later sections.

Results

TABLE 1: SCHOOL OF ARCHITECTURE EMISSIONS, FY 2015

Emissions Source	Scope	Emissions (Short Tons CO2e)
Electricity	1	483
Chilled Water	1	213
Steam	1	negligible
Domestic Water	3	0.03
Wastewater	3	0.12
Travel	3	1,038
Vehicle Fleet	1	NA
Scope 1 Emissions	1	696
Scope 3 Emissions	3	0.16
Total Emissions	1 & 3	1,734

TABLE 2: JACKSON SCHOOL EMISSIONS, FY 2016

Emissions Source	Scope	Emissions (Short Tons CO2e)
Electricity	1	1,080
Cool Water	1	208
Steam	1	negligible
Domestic Water	3	0.07
Waste Water	3	0.37
Travel	3	953
Vehicle Fleet	1	50
Scope 1 Emissions	1	1,338
Scope 3 Emissions	3	953
Total Emissions	1 & 3	2,291

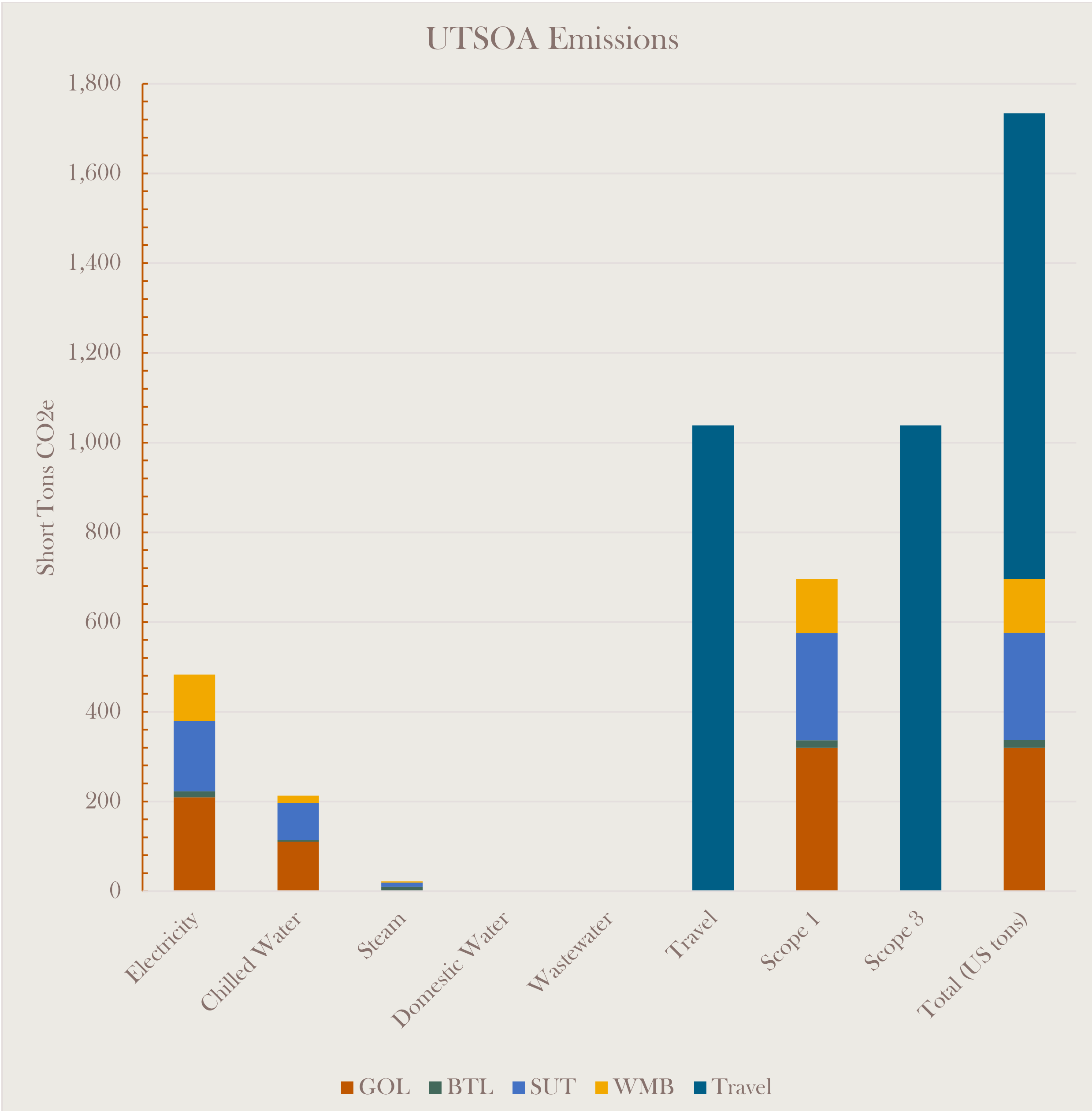


FIGURE 3: UTSOA BUILDING EMISSIONS FY 2015

As shown in the figure above, Goldsmith Hall contributed more emissions than any other of the School of Architecture's buildings. Almost half of the total building emissions come solely from Goldsmith Hall (GOL). In emissions stemming from steam use, Battle Hall (BTL) contributes the most. West Mall Building (WMB) contributes the most Scope 3 emissions (Domestic Water and Wastewater). Travel emissions eclipse all building emissions combined.

