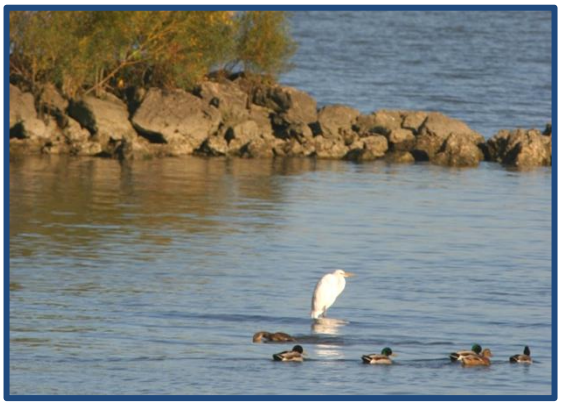
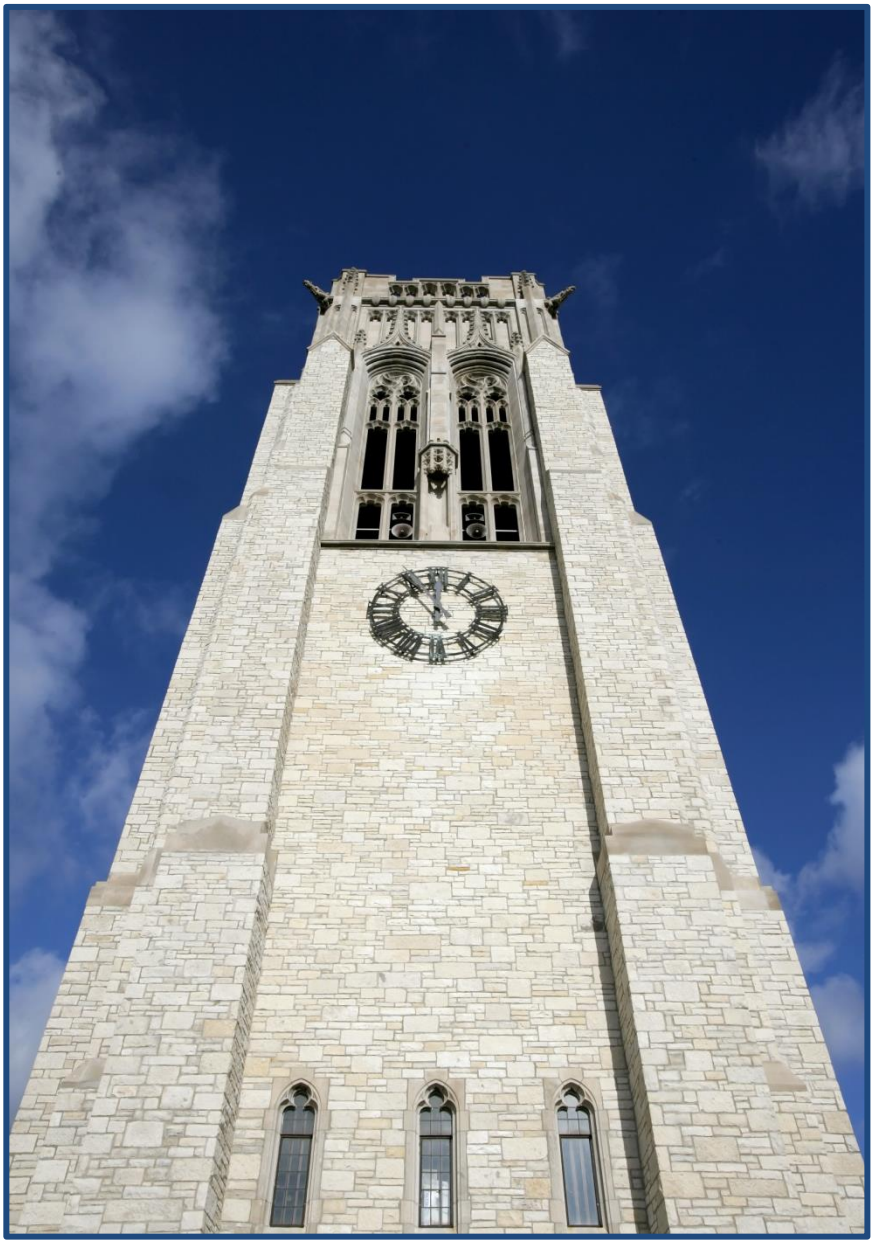
SUSTAINABILITY STRATEGIC PLAN

THE UNIVERSITY OF TOLEDO





THE SEED INITIATIVE

DEPARTMENT OF FACILITIES & CONSTRUCTION

FISCAL YEAR 2015

SEED

SUSTAINABILITY, ENERGY EFFICIENCY AND DESIGN

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Acknowledgements

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Thank you to the following Sustainability committee members for their collaboration.

Brooke Mason, University of Toledo Interim Sustainability Specialist
Jennifer Pastorek, Finance/Purchasing
Michael Green, Energy Management
Rey Guerra, Environmental Services
Howard Hillard, Purchasing
Steve Wise, Grounds & Transit
Margie Traband, Government Relations
Vicki Riddick, Community Wellness & Health Promotion
Kaye Patten-Wallace, Student Experiences
Geoffrey Martin, Institutional Research
Nicole Miliken, Aramark
Larry Burns, External Affairs
Andy Jorgenson, Chemistry
Glenn Lipscomb, Chemical & Environmental Engineering
Defne Apul, Civil Engineering
Randy Ellingson, Physics
Alison Spongberg, Environmental Sciences
Emily Kramp, Student Government
Stephanie Clendenen, Student Green Fund
Tim Murphy, City of Toledo
Alexa Orr, University of Toledo SEED Intern
Makenzie Smith, University of Toledo SEED Intern

Introduction

At The University of Toledo (UT), blue and gold make green as we strive to minimize our impact on the planet. To ensure UT moves in this direction, the University Sustainability Policy was created stating, "The University of Toledo is committed to environmentally responsible use of resources and sustainability in all areas of its environment. The University seeks to integrate the values of sustainability, stewardship, and conservation of resources into activities and services."

The University of Toledo's SEED Initiative, housed within but not limited to Facilities & Construction, focuses on Sustainability, Energy Efficiency, and Design to ensure the University is operating in a manner that betters our neighbors, economy, and planet. Through environmental sustainability projects, energy conservation measures, innovative building renovation and design, and a comprehensive educational campaign, SEED commits itself to leaving behind a better planet than when we started.

What is Sustainability?

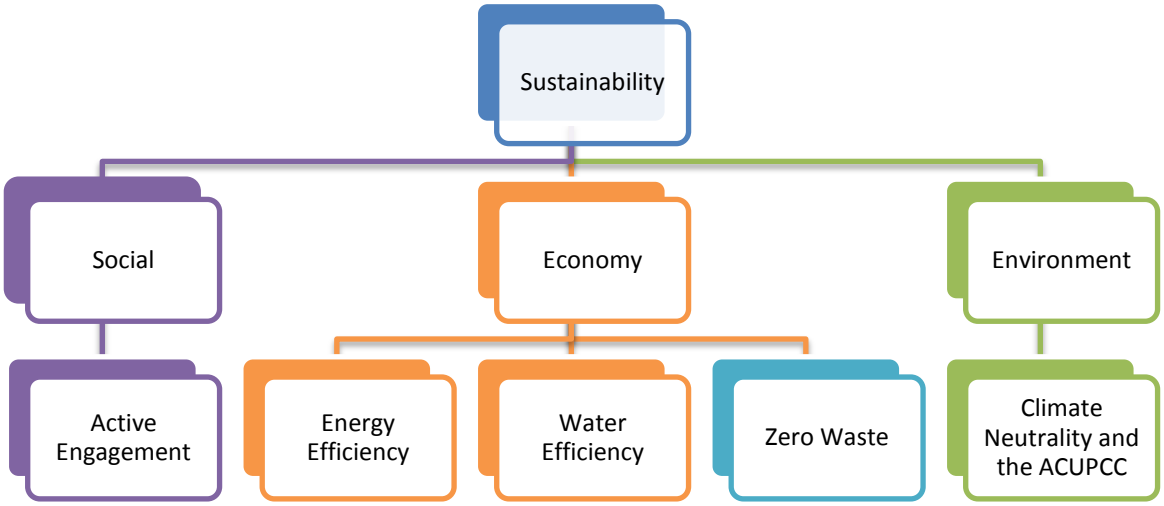
Sustainability "meets the needs of current generations without compromising the ability of future generations to meet their own needs" (Brundtland Commission, 1987). Sustainability is a three-pronged approach to consumption. It takes into consideration: the environment, the economy, and equity. Sustainable practices save money because they reduce consumption, reduce waste production, and maximize efficiency.

The University of Toledo lacks the financial resources of larger universities. It is critical during this time of economic constraints that any investments we make to achieve our sustainability goals result in long-term operational savings. We also need to remember that savings and "return" can and should be calculated in many ways. We must balance direct and indirect payback efforts with practices that are the "right thing to do." As we move forward with our plans, we are mindful to review our progress and recalibrate our path accordingly.

UT focuses on the people of the university because they are the real agents of change. Since we cannot compete with the larger universities in the race for leadership, we are focusing on action within our means. UT has had many years of successful planning, actions, and accomplishments in sustainability. If we can continue this tradition, the University of Toledo can become a more sustainable campus and we promised through the American College and University Presidents Climate Commitment in 2009.

Summary of Goals

Our goals are organized into the three pillars of sustainability. The first and most important component for the University is the social aspect. With increased engagement from faculty/staff, students, and the greater community, we can meet our sustainability goals. The second component, the economy, provides a budget so that the university can continually make changes and implement sustainable projects. The third and final component is the environment. If the first two components are properly implemented, then the environmental benefits come naturally. This does not mean that the environmental component is less important than the others. In fact, it is critical to protect the environment because without it we cannot have an equitable society or a flourishing economy.



Goal One: Active Engagement

- Increase on-campus engagement: Engagement will be tracked by percentage of UT's population SEED interacts with directly.
    - 10% by 2020
    - 20% by 2025
    - 30% by 2030
    - 40% by 2035
- To continually increase awareness and participation in sustainable practices throughout the greater-Toledo area.

Goal Two: Energy and Water Efficiency and Conservation

Energy

- Reduce energy use to 22% below 2004 baseline by 2025 (SB221)
- Increase the use of renewable energy

Water

- Reduce water consumption by 20% from the FY2004 baseline by 2025
- Increase grey water use and water reclamation

Goal Three: Zero Waste

- Increase recycling on campus by 2% annually from FY2014 baseline
- Divert 90% of campus solid waste from landfill from FY 2011 baseline by 2060
- Increase item reuse
- Decrease excess purchasing

Goal Four: Carbon Neutrality

- Reduce greenhouse gas emissions 2% annually (ACUPCC)
- Carbon Neutrality by 2058

Goal One: Active Engagement

Working Definition:

To promote the integration of sustainability principles into general practice and encourage personal initiative by providing learning opportunities and resources such as sustainability education and awareness programs relevant to the campus environment and encouraging the active engagement of all campus community members through education, participation and collaboration. This includes, but is not limited to: literacy, awards/recognition, and overall community engagement.*

Background and Baselines:

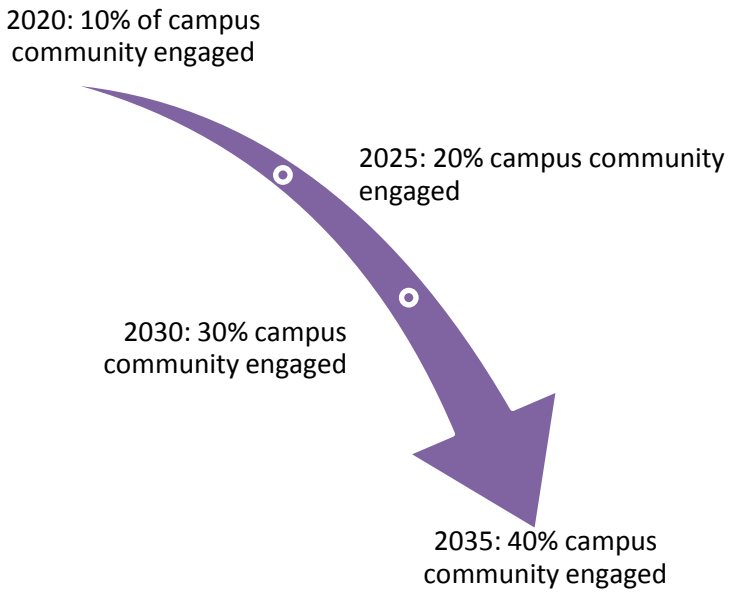
There have been about 100 volunteers each year, 100 students in the Environmental Sustainability Living Learning Community, and 50 students in the Environment-focused student organizations. This equates to about 1% of the students on campus. SEED attends 30-40 events annually in the community and at UT interacting with 800 people annually. Some examples of outreach programs that SEED representatives have attended in the past are the Greentown Conference, SustainableU Conference, Penta Green Career Day, and UT Earth Fest.