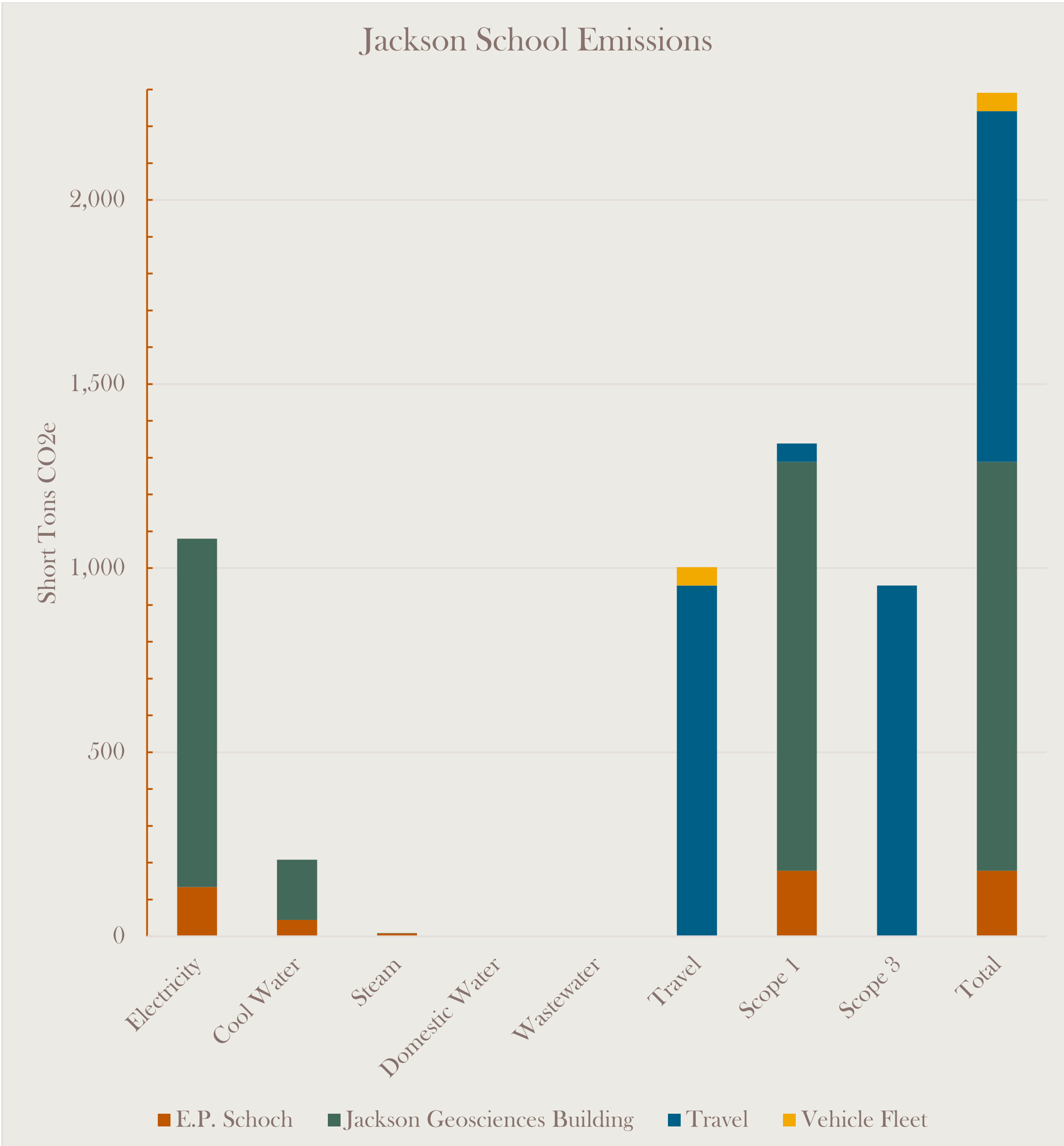


FIGURE 4: JACKSON SCHOOL EMISSION SOURCES FY 2016

Again, not surprisingly because it is a much larger building and used more frequently the Jackson Geosciences building contributes the most emissions by far compared to the E.P. Schoch building. What was surprising however is the amount of emissions attributed to travel. Travel is responsible for 5x more greenhouse gases than the E.P. Schoch building. This means properly managing travel logistically has the potential to drastically reduce CO2 emissions. For example if two faculty or student members need to get to the same place from Austin, it might be worthwhile to see if they can accommodate leaving at the same time/flight as oppose to leaving separately just days apart.

Footprinting Your Own Department

The intention for this body of work is to provide guidance for departments at The University of Texas at Austin to calculate their own carbon footprints, using the School of Architecture's and School of Geoscience's as starting points. This effort has yielded several documents available in the Appendix and on Box (https://utexas.app.box.com/files/0/f/6324903737/Carbon_Roadshow), the university's shared file system that are ready for your use. Despite these materials, differences between departments will emerge, and this methodology will require adjustment.

Assembling a Footprint Team

Acquiring the full set of data needed to compile a greenhouse gas inventory, especially Scope 3 emissions, requires building relationships with administrative offices across campus. An ally within your department's administration may prove helpful in approaching other offices and in retrieving documents and data from within the department's own organizational structure.

Departmental Differences

Each department on campus has its own organizational structure replete with its own quirks. While the School of Architecture greenhouse gas accounting pilot was intended to provide an easy, one-size-fits-all guide to carbon footprinting for departments across campus, the results indicated that this is not currently possible. How a given department records and stores detailed information regarding purchasing, production of waste materials, commuting, and school-sponsored travel will inform the precision and methods to calculate the greenhouse gases arising from these activities. Gaining access to this information will also differ based on the specificities of each department. Gathering one's own data is always an option, though the size of department, its responsiveness to survey requests, and its support for the greenhouse gas footprinting project could affect the robustness of the data collected.

Future Carbon Footprinting Goals

Given the realities of departmental differences across campus, it is our hope that the School of Architecture and the Jackson School pilot projects will spark a larger effort across campus that includes some standardization for information gathering and processing. An identical, one-size-fits-all inventory method would provide a number of benefits for campus. For one, subsequent departmental inventories would require less time and energy in deciding the best avenues for inquiry and analysis. In addition, having a template would permit the comparison of departments, establishing the basis for friendly competition for emissions reductions outcomes.

If greenhouse gas mitigation efforts become an institutional priority, establishing a standardized method for departmental greenhouse gas inventory processes will be necessary. In order to create this standardized method, there must be an organized and consistent method for tracking data related to greenhouse gas emitting activities. This would include modifying purchasing reports so that their components can be extracted and plugged into greenhouse gas calculators, partnering with administrative offices to collect finer data on commuting, and more. These efforts would likely require institutional support in the form of a high level directive.

Scope 1:
Direct Emissions

Scope 1- Stationary/Mobile Combustion and Refrigerants

Scope 1 emissions refer to those that are generated directly on the grounds of campus in the form of stationary combustion, mobile combustion, and refrigerants. At The University of Texas at Austin, the majority of these emissions come from energy generated by the Carl J. Eckhardt Combined Heating and Power Complex, which supplies the university with electricity, steam, and chilled water—a department's usage of these resources are considered under the stationary combustion category. Mobile combustion refers to emissions generated by vehicles and mobile equipment that are owned by the university. For a specific department, only the fleet vehicles owned by that department would be considered. Refrigerants are chemicals most often used for refrigeration and air conditioning purposes. Although refrigerants have largely been phased out of university operations, individual labs and departments may use them for a variety of research or laboratory purposes.

Stationary Combustion

Touted as the most efficient university utility in the country, the Carl J. Eckhardt Combined Heating and Power Complex provides electricity, steam, and chilled water for all of the main university campus. As a combined heating and power plant (CHP), the facility uses natural gas as its fuel source, but also captures waste heat from the combustion process to turn a steam turbine. Electricity from both the natural gas and steam turbines provide campus with electricity and chilled water. Recovered heat is used to provide steam for labs and for heating purposes. The utility's largest load (or source of demand) comes from air conditioning use in the hot summer months (Utilities and Energy Management, 2015).