In this section we want to define the categories of people that we want to involve in our sustainability practices. Engagement can be divided into two groups: Campus-wide (divided into students and faculty/staff) and Greater Community.

Campus-wide Engagement

Specific Goal:

UT's goal is to increase engagement within The University of Toledo community. The engagement will be tracked by how many people we interact with directly.



Projects: Student Engagement

Projects	Description	Timeline/ Status
BlackoUT	Campus-wide residence hall energy competition in which consumption of each residence hall will be monitored and then compared to the same period the past year.	Nov 1-30th Annually
Friday Night Lights	Group of student volunteers dedicated to helping UT conserve energy by turning off lights in academic buildings on Friday nights. Volunteers have the opportunity to earn service hours.	Weekly
RecycleMania	Engage students through programs in the Res Halls to build interest and education on recycling	Spring Annually
Internship Positions	Available for all UT students with interest in sustainability for academic credit and/or resume building with no restrictions on area of study.	Every Semester
Environmental Sustainability Living Learning Community	Students have the opportunity to learn about the environment through fun programming! Service learning projects are a key component of this community.	Annually
Building Ohio's Sustainable Energy Future	BOSEF is a research opportunity for both Undergraduate and Graduate students in Northwest Ohio Universities and Community Colleges.	Academic Year
Society for Environmental Education/ Earth Fest	An organization on campus that educates the campus and community about environmental issues. Responsible for hosting the annual Earth Fest.	Academic Year
Student Green Fund	A fund of voluntary student donations that finance student proposed and executed projects promoting sustainability, efficiency/renewable energy, waste reduction, and education.	Academic Year
E-Newsletters	Biweekly electronic newsletter sent out to faculty, staff, students, and community members who sign up that provides current projects, success stories, and volunteer opportunities.	Biweekly
Rocket Launch & Transition	Various organizations, businesses, departments, and student organizations have tables at the Information Fair during orientation for new students. SEED hosts one of these tables.	Bi-Annually
The Sustainability Literacy Test	A test designed to evaluate undergraduate and graduate students' basic knowledge of sustainability and social responsibility	FY16
Sustainability Stall Talks	Create flyers hung in bathroom stalls with the latest information on campus sustainability and ho to get involved	FY16

Projects: Faculty and Staff Engagement

Projects	Description	Timeline /Status
Class Projects	Work with colleges and departments to create projects for students to work on (ex: GHG Inventory, CAP, etc.). Thus far we primarily work with Environmental Science and Engineering, want to expand to other areas of study.	Ongoing
Faculty Research	Research done by faculty in areas related to energy and sustainability.	Ongoing
Lake Erie Center	An interdisciplinary research and education center dedicated to solving environmental problems at the land-water interface and bay-lake exchanges. The LEC is also home to education and outreach programs including public lectures, summer science camps, and both graduate and undergraduate courses.	Ongoing
UT Outdoor Classroom Garden	Garden located by the Law Center, maintained by Environmental Sciences. We seek to facilitate discussions of biodiversity, sustainable agriculture, and human well-being through integrative teachings on the environment.	Ongoing
Update Faculty/Staff on Projects Attend PSA Meeting	Do this by attending PSA meetings, Business Managers meetings, CWA meetings, HSC Associate Deans meetings, and other larger meetings.	Ongoing
Green Team	Create a group of faculty/staff that can act as sustainability champions and help guide others in their departments in sustainable initiatives.	FY16
Class Curriculum	Implement degrees: Sustainability degree, Green Business degree, Green Chemistry degree	FY16
Job Descriptions	Incorporate sustainability language in additional faculty/staff job descriptions.	FY16

The Greater Community

Specific Goal:

To continually increase awareness and participation in sustainable practices throughout the greater-Toledo area.

Projects:

Projects	Description	Timeline/ Status
Community E-Waste Day	UT hosts a day in partnership with its electronics recycling contractor to provide the community an opportunity to properly recycle their old electronics.	Annually
Partnership with the Toledo-Lucas County Sustainability Commission	The Toledo-Lucas County Sustainability Commission is a group of representatives from local Businesses, governments, and non-profit organizations that work to promote and educate about sustainability in our region. They work to enhance the health of ecological, social, and economic systems to produce vibrant, sustainable communities and happy, healthy citizens. Our sustainability specialist sits as a liaison for UT.	Ongoing
Toledo Public Schools	Toledo Public Schools has limited recycling in its facilities. UT and TPS are working on a partnership to increase TPS recycling as well as increase education and outreach on sustainability in the schools.	FY15
Notre Dame Academy	Notre Dame Academy has a small recycling program ran by their environmental student organization. NDA and UT are working on a partnership to increase TPS recycling as well as increase education and outreach on sustainability in the school.	FY16

Goal Two: Energy and Water Efficiency and Conservation

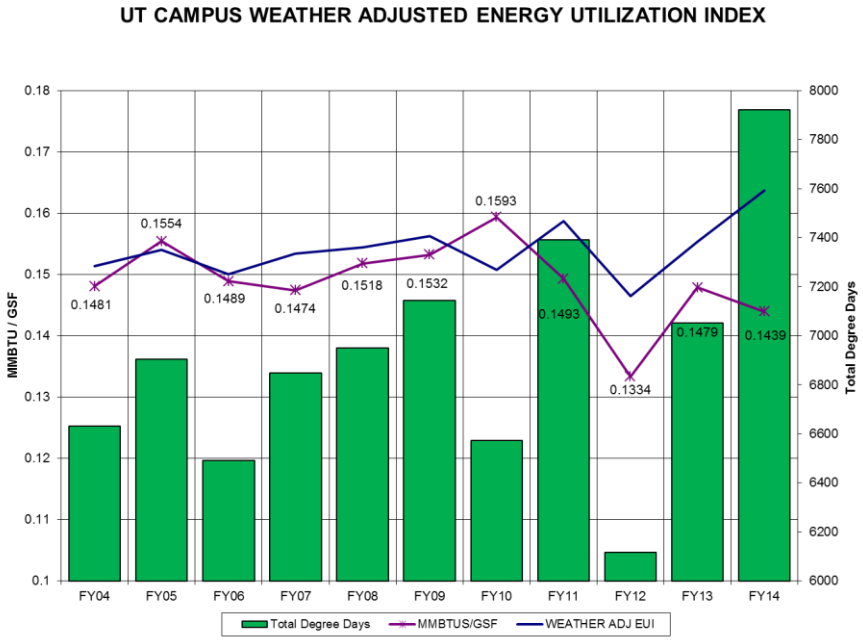
2a. Energy

Working Definition:

Energy efficiency is a way of managing and restraining the growth in energy consumption. Something is energy efficient if it delivers more services for the same energy input, or the same services for less energy input. UT is constantly looking for a more efficient way to move our energy so that less is consumed and/or wasted. Coupled with decreasing our energy use, we are looking to use the natural sources of movement like wind, photons, and Earth-generated thermal energy transfer to provide our energy.

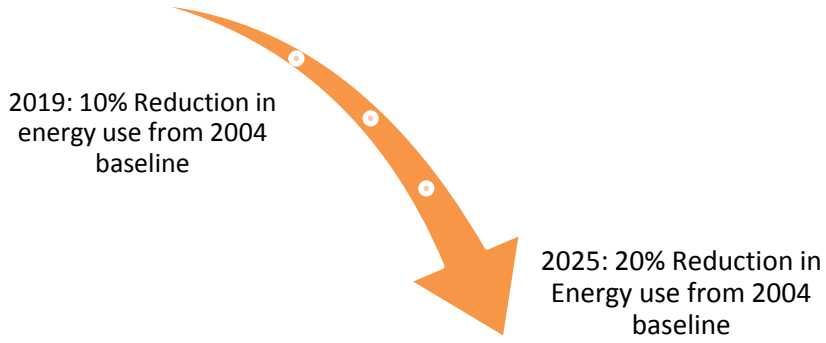
Background and Baselines:

Electricity is used across all three campuses, while natural gas and steam are only used on the Main Campus and the Health Science Campus. A solar field on the Scott Park Campus produces 25% of the energy used on that campus. Energy is distributed to the buildings via steam and chilled water pipes as well as through the electric grid. The data on electric use is measured by meters on every building. The University is continually adding meters to every building in order to track steam and chilled water use. This data is collected and used by the Director of Energy Management to create an Energy Summary that shows trends and reduction in the use of energy. The graph below shows the energy utilization index adjusted with weather. UT managed energy well last year, despite the high heating and cooling degree days. This is shown because the purple line is below the blue line.



Specific Goal:

The goal for energy reduction is to meet the Governors 20% reduction mandate. The mandate for Ohio is a standard for Ohio utilities mandating that by 2025, utility programs achieve annual energy savings through efficiency equal to at least 2% of a rolling three year average.



Accomplishments:

- 99.9% LED exterior lighting
- 99.9% T12 lighting fixtures replaced with energy efficient T8 fixtures (CACR Project)
- Main Campus Cogeneration Plant at Computer Center
- UT Daily electrical metering
- HSC Boilers 4-6 replaced with more efficient boilers (CACR Project)
- Rework of HSC and UTMC chilled water pumping for more efficiency
- LEED Certified Buildings: 3 Silver and 2 Gold Projects (5 additional pending)
- Main Campus steam and chilled line extensions to reduce maintenance costs and increase efficiency (CACR Project)
- Rework of chilled water lines and add new chiller HSC Core Labs (CACR Project)
- Presidents Hall chilled water plant upgrades
- UT Westerville Fuel Energy Fuel Cell feasibility study
- 1.12 MW, 8 acre solar field
- 10 kWh Xunlight paneled roof display
- 80 kWh two-bladed wind turbine
- 4 kWh helical wind turbine

Projects:

Project	Description	Timeline/Status
HVAC/Automation System Training	Group training 2 hours/month	Ongoing
UT Energy Rebates	Rebates for energy upgrades through utility companies. Funds sustainability initiatives on campus.	Ongoing
UT Energy Management Public Dashboard (CACR Project)	Creation of a public dashboard to view live energy consumption. Can view campus totals or zoom into individual buildings.	FY15 (in-progress)
UT Steam and Chilled Water Metering installation	Create more metering points, better monitoring, catch errors and fix quickly.	FY15 (in-progress)
UT Energy Star Compliant Building	Achieve at least one Energy Star for a campus building.	FY15 (in-progress)
HSC 2.5 MW Solar Field (CACR Project)	Install a 2.5MW solar field on top of old coal plant location on HSC. Current proposals are feasible given electric increases expected.	FY15 (in-progress)
Computer Center	Economizer assessment/design and construction for energy savings.	FY15
Install Deduct Meters	Install deduct meters on multiple cooling towers for fiscal savings.	FY15
Vault Pump/Trap Project	Assessment, redesign, rebuild	FY15
University Building Automation System Deferred Maintenance	Upgrade 1985/91 computer equipment.	FY15
University Energy Reduction Phase 2	Change pneumatics to DDC motion sensors to control both HVAC and lighting.	FY15
University Steam and Chilled Water Line Extension Phase 2 (CACR Project)	Connect the line to Crossings to finish the south loop and provide extra redundancy.	FY15
Campus (MC & HSC) Heating and Ventilation Upgrades (CACR Project)	Fix a lot of HVAC equipment, predominately maintenance.	FY15

Main Campus South Chilled Water Plant Phase 3	Upgrade cooling towers and chillers at Crossings.	FY16-17
Snyder Memorial HVAC Systems Replacement (CACR Project)	Air handler replacement.	FY16-17
University Building Utility Meters	Create more metering points, better monitoring, catch errors and fix quickly.	FY16-17
SP Chilled Water Plant and HVAC Improvements (CACR Project)	Optimize plant and improve efficiencies.	FY16-17
HSC Chilled Water Upgrades	Change from 3-way to 2-way values, completing system upgrades.	FY16-17

2b. Water:

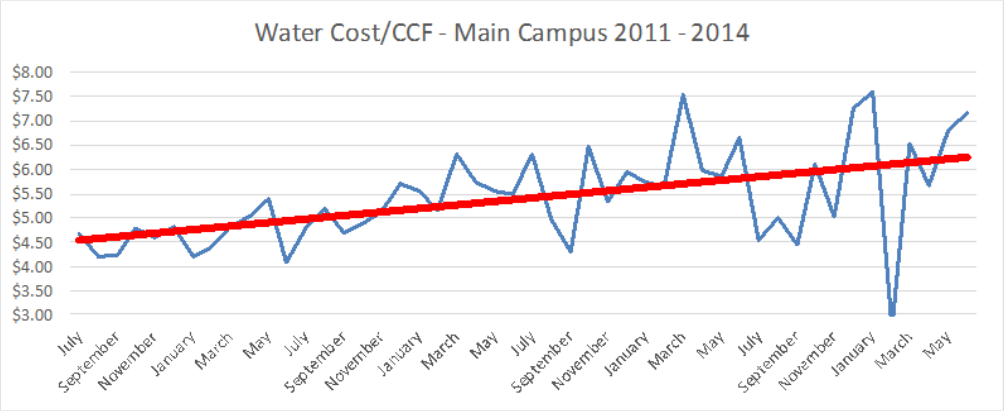
Working Definition:

Water efficiency is a way of managing and restraining growth in water consumption. Similar to energy efficiency, something is considered more sustainable if it delivers more services for the same water input, or the same services for less water input. UT is constantly looking for ways to use water more efficiently so that less is consumed and/or wasted. Coupled with decreasing water use through more efficient fixtures and water conservation behavior modification, storm water and gray water can be collected and used as an alternative water source.