Data

Electricity, Chilled Water, and Steam Consumption by Building: The energy usage data for this project was provided by Tejas Pevekar, the Energy Manager of the Utilities & Energy Management division at The University of Texas at Austin. It is based on actual usage of electricity, chilled water, and steam for the analysis period (FY 2015). In addition, most buildings on the main university campus have individual energy meters, including the four UTSOA buildings (UEM, 2016). Utilities & Energy Management recently launched The Energy Portal, which supports demand-side energy conservation on campus. The portal is a tool which faculty, staff and students can use to look at the energy consumption of an individual building or a group of buildings. The tool is accessible to all computers on the campus network or VPN. This tool will allow you access to hourly, daily and monthly data for most buildings on campus for all utilities. The Energy Portal tool can be found online here: https://energyportal.utilities.utexas.edu.

Building and Space Type Data: Building space type data is available through the Work Order Request and Query System (WORQS). The intended use of this database is for university employees to request work from facilities services. However, the organizational structure of WORQS displays a finer level detail of who is responsible for and who occupies a given space (Iannuccilli, 2014).

Resource Intensity Multipliers per Space Type: The Energy and Water Conservation Program (EWC) provides space type energy use intensities based on sample benchmarks of energy use. These have been incorporated into the methodology. The Office of Sustainability provided baseline numbers for chilled water and steam intensities that were adjusted to correlate with the EWC space type categories.

Emissions Resource Multipliers: Utilities and Energy Management provides the carbon dioxide and equivalent greenhouse gas emissions rates that occur from energy usage. These rates apply to electricity in pounds per kilowatt hour, chilled water in pounds per ton hour, and steam in pounds per million pounds of steam (Reid, 2010).

Methods

Using the above data sources, the following items were consolidated into one Excel workbook:

- Electricity, Chilled Water, and Steam Consumption by Building
- Building and Space Type Data
- Resource Intensity Multipliers by Space Type (Space Type Multiplier)
- Emissions Resource Multipliers (Resource Multiplier)

The School of Architecture occupies four buildings on campus: Goldsmith Hall, Sutton Hall, West Mall Building, and Battle Hall. The Jackson School of Geosciences occupies only two campus buildings: Jackson Geosciences Building and E.P. Schoch. However, the SOA and JSG do not control the full spaces of any building; libraries, shared facilities, and maintenance spaces, for example, are not under the purview of the school's administration. Therefore, the emissions of the whole building cannot be attributed directly to the school. This is important when considering the diverse activities conducted within a single building on a university campus. One campus building may house laboratories, computer servers, food preparation areas, and classrooms used by a number of departments—uses that vary in resource intensity. Dividing the building's resource use by the square footage occupied by each department would blend the individual resource consumptions together.

The method for disaggregating the department's emissions requires two steps: 1) analyzing the full building by weighting each space type by resource intensity, 2) analyzing the department's share of the total resource intensity by occupancy.

Building Analysis

Using a pivot table, each space type for a given building and its square footage was extracted onto its own worksheet. For each resource (electricity, chilled water, and steam), the following steps were taken individually. The square footage of each space type was weighted using the corresponding space type resource multiplier and summed. This sum is the building's weighted square footage, which will be used in departmental analysis. Next, the percentage of weighted square footage was determined for each space type. The weighted space type percentage was then multiplied by the total resource usage. The weighted resource usage was then multiplied by the corresponding resource multiplier. This process yields the total emissions for a building's use of each resource, divided by space type. The sum of these emissions for each space type represents the building's carbon footprint.

$$\left(\frac{space\ type\ sq\ ft \times resource\ multiplier}{(\sum space\ type\ sq\ ft \times resource\ multiplier)}\right) \times building\ resource\ use \times resource\ emissions\ multiplier = space\ type\ emissions$$

Departmental Analysis

Using the same pivot table, the department's share of the building's space types were extracted onto its own worksheet. For each resource (electricity, chilled water, and steam), the following steps were taken individually. The square footage of each space type was weighted with the resource multiplier. This weighted square footage for each space type was then divided by the total weighted square footage for the building as determined during the building analysis portion. The resulting percentage conveys the department's share of the weighted resource use of the building.

This percentage is then multiplied by the building's total resource use, to which the corresponding resource multiplier can be applied.

Results

The School of Architecture generated approximately 696 US tons of CO2 equivalent gases from Scope 1 stationary emissions in FY 2015.

The Jackson School of Geosciences generated approximately 1,288 US tons of CO2 during FY2016, nearly twice the amount of as UTSOA.

Technical Assistance

An example workbook used for the School of Architecture Pilot can be downloaded here: https://utexas.box.com/v/architecturebuildingemissions

A blank workbook including the base resources needed for an inventory can be downloaded here: https://utexas.app.box.com/files/0/f/29012360027/Jackson_School_Inventory

A technical assistance document for determining Scope 1 Stationary Combustion Emissions from buildings can be found here: https://utexas.box.com/v/BuildingEmissions-Scope1-3

Please note that these documents include Scope 3 domestic water and wastewater emissions. This is because their calculation requires a similar method that relies on dividing building aggregates by department.

Mobile Combustion

Mobile combustion comprises the other part of Scope 1 emissions, as they derive from fuels combusted on campus property. For the purpose of the departmental inventory, this includes fuels consumed by vehicles owned by the department. While many departments own and maintain their own vehicle fleets, the School of Architecture does not. As such, the greenhouse gas contribution of Scope 1 for UTSOA's mobile combustion is zero. The Jackson School owns and operates a fleet of 10 vehicles (6 Suburbans, 3 Vans, 1 Pickup), and covers expenditure on fuel for all of them.

Data

Parking and Transportation Services (PTS) keeps records of all vehicles owned by a given department and on the amount of fuel consumed in a database called CARMA. To access this information, someone from your department's administration (not a student) will need to contact Fleet Services to obtain a spreadsheet.

The CARMA database includes descriptive information about each vehicle including:

- Make
- Model
- Year
- Engine Size
- Fuel Type
- Fuel Transaction Data
    - Date
    - Time
    - Gallons
    - Price per Gallon
    - Cost

From this data, you can find the total amount of fuel used by your department's vehicles over the course of the fiscal year.