Background and Baselines:

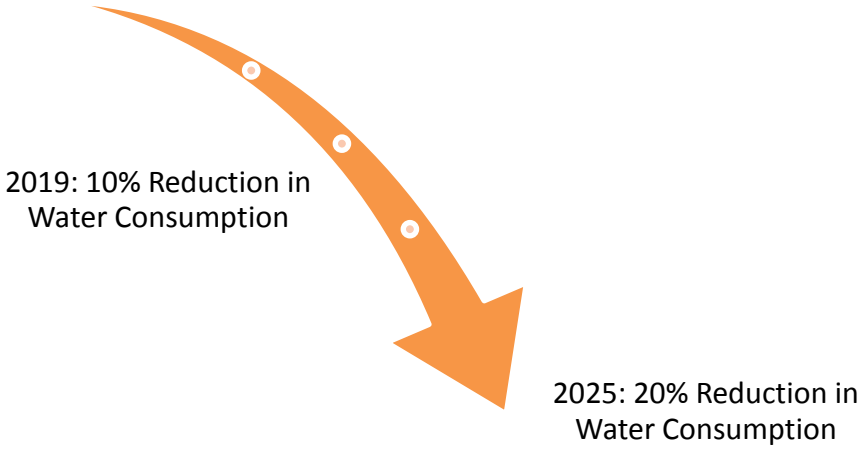
There are a few different sources of water used, and proposed for use, across the University of Toledo's Campuses. UT currently uses the City of Toledo's water in all buildings and in some locations for irrigation on all three campuses. The majority of irrigation is through wells on all three campuses. To date, gray water systems have been considered but are too cost prohibitive. A large rainwater collection basin exists on the Nitschke Tech building on Main Campus. Currently is not being utilized to its maximum potential for irrigation. Some buildings have water efficient fixtures, particularly those with LEED certification. A lot of potential exists for fixture upgrades across all three campuses for reducing water consumption.

The water consumption for each building is measured by existing water meters. Data regarding water use through irrigation was not readily available for analysis. UT has been concerned about increasing costs for City of Toledo water and therefore is looking more closely at reducing water consumption. As seen in Graph 4 below, between the beginning of FY2011 and the end of FY2014, water costs have jumped from $4.50 to about $6.25 per 100 cubic feet (CCF) of water.



Specific Goal:

The goal established by SEED for water reduction is to reduce water consumption by 20% from the 2004 baseline by 2025. SEED has also set a goal to increase grey water use and water reclamation.



Accomplishments:

- 10 LEED certified buildings on campus have low-flow fixtures
- Student Green Fund was established to provide funding for sustainability improvements on campus, including water conservation

Projects:

Project	Description	Cost Savings ($)	Timeline
Toilet Retrofits Urinal Retrofits (CACR Project)	The toilets can be retrofitted with a 1.28-gallon flush valve. The urinals can be retrofitted with a 0.125-gallon flush valve.	$2,186 $1,375	Unknown
Parks Tower Toilet Retrofits and Urinal Replacement	The toilets can be retrofitted with a 1.28-gallon flush valve. The urinals can be replaced with waterless urinals.	$4,746 $506	Unknown
Parks Tower Shower and Sink Upgrades	The showers can be fitted with a 1.25 gpm showerhead. The sinks can be upgraded to 0.5 gpm aerators.	$8,606 $5,062	Unknown
Carlson Library Toilet and Urinal Replacement	The toilets can be replaced with a 1.1-gpf toilet. The urinals can be replaced with waterless urinals.	$5,670 $2,531	Unknown

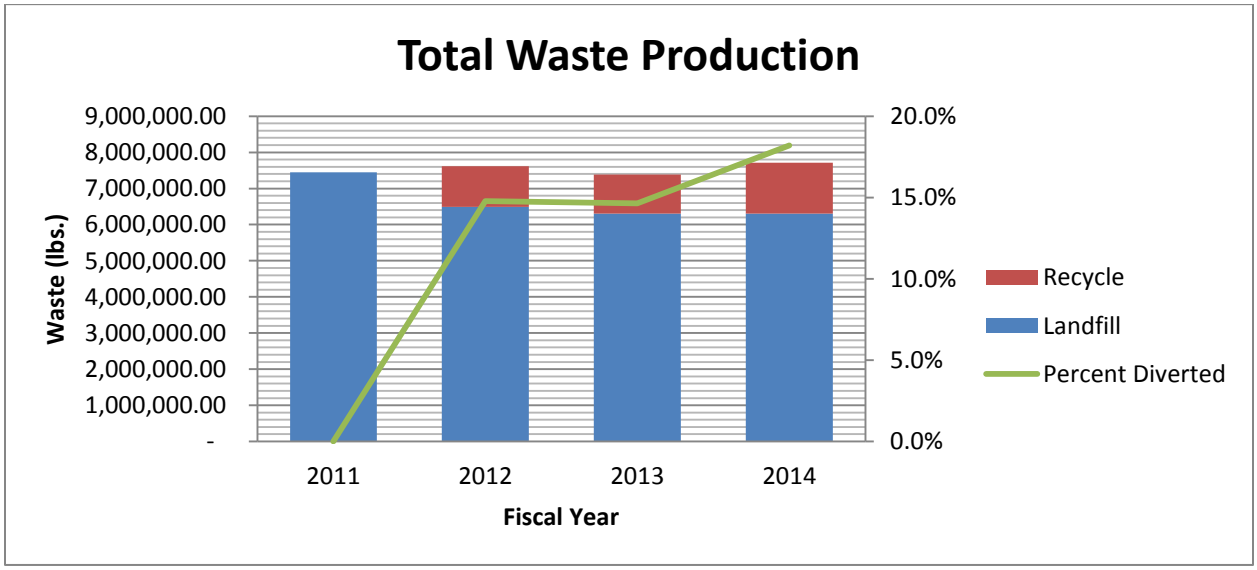
Carlson Library Sink Upgrades	The sinks can be upgraded to 0.5 gpm aerators.	$2,813	Unknown
Wolfe Hall Toilet Retrofits and Urinal Replacement	The toilets can be retrofitted with a 1.28-gallon flush valve. The urinals can be replaced with waterless urinals.	$5,400 $563	Unknown
Wolfe Hall Sink Upgrades	The sinks can be upgraded to 0.5 gpm aerators.	$1,500	Unknown
Water-Saving Event	Students participate in an event to limit water personal use for one day, which raises awareness.	N/A	Unknown
Water Use Awareness Stickers	Reminders placed in restrooms can inform students about water use.	Unknown	Unknown
Install State-of-the-Art Water Meters	New meters can provide more specific data for better analysis	Unknown	Unknown
Gray Water for Landscaping	The water from sinks, washer machines and showers can be collected and used for landscaping	Unknown	Unknown

Goal Three: Zero Solid Waste

Working Definition:

Zero waste is defined as ninety percent or more of the solid waste generated on campus is either diverted from the landfill through recycling, repurposing, reusing and composting practices or is averted by a reduction of consumption and 10% of waste may be disposed of as "trash," provided there is no other more cost-effective disposal option. As practical options become available, that allowable 10% will be reduced. This definition does not encompass sewage waste at this time.

Background and Baselines:



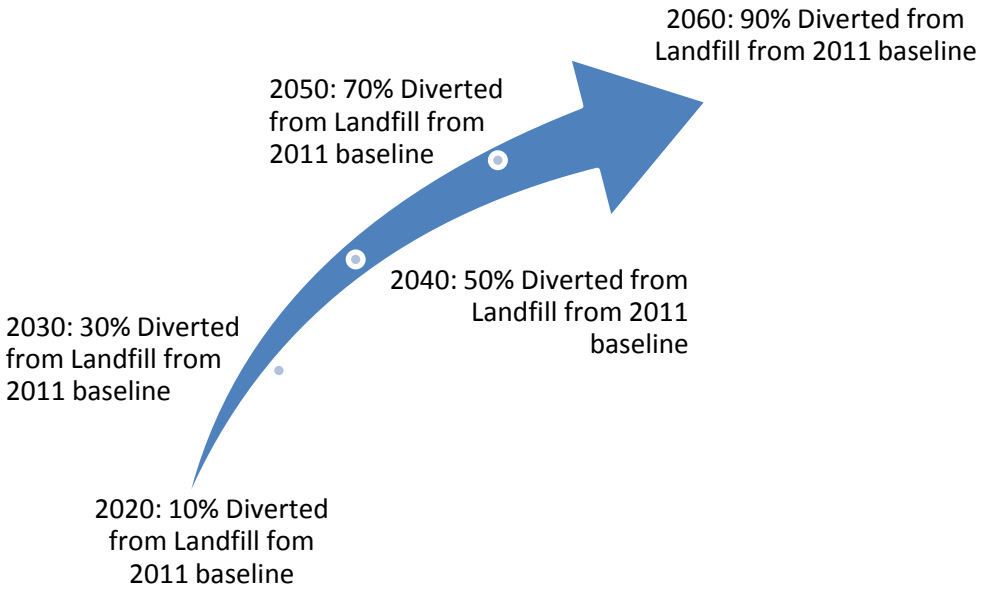
This data provides information from FY2014 on how much material is recycled and taken to the landfill by the University as well as percent diverted. Diversion rate is calculated using the following equation:

$$\textbf{Conversion rate} = \frac{\textbf{Amount recycled}}{(\textbf{Amount recycled} + \textbf{Amount sent to landfill})}.$$

Diverting waste from landfills is not only environmentally responsible, but has economic incentives as well. While, the Midwest does not have high rates for waste disposal, it is not free. As climate change and the world population continues to grow, land space for landfills will become limited and the demand for more areas to store waste will increase, leading to a rise in the price of disposal. If our waste is no longer going to a landfill, we do not have to pay for that service. Also, the university is able to make money on the items recycled, so by recycling more UT spends less money and increases revenue.

Specific Goals:

- Increase recycling on campus by 2% annually from FY2014 baseline
- Divert 90% of campus solid waste from landfill from FY 2011 baseline by 2060
- Increase item reuse
- Decrease excess purchasing



Accomplishments:

- Rocket Recycling has increased recycling rate from 14.7% in FY2013 to 18.2% in FY2014
- Expanded recycling to also include plastic film (HDPE)
- Created five student jobs and one full time job for recycling on campus
- City of Toledo & UT Regional Composting Facility Feasibility Study FY2013
- 11 water bottle refill stations added to buildings

Projects:

Project	Description	Timeline/Status
Rocket Recycling (CACR Project)	Rocket Recycling provides the UT community with opportunities to recycle plastic, paper, metal, electronics, and many other miscellaneous items.	Ongoing
Water Bottle Refill Stations	Offers students and faculty/staff a convenient way to fill water bottles so they do not have to purchase throw-away plastic bottles.	Ongoing
Move-In/Out Programs	Education on recycling and environmentally friendly behavior and cardboard capture and the collection of non-perishable goods.	Ongoing
Athletic Recycling	Revamp recycling and increase recycling awareness and opportunities in athletic venues including green tailgating by partnering with Learfield Sports.	Ongoing

Office Trash Cans- Responsibility of Room Occupant	Office occupants would be responsible for emptying their own trash into centralized waste stations.	FY15
Document Destruction Opportunity	Research feasibility of servicing document destruction in-house.	FY16
Stryker (Hospital Program)	Continuing to increase the amount of equipment that is re-sterilized and reduce the amount sent to the landfill.	FY16
Composting (CACR Project)	Yard waste is currently collected and composted. Expand to include food scrap composting.	FY16
Surplus: Increasing sales and donations	Reselling or donating items that would normally be thrown away.	FY16