According to the EPA, each gallon of gasoline contains 8,887 grams of CO_2. Each gallon of diesel fuel contains 10,180 grams of CO_2 (US EPA, 2014b). The US Department of Energy's Fuel Economy website also includes directories that can provide emissions factors for electric vehicles and plug-in hybrids that use electricity as a fuel source (US DOE, 2016a, 2016b). Though it is unlikely your department will own an alternative fuel vehicle, the university does own vehicles that use natural gas and blends of biodiesel. According to the US Energy Information Administration, E85 fuel contains 1,340 grams of CO_2 in each gallon, while compressed natural gas contains 54,600 grams of CO_2 in each thousand cubic feet (mcf) of the fuel source (US EIA, 2011). It seems impossible that a gallon of gasoline, which weighs about 6.3 pounds, could produce 20 pounds of carbon dioxide (CO_2) when burned. However, most of the weight of the CO_2 doesn't come from the gasoline itself, but the oxygen in the air. When gasoline burns, the carbon and hydrogen separate. The hydrogen combines with oxygen to form water (H_2O), and carbon combines with oxygen to form carbon dioxide (CO_2).

Methods

There are a number of methods for calculating the carbon dioxide emissions from vehicle use. Most vehicles owned by individual departments are conventional vehicles such as passenger vans and light-duty trucks. The university keeps detailed records on fuel use, the simplest method involves totaling the amount of fuel used and calculating the carbon content within.

To do this, find the total sum of each type of fuel consumed in the fiscal year. Then, multiply the total of each fuel with the appropriate emissions factor.

For example:

$$Greenhouse\ gas\ emissions\ (grams) = \left[gallons\ of\ gasoline \times 8{,}887\ grams\ of\ \frac{CO2}{gallon}\right] + \left[gallons\ of\ diesel \times 10{,}180\ grams\ of\ \frac{CO2}{gallon}\right]$$

Results

The School of Architecture did not produce Scope 1 mobile combustion emissions for FY2015.

During FY2016, the Jackson School fleet generated 49.7 US tons of CO2.

Technical Assistance

A workbook that can assist you with these calculations is available here: https://utexas.box.com/v/Scope1Mobile

Refrigerants

Refrigerants refer to chemicals generally used to reduce temperatures in refrigeration and air-conditioning equipment. At the university level, the department of Utilities and Energy Management has phased out the most potent refrigerants, chlorofluorocarbons, in 2015 (Ontiveros, 2016). The university-wide greenhouse gas inventory for fiscal year 2013 found that the emissions from fugitive refrigerant loss was only 0.4% of the university's total footprint (Office of Sustainability, 2014).

Neither The School of Architecture nor the Jackson School own or operate facilities that require a supply of these substances. While some office refrigerators may contain refrigerants, these do not emit gases unless there is a leak or unless they are subject to improper disposal. There is no evidence of refrigerant leak or improper disposal for the study period, so the assumption is that the greenhouse gas footprint of refrigerant use for the School of Architecture as well as The Jackson School is zero.

Data

It is possible that departments with large laboratory divisions may have supplies of refrigerants for equipment or that are used in research. These departments will need to consult their own purchasing histories and laboratory records to see what quantity of refrigerants was consumed over the fiscal year.

Emissions factors for refrigerants come from the EPA's climate leadership technical documentation (US EPA, 2014a).

Methods

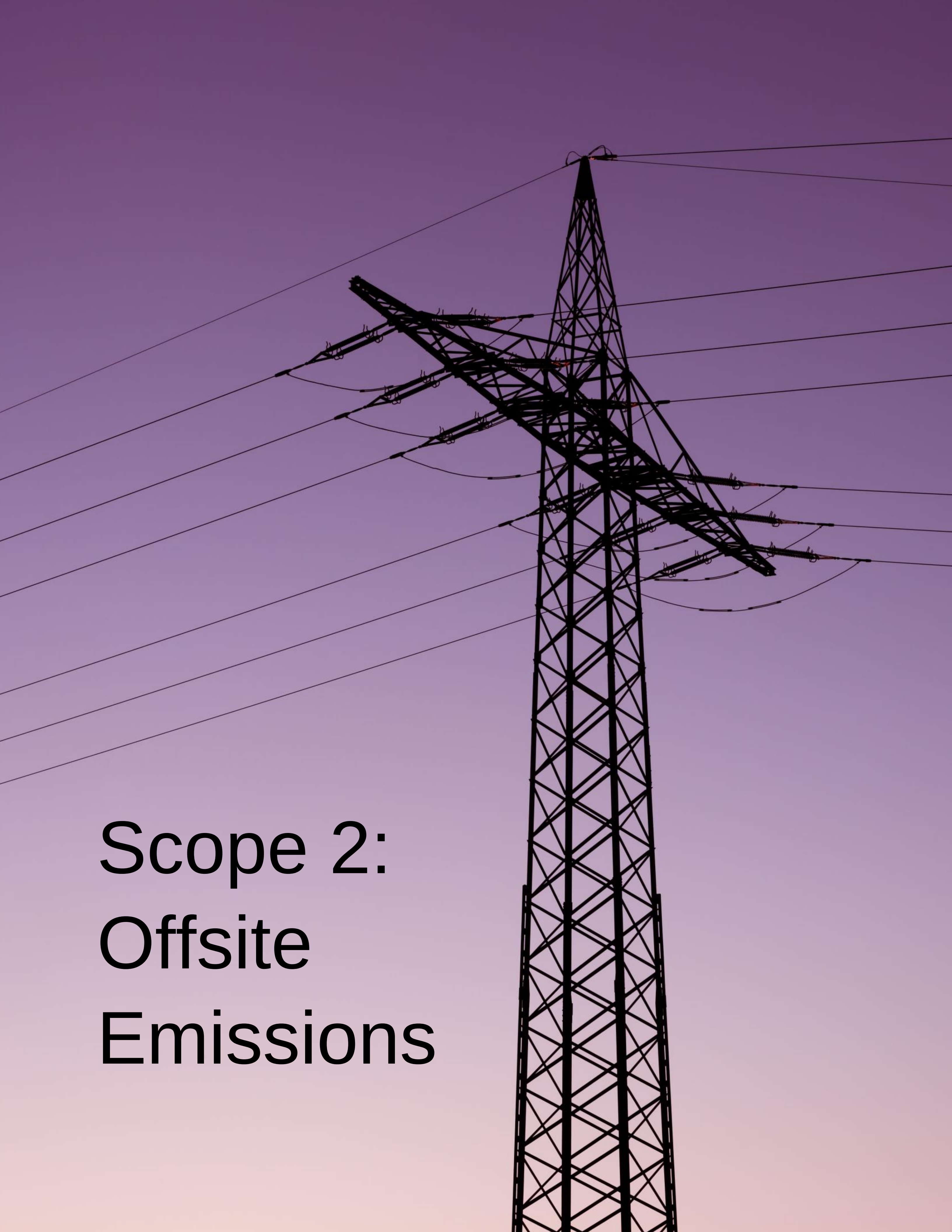
Because the potential use of refrigerants depends on a department's highly specific actual use, determining a methodology that will suit all is not possible at this time. For this reason, we recommend using the EPA's method for calculating the greenhouse gases that stem from refrigerant use. A detailed document published by the EPA is available in the technical assistance section.