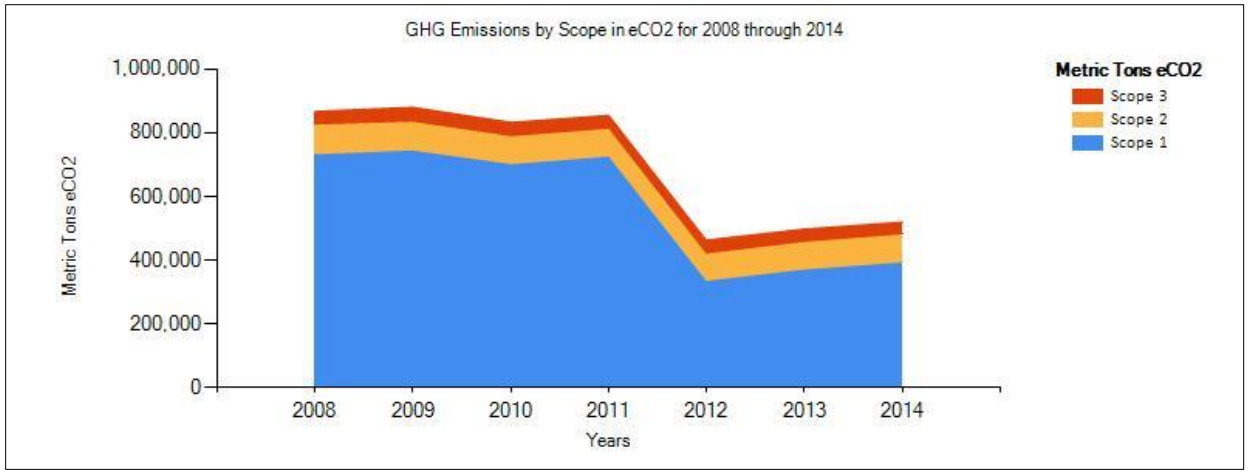
Goal Four: Climate Neutrality

Working Definition: Climate neutrality is defined as having no net greenhouse gas (GHG) emissions, to be achieved by minimizing GHG emissions as much as possible, and using carbon offsets or other measures to mitigate the remaining emissions.

Background and Baselines: To further our pledge towards sustainability, the University of Toledo became a signatory of the American College & University Presidents' Climate Commitment (ACUPCC), in 2009. As such, UT has made an institutional commitment to eliminate net greenhouse gas emissions from specified campus operations and to promote the research and educational efforts of higher education to address climate change. The standard procedure for implementing these initiatives includes:

- Create an implementation profile for the University, tabulate GHG emissions inventory
- Produce a climate action plan with emission reductions for projects
- Update GHG inventory
- Submit progress reports on Climate Action Plan

To perform the GHG inventory and measure GHG emission reductions for universities across the nation, the ACUPCC recognizes the Clean-Air Cool-Plant Campus Carbon Calculator as a reporting tool. The Calculator translates university operations into GHG emission profiles. Greenhouse gas emissions are categorized into 3 scopes:



This graph shows the cumulative GHG emissions each fiscal year from 2008 to 2014. Overall, we have reduced our emissions significantly from our baseline year.

- From the baseline year FY2008 to FY2014 GHG emissions reduced by 40%
- Significant drop from FY2011 to FY2012 resulted from ending coal use on campus
- FY2012 was a record low

*For more detailed information on GHG emissions, please see Appendix C.

Specific Goal: UT's is striving for two percent annual reduction in greenhouse gas emissions leading to carbon neutrality in 2058.

Accomplishments:

- Boiler Replacement
- UT Lighting Retrofit
- Bicycle Initiative: Purchased 30 bikes for the Rocket Recycle Bike Loan Program
- Rocket Recycling: implemented new recycling stations

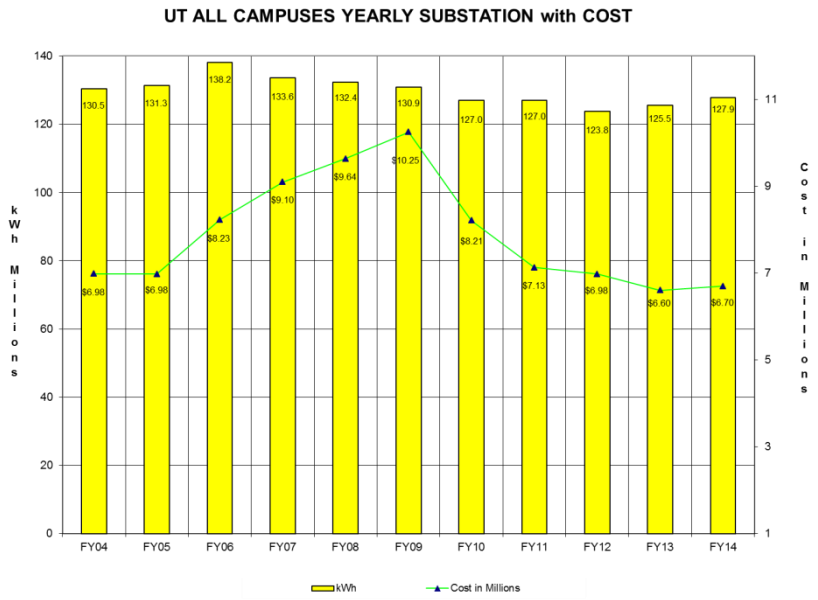
Projects: For more details on each project, please see Appendix B.

Scope	Project	Description	Cost Savings (Annual)	Annual GHG Reduction	Timeline/Status
1	**Boiler Replacement**	Replace four boilers in Savage with more efficient models.	$128,808	566 MTCO2e	Completed FY14
1	**Fleet Upgrade**	Replace 17 vehicles with more efficient models: 3 Chevy Volts, 12 Ford Transit Connect XL Vans, and 2 Smart Cars.	$16,304	49 MTCO2e	1 of 17 Complete FY15
1	**Steam Plant Efficiencies**	Basic maintenance and the prevention of leaks and loss of temperature over long distances.	$122,364	538 MTCO2e	Ongoing
1	**Bicycle Initiatives**	Purchase of 30 bicycles to be checked out by students for use on campus.	N/A	TBD	FY15
1	**Fertilizer Replacement**	Compost food and use the by-product to replace chemical fertilizers.	$26,306	47 MTCO2e	FY16
2	**UT Lighting Retrofits**	Convert last T12 bulbs to T8s, and some fixtures to LED	$116,976	1,478	Completed FY14
2	**Student/ Faculty-Led Initiatives**	These actions are ones in which students, staff, and faculty members on campus are able to contribute to saving energy.	$10,347	131 MTCO2e	Ongoing