Results

The School of Architecture and The Jackson School do not generate any measurable Scope 1 refrigerant emissions in FY2015 and FY2016, respectively.

Technical Assistance

The EPA's methods for calculating the greenhouse gas footprint of refrigerants can be accessed here: https://utexas.box.com/v/Scope1Refrigerants-EPA



Scope 2: Offsite Emissions

Scope 2 – Offsite Electricity Production Emissions

Scope 2 emissions refer to those emitted by offsite electricity production. These indirect emissions are generated outside the physical boundaries of campus, but are transported through powerlines to supply electricity.

Purchased Electricity

The University of Texas at Austin purchases energy for the Pickle Research Campus in north Austin, as well as for a handful of buildings on the main campus. Austin Energy, the utility owned by the City of Austin, generates the majority of this electricity from a combination of coal, natural gas, nuclear, and renewable energy sources. In addition, Austin Energy purchases electricity from the Electric Reliability Council of Texas (ERCOT).

No building occupied by the School of Architecture uses electricity from Austin Energy. However, there are several buildings on the main campus for which Austin Energy does provide electricity. Therefore, several departments may need to complete an inventory process for purchased electricity.

The Jackson School of Geosciences has two research units that operates at the J.J. Pickle Research Center, The Bureau of Economic Geology (BEG) and The Institute of Geophysics (UTIG). The BEG in the Jackson School of Geosciences is the oldest and second-largest organized research unit at The University of Texas at Austin. However, the research units were not included in the Jackson School pilot study for two main reasons. First, it was difficult to obtain data for Pickle's energy, water, steam, and waste water usage. Unlike UT's main campus, energy data for the Pickle campus is not easily available through an online portal. Nevertheless, attempts at gather the data was made was no success. Secondly, if the data was obtained it would be even more difficult to correctly separate the usage of these two organization from the rest of the research entities on the Pickle campus.

Data

Electricity Consumption by Building: The energy usage data for this project was provided by Tejas Pevekar, the Energy Manager of the Utilities & Energy Management division at The University of Texas at Austin. It is based on actual usage of electricity for the analysis period (FY 2015) using the buildings' own meters.

Three buildings on the main campus using Austin Energy's electricity have a departmental presence for FY2015:

- UTA – UT Administration
- DEV – Development Office
- FDH – J. Frank Dobie House

Please see the technical assistance documents for more information on the data available for these buildings. Your department may need to contact a building administrator to track down more information.

Building and Space Type Data: Building space type data is available through the Work Order Request and Query System (WORQS) as it was in the Scope 1 stationary process.

Resource Intensity Multipliers per Space Type: The Energy and Water Conservation Program (EWC) provides space type energy use intensities based on sample benchmarks of energy use. These have been incorporated into the methodology.

Emissions Resource Multipliers: Austin Energy publishes its average carbon intensity over the course of a given calendar year. This method encapsulates the utility company's many fuel sources through an annual carbon intensity index provided in pounds of CO2 per kilowatt hour (Wisner, 2016). Because FY2015 includes four months of 2014 and eight months of 2015, the values for each month were averaged for these purposes.

Methods

The method for determining Scope 2 emissions from purchased electricity parallels that of the stationary combustion emissions calculations in Scope 1. Using the above data sources, the following items were consolidated into one Excel workbook:

- Electricity by Building
- Building and Space Type Data
- Resource Intensity Multipliers by Space Type (Space Type Multiplier)
- Emissions Resource Multipliers (Resource Multiplier)

It is unlikely that any department controls the full space of any building using purchased electricity. Electricity use depends on not just the space occupied by a department, but also the function of the space it controls. For instance, a computer lab requires more energy than an office. Therefore, the building's electricity use must be disaggregated to the department in a way that considers its occupation in square footage as well as the nature of its use.

The method for disaggregating the department's emissions requires two steps: 1) analyzing the full building by weighting each space type by resource intensity, 2) analyzing the department's share of the total resource intensity by occupancy.

Refer to Building Analysis on page 16

The building analysis incorporated the following steps in an example using the School of Information, which has some of its operations in the UT Administration Building. Using a pivot table, each space type for a given building and its square footage was extracted onto its own worksheet. The square footage of each space type was weighted using the electricity resource multiplier and summed. This sum is the building's weighted square footage, which will be used in departmental analysis. Next, the percentage of weighted square footage was determined for each space type. The weighted space type percentage was then multiplied by the total electricity resource usage. The weighted resource usage was then multiplied by the electricity resource multiplier. This process yields the total emissions for a building's use of electricity, divided by space type. The sum of these emissions for each space type represents the building's carbon footprint for Scope 2 purchased electricity.

$$\left(\frac{space\ type\ sq\ ft \times resource\ multiplier}{(\sum space\ type\ sq\ ft \times resource\ multiplier)}\right) \times building\ resource\ use \times resource\ emissions\ multiplier\ = space\ type\ emissions$$

Departmental Analysis

Using the same pivot table, the department's share of the building's space types were extracted onto its own worksheet. The square footage of each space type was weighted with the electricity multiplier. This weighted square footage for each space type was then divided by the total weighted square footage for the building as determined during the building analysis portion. The resulting percentage conveys the department's share of the weighted electricity use of the building. This percentage is then multiplied by the building's total electricity use, to which the electricity resource multiplier can be applied.

Results

The School of Architecture did not produce any Scope 2 emissions from purchased electricity in FY2015. Although The Jackson School of Geosciences does produce Scope 2 emissions from purchased electricity due to its two institutes (Bureau of Economic Geology and The Institute of Geophysics) located at the J.J Pickle Research Center, it was not included in this report due to difficulty of gathering data. The BEG and UTIG have access to modern high tech equipment used in a laboratory setting for geology research purposes. If they were included in the report, one can conclude that the overall energy, water and wastewater consumption for the Jackson School would be much higher than reported in this report. However, Jackson School buildings on UT campus do not produce any Scope 2 emissions from the purchased electricity in the FY2016.

Technical Assistance

An example workbook using the School of Information can be downloaded here: https://utexas.box.com/v/purchasedelectricityemissions

A technical assistance document for determining Scope 2 Purchased Electricity Emissions from buildings can be found here: https://utexas.box.com/v/BuildingEmissions-Scope2-3

Please note that these documents include Scope 3 domestic water and wastewater emissions. This is because their calculation requires a similar method that relies on dividing building aggregates by department.

Scope 3: Indirect Emissions

Scope 3 – Indirect Campus Activity Emissions

Scope 3 emissions refer to those that are generated by indirect campus. These are the emissions that stem from resource consumption that does not directly tie to one fuel or chemical source, as in Scopes 1 and 2, but those that happen along the consumption chain, including water and wastewater, travel, solid waste, commuting to campus, and those embedded within the supply chain of the items we consume. Each source has a distinct method of calculation, some of which are not yet possible for departments to calculate for the FY2015 measurement period.

Water and Wastewater

The provision of water and wastewater generate emissions through their pumping and treatment processes. The water that flows through campus pipes is purchased from Austin Water, who is responsible for treating water from the original source, Lake Travis, so that it is safe for drinking. The electricity consumed in this process produces emissions. Campus also generates wastewater on campus that requires energy intensive treatment before reentering the landscape. While there are some water reclamation processes on campus, most of the water that goes down the drain and all of the water flushed down toilets is subject to the wastewater treatment process.

Data

Water and Wastewater Consumption by Building: The water usage data for this project was provided by Tejas Pevekar, the Energy Manager of the Utilities & Energy Management division at The University of Texas at Austin. It is based on actual usage of water and generation of wastewater over the course of the analysis period (FY 2015). In addition, most buildings on the main university campus have individual water meters (UEM, 2016). Utilities and Energy Management's new Energy Portal provides real-time and historical energy and water data for a metered building or group of buildings. Out of the four buildings that house School of Architecture activity, three have data for water and wastewater: Goldsmith Hall, Sutton Hall, and West Mall Building. While Battle Hall has functioning pipes and bathrooms, and thus generates Scope 3 water and wastewater emissions, they could not be calculated for this project. Both Jackson School Buildings, the Jackson Geosciences Building and E.P. Schoch have data for water and wastewater.

Building and Space Type Data: Building space type data is available through the Work Order Request and Query System (WORQS). The intended use of this database is for university employees to request work from facilities services. However, the organizational structure of WORQS displays a finer level detail of who is responsible for and who occupies a given space (Iannuccilli, 2014).

Resource Intensity Multipliers per Space Type: The Office of Sustainability provided baseline numbers for water and wastewater usage based on space type. These were adjusted to correlate with the EWC space type categories used in the Scope 1 stationary emissions calculation methods.

Emissions Resource Multipliers: David Greene, the Climate Program Coordinator for Austin Water, provided the carbon dioxide and equivalent greenhouse gas emissions rates that occur from water and wastewater usage. These rates apply to water and wastewater use in pounds per thousand gallons (kgal).

Methods

Results

The School of Architecture generated 0.115 US tons of CO2 equivalent from the provision of water and wastewater to its buildings. Meanwhile, The Jackson School of Geosciences generated 0.401 tons of CO2 equivalent from the provision of water and wastewater for its two buildings.

Technical Assistance

https://utexas.app.box.com/files/0/f/29012360027/Jackson_School_Inventory

Travel

Data

School of Architecture Travel Data

Travel data for the School of Architecture was obtained from the travel coordinator and from the Study Abroad office. This included only the date of travel, destination, and number of people traveling. The data available for faculty and staff travel was particularly messy. The records could not confirm if travel had occurred, or if a faculty or staff member had simply submitted an authorization to travel from the school. No distances were provided, and neither was the method of travel.

Jackson School Travel Data

Travel data for the Jackson School includes that associated with air travel, rental car travel, and hotel stays. This information was obtained from Sean McKeever the Jackson School Business office with the help of Lee Loden from the Travel Management Services. Their offices are located on the first floor of the E.P. Schoch building. The Business Office works in conjunction with the university's Travel Management Services and an outside company Corporate Travel Planners (CTP) to provide information and customer service to assist the university community in navigating the pre-trip, business travel planning process. Together these groups manage travel plans for all institutes and organizations that are part of the Jackson School system including all programs under the Jackson School of Geosciences as well as the Environmental Science Institute, Bureau of Economic Geology and Institute of Geophysics, located at the J.J. Pickle Research Center. The frequent amount of the travel is due to conferences, meetings, presentations and field research conducted by faculty researchers, professors and students.

Methods

School of Architecture Travel Methods

The distance between Austin and each destination was provided by Wolfram Alpha. This one-way distance was doubled to create a round-trip distance. All travel over 175 miles in distance from Austin was assumed to be air travel, while all travel under 100 miles was assumed to be car travel. Trips to Dallas and Houston could not be determined and were not included. Trips with multiple destinations were assumed to be completed in the order that they were listed. Each mile of travel was assigned an emissions factor for CO2, CH4 and N2O in kilograms as per the CA-CP carbon footprinting tool. CH4 was assigned an additional emissions factor of 50 to convert the gas into CO2 equivalence. N2O was assigned an additional emissions factor of 298 to bring the emissions into equivalence with CO2. Final results were converted into tons.

TABLE 3: EMISSIONS FACTORS FOR AIR AND CAR TRAVEL PER MILE

Method	kg CO2 / mile	kg CH4 / mile	kg N2O / mile
Air	0.52480	0.00001	0.00001
Car	0.36677	0.00008	0.00003

Jackson School Travel Methods

The reports obtained from the Corporate Travel Planners included air, car and hotel CO2 emissions by month for each institute within the Jackson School. Calculating the total CO2 travel emission was done by adding each type of emission (car, air and hotel) for each month for all the branches of the college.

Results

School of Architecture Travel Results

The School of Architecture emitted 1,038 tons of CO2 equivalent from travel in FY2015. Of this, 623 tons derived from faculty and staff travel and 415 tons stemmed from student travel.

The School of Architecture results are severely limited in that the data source required significant interpretation and many assumptions that cannot be verified. In addition, it does not include emissions stemming from hotel stays, which the Jackson School analysis includes.

Jackson School Travel Results

The Jackson School emitted 953 tons of CO2-equivalent from travel in FY2016. From the Jackson School, the Institute of Geo Physics is responsible for the largest travel emissions with 826,200 pounds of CO2. The majority of these emissions are from travelling from Austin to San Francisco. While the Vertebrate Paleontology Lab had the least travel emission by far with only 5,216 pounds of CO2. These emissions were generated during June 2016 via three flights, Austin to Berlin, Washington to Berlin and Austin to Washington.

Technical Assistance

https://utexas.box.com/v/UTSOATravelEmissions

https://utexas.box.com/v/JacksonSchoolTravel

Other Scope 3 Emissions Sources

There are three additional metrics commonly included in Scope 3 emissions calculations that we did not address as part of this report: solid waste, commuting, and supply chain emissions.

Solid Waste

In the 2015 calendar year, The University of Texas at Austin main campus generated approximately 5.7 million pounds of solid waste. This represents about 177 pounds of solid waste per student. Of this total, 36% was diverted to recycling and compost streams.

Because multiple buildings and school use the same trash disposal systems it is difficult to measure the solid waste of a school or college and appropriately attribute responsibility. Trash is not collected on a departmental basis. Solid waste metrics are only available in aggregate for the entire university campus. Therefore, the best metric available for departmental solid waste contributions would be to calculate an amount of waste per person and multiply it by the number of people associated with a particular department. However, that metric does not fit the spirit of this report in properly attributing emissions via departments.

We conclude that solid waste is a greenhouse gas producing material that is more appropriately dealt with at a macro level. The University of Texas at Austin employs a Zero Waste Coordinator and has implemented many measures campus-wide to insure proper waste collection and diversion efforts. However, there is work to be done in reducing overall consumption of materials and single-use items, whether those items are recyclable or not. While recycling efforts divert landfill waste, recyclable goods are collected via greenhouse gas emitting vehicles and processed in facilities that consume large amounts of energy.

Possible solutions to reduce campus waste at the campus-level include simplifying the supply stream of materials entering campus. Currently many single-use items combine materials that must be landfilled with recyclable and compostable components that make it difficult to appropriately separate waste streams and prevent contamination.   For example, many drink containers are recyclable, but their straws or tops may need to be separated into landfill streams. Policies concerning vendor materials reside outside the realm of departments and therefore should be considered in university-wide contracting processes.

There are tangible steps that departments can take to reduce their greenhouse gas footprint associated with solid waste streams as well. Reducing single-use products and consumption overall would also reduce solid waste production on campus. Many departments and colleges, such as the School of Architecture, require their students to acquire laptops that meet technological specifications. There are also programs in place to help digitize coursework, such as Canvas and the UT Box system. While there is an e-waste stream associated with technology, its use is required. Therefore, encouraging the distribution of class material and readings using this technology could reduce what is currently dual waste stream of eventual e-waste and immediate paper waste associated with handouts, syllabi, readings, and assignments. Students and professors who prefer to print material should be encouraged to print on double sided sheets as oppose to only using one side.

Departments that make use of other physical materials beyond paper can reduce their waste streams through policies and programming that address their specific research and learning needs. For instance, the School of Architecture, with support from the UT Green Fee, implemented a

Materials Exchange to encourage reuse and sharing of materials used for physical architectural models. The exchange provides space for students to unload their leftover materials from studio courses. Other students can then come as they please and source materials from the exchange, first, before buying new supplies. This program encourages full use of resources and sharing of resources while preventing unnecessary and costly purchases. Other departments supporting fine arts endeavors could replicate this model. Departments using materials for experimentation may also be able to replicate the exchange model, though perhaps with more oversight.

Commuting

After building emissions, transportation represents the second largest contributor to greenhouse gas emissions according to the most recent campus-wide greenhouse gas inventory. However, transportation data is not readily available for over 50,000 faculty, staff, and students that attend The University of Texas at Austin. When developing a database, forms of transit that generate emissions, such as cars, buses, and motorcycles are to be in a separate category from walking and biking. When calculating the emissions from cars and other motorized vehicles, The Parking and Transportation Services should be contacted to find how many permits of each type are active. Capital Metro, which requires students to scan their IDs when entering a bus, is expected to have public ridership data. Means of Transportation to Work data from Social Explorer can then validate the permit findings. Social Explorer, which uses American Community Survey (ACS) from the Census Bureau, also contains Travel Time data for census blocks in Travis County. Therefore, the combination of permit quantity, bus ridership information, travel time, and an estimation of travel frequency based on the UT school calendar can generate a reasonable estimate of the aggregate amount of miles traveled based on transit type. The miles traveled can then be converted to emissions and a baseline created.

Developing a baseline for each school would require an entirely different approach – the use of surveys. The CARMA database from the Parking and Transportation Services can help guide the creation of a survey. At the start of each semester students can be asked what their main mode of transportation is along with travel distance and frequency. In conjunction with information submitted by faculty and staff, transportation emissions could then be calculated. In person surveys are recommended since the completion rate of online surveys is much lower.

Supply Chain

Emissions associated with goods in a department's supply chain were not included as part of this analysis due to a lack of calculating materials. The most recent university-wide greenhouse gas inventory estimated the total number of greenhouse gas emissions from supply chain purchases the amount of money spent over the study period into Carnegie Mellon's Economic Input-Output Life Cycle Assessment (EIO-LCA) database available here: http://www.eiolca.net/. However, this model has not been updated since 2002. We did not find an alternative greenhouse gas calculator that could take the aggregate purchasing numbers available and assign well-researched and rigorously-developed emissions factors to them. The only alternative to emissions factors per dollars spent would be to find individual emissions factors for every line item on purchasing reports. The purchasing reports from the School of Architecture did not provide the level of detail necessary to facilitate such an analysis.

FIGURE 5: EIO-LCA EMISSIONS FACTORS FOR CONSTRUCTION

Sector #230103: Other nonresidential structures
Economic Activity: $1 Million Dollars
Displaying: Greenhouse Gases
Number of Sectors: Top 10

Change Inputs (Click here to view greenhouse gases, air pollutants, etc...)

Documentation:
The environmental, energy, and other data used and their sources.
Frequently asked questions about EIO-LCA.

This sector list was contributed by Green Design Institute.

	Sector	Total t CO2e	CO2 Fossil t CO2e	CO2 Process t CO2e	CH4 t CO2e	N2O t CO2e	HFC/PFCs t CO2e
	Total for all sectors	*612.*	*488.*	*71.2*	*38.3*	*9.68*	*4.83*
230103	Other nonresidential structures	200	200	0.000	0.000	0.000	0.000
221100	Power generation and supply	110	109.0	0.000	0.299	0.675	0.699
327310	Cement manufacturing	59.6	24.9	34.7	0.000	0.000	0.000
211000	Oil and gas extraction	38.4	10.8	7.03	20.5	0.000	0.000
331110	Iron and steel mills	33.3	12.6	20.5	0.203	0.000	0.000
324110	Petroleum refineries	29.0	28.9	0.000	0.090	0.000	0.000
484000	Truck transportation	19.0	19.0	0.000	0.000	0.000	0.000
325310	Fertilizer Manufacturing	8.72	2.16	2.92	0.000	3.64	0.000
3274A0	Lime and gypsum product manufacturing	6.59	2.45	4.14	0.000	0.000	0.000
486000	Pipeline transportation	6.57	3.00	0.008	3.56	0.000	0.000

FIGURE 6: EIO-LCA'S EMISSION FACTORS FOR GOODS & SERVICES AT COLLEGES, UNIVERSITIES, AND JUNIOR COLLEGES

Sector #611A00: Colleges, universities, and junior colleges
Economic Activity: $1 Million Dollars
Displaying: Greenhouse Gases
Number of Sectors: Top 10

Change Inputs (Click here to view greenhouse gases, air pollutants, etc...)

Documentation:
The environmental, energy, and other data used and their sources.
Frequently asked questions about EIO-LCA.

This sector list was contributed by Green Design Institute.

	Sector	Total t CO2e	CO2 Fossil t CO2e	CO2 Process t CO2e	CH4 t CO2e	N2O t CO2e	HFC/PFCs t CO2e
	Total for all sectors	*768.*	*632.*	*12.9*	*92.0*	*26.9*	*4.09*
221100	Power generation and supply	302.0	297.0	0.000	0.818	1.85	1.91
611A00	Colleges, universities, and junior colleges	139.0	139.0	0.000	0.000	0.000	0.000
S00700	General state and local government services	87.3	87.3	0.000	0.000	0.000	0.000
211000	Oil and gas extraction	32.7	9.21	5.99	17.5	0.000	0.000
1121A0	Cattle ranching and farming	29.1	1.90	0.000	16.5	10.6	0.000
562000	Waste management and remediation services	19.6	0.717	0.000	18.7	0.212	0.000
324110	Petroleum refineries	13.9	13.8	0.000	0.043	0.000	0.000
486000	Pipeline transportation	11.9	5.46	0.015	6.46	0.000	0.000
221300	Water, sewage and other systems	10.4	0.323	0.000	8.54	1.56	0.000
212100	Coal mining	8.58	0.969	0.000	7.61	0.000	0.000

Analysis

Recommendations for Greenhouse Gas Reductions

After completing the pilot studies for the Jackson School and the School of Architecture, we can offer several recommendations for reducing greenhouse gases at The University of Texas at Austin. For instance, the energy portal is a great tool for campus that departments can utilize to reduce carbon emissions. The success of the energy portal is based on how much it is used to make decisions on reducing energy and water consumption. The energy portal is a valuable tool that should be marketed to colleges, schools, and departments as a means to increase accountability for energy use. Furthermore, the tool is ripe for use as an analytic tool in student reports and coursework.

Another recommendation is for individual colleges to collect data on how their students commute. Unfortunately, we were unable to calculate the carbon emissions for commuting as the data we collected would not match the period of analysis. For instance, the School of Architecture's emissions from FY 2015 would require commuting data for that same year—this information was not collected. Had we initiated a student survey during the time of analysis, that data would only serve subsequent years' carbon assessments.

Collecting commuting data at the scale of a department would be beneficial to the university for several reasons beyond greenhouse gas accounting. For example, it could provide the City of Austin with information that could be used to planning purposes such as the need to construct bike lanes or improve walk ways near or around campus. This could improve the campus transportation system and provide a clearer view of where bus routes should be expanded or eliminated. In addition, in the case of a tragic event, the university could send a message to its commuters on the roads or paths to avoid, since it would know the number of students driving to school from a specific area. One method the university could use to collect this data is by sending every student an email at the beginning of the semester asking them to check a box about the form of transportation a student plans to use in order to get to and from school.

Another recommendation for reducing campus carbon emissions would be to support emission reductions efforts at the college level. One of the goals of this report is to develop a roadmap for college across campus to calculate and analyze their carbon emission sources. If more campus departments calculated their carbon emissions it would develop an infrastructure for friendly competitions and awards for the schools that successfully reduce their carbon emissions. For example, schools could compete to reduce electricity, water or steam consumption from the prior year or semester. These competitions could be the key to greatly reduce carbon emissions across campus. Thanks to the energy portal, monitoring progress would be quite simple.

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Glossary

Accounting – Generally used to describe a system of organizing financial records, "accounting" is also used to describe the process of calculating and organizing greenhouse gas emissions for a particular source.

BEG - the Bureau of Economic Geology in the Jackson School of Geosciences is the oldest and second-largest organized research unit at The University of Texas at Austin. In addition to functioning as the State Geological Survey of Texas, the Bureau conducts research focusing on the intersection of energy, the environment, and the economy, where significant advances are being made tackling tough problems globally.

Carbon – A shortened way to refer to Carbon Dioxide, or CO2, a common greenhouse gas.

Chilled Water – Water that is chilled in order to provide cooling and air-conditioning to campus. Because it takes energy to chill water, it can be a source of greenhouse gas emissions.

CO2 – Carbon Dioxide, a common greenhouse gas.

Direct Emissions - Emissions from sources that are owned or controlled by the reporting entity.

Domestic Water – water used for indoor and outdoor household purposes

EPS - E.P. Schoch is immediately west of the JGB building. The Department of Geological Sciences and academic offices are on the ground floor of EPS. The Environmental Science Institute is located on the 3rd floor of EPS.

Footprinting – The process and procedure of finding, calculating, and organizing greenhouse gases emitted by a particular source. The process that leads to the discovery of a greenhouse gas footprint.

Global Warming Potential (GWP) - A relative measure of how much heat a greenhouse gas traps in the atmosphere.

Greenhouse Gases (GHGs) - A gas in an atmosphere that absorbs and emits radiation within the thermal infrared range.

Greenhouse Gas Equivalent (eCO2, CO2e) - The concentration of CO_2 that would cause the same level of radiative forcing as a given type and concentration of greenhouse gas.

Indirect Emissions - Emissions that are a consequence of the activities of the reporting entity, but occur at sources owned or controlled by another entity.

JGB - Jackson Geological Sciences Building is immediately north of the Martin Luther King, Jr. statue. The Dean's Office and the Geology Foundation are on the sixth floor of the newer, west addition of the JGB building. The Holland Family Student Center is located on the second floor, which is the ground floor for all but the east side of the building.

JSG – The Jackson School of Geosciences at The University of Texas at Austin unites the Department of Geological Sciences with two research units, the Institute for Geophysics and the Bureau of Economic Geology.

Kilowatt Hours (kWh) - A measure of electrical energy equivalent to a power consumption of 1,000 watts for 1 hour.

K-gals - An abbreviation for kilogallon. A kilo gallon is 1000 gallons.

Metric Tonnes (t) - a unit of weight equal to 1,000 kilograms (2,205 lb).

MLBS – An abbreviate meaning million pounds that is a common unit of measurement for steam.

Purchased Electricity – Electricity that is not sourced from the Carl J. Eckhardt Heating & Power Complex and instead bought from Austin Energy.

Steam - The vapor into which water is converted when heated, forming a white mist of minute water droplets in the air.

Ton-Hours - used in conjunction with thermal storage and it usually relates to how many tons of cooling capacity you have available based on, the pounds (tons) of ice storage multiplied by the hours the load is present.

UTIG - the University of Texas Institute for Geophysics (UTIG) is a world leader in expeditionary-scale geophysical research, conducting research in four broad themes: climate, energy, marine geosciences, seismology and tectonophysics, and planetary and polar geophysics.

UTSOA – University of Texas School of Architecture