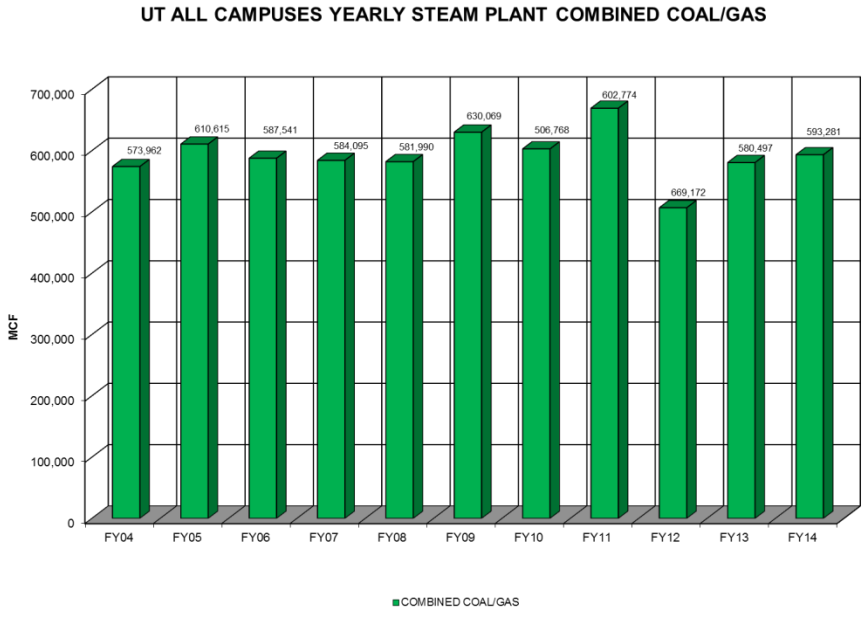
2	**HVAC Reduction Initiative**	During the hours from 4 p.m. to 6 a.m. the building will run its HVAC system at 80% letting the heat of buildings creep up during the night time when less people are occupants.	$220, 000	2,779 MTCO2e	FY15
2	**HVAC Sensors**	Install a new, delicate device called a DDC (Direct Digital Control) device in buildings experiencing the most stress on its current HVAC structure.	$352,000	4,446 MTCO2e	FY15
2	**Health Science Campus Solar Field**	2.5 MW (megawatt) photovoltaic (PV) solar field on the Health Science Campus (HSC).	$1,750	2,035 MTCO2e	FY15
3	**UT SEED Recycling Program**	Installation of waste stations which provide options for recycling and landfill.	$99,500	233 MTCO2e	Completed FY14
3	**Toilet Retrofits** **Urinal Retrofits**	The toilets can be retrofitted with a 1.28-gallon flush valve. The urinals can be retrofitted with a 0.125-gallon flush valve.	$2,186 $1,375	9 MTCO2e 2MTCO2e	Unknown
3	**Carpooling Dashboard**	Create dashboard for students to find carpooling options to eliminate one or more vehicles commuting.	$0	TBD	FY15
3	**Paper Reduction**	Ensuring computer labs are outfitted with printers that can and are set to print double-side and reduce student print quotas.	$35,000	67 MTCO2e	FY16
3	**Composting**	Purchase, install, and maintain in-vessel composting systems as part of the University of Toledo facilities.	$0	68 MTCO2e	FY16
3	**Carpooling Dashboard**	Create dashboard for students to find carpooling options to eliminate one or more vehicles commuting.	$0	TBD	FY15
	Total Cost Savings: $1,133,276				

Appendix A: Energy Data

Below is a graph showing the total electricity usage in millions of kWh with costs in millions for FY2004 through FY2014. Usage was up slightly in FY2014 but this was due to higher than average heating and cooling days.



Below is a graph of the total gas usage for the Main Campus and Health Science Campus steam plants. The steam plants account for 80% of UT's total natural gas usage, the rest is on the building by building level.



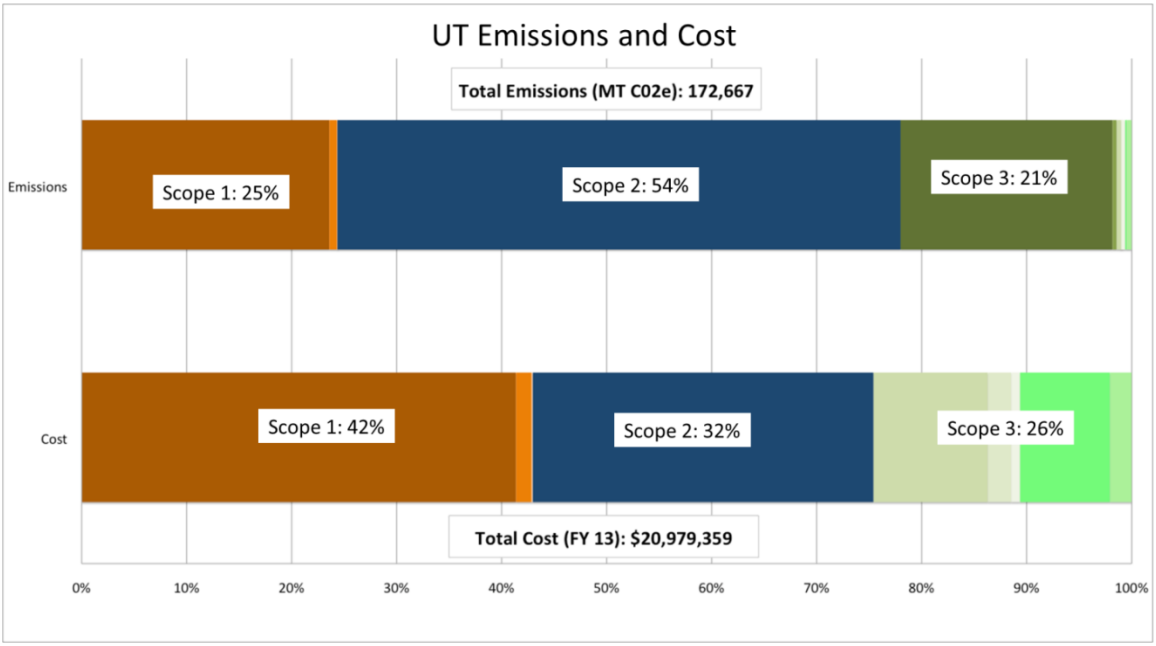
Appendix B: Climate Action Plan

The table below categorizes the University operations that contribute to greenhouse gas emissions by scope and includes the associated annual costs and emissions (MTCOCe). These numerical values were acquired from both the University Facilities and Construction Energy Summary report for 2012 and from the Carbon Calculator for 2013. The total costs and emissions were split into Scopes 1, 2, and 3 and will be referred to in each section of the report, as this was our baseline for calculating the overall reduction in costs and emissions. Our overall goal for this Climate Action Plan is to reduce the emissions of the University and associated costs. While the University is determined to reduce its overall emissions, costs are an important factor. Cost-benefit analysis is required to make final decisions on appropriate plans of action.

Emission Sources		Cost FY 2013	Emissions (MT CO2e)
Scope 1 - Direct UT Emissions			
Natural Gas	7,265,340 MMBTU	$713,670	386,426
UT Fleet	77,862 Gal Gas 15,100 Gal B5	$4,670,651	777
Synthetic Fertilizer	44,200 lbs Synthetic	$26,306	47
Scope 2 - Indirect Energy Emissions			
Purchased Electricity	126,563,104 kwh	$6,808,243	87,927
Scope 3 - Other Indirect Emissions			
Faculty / Staff Commuting	34,309,214 miles traveled		13,117
Student Commuting	50,065,328 miles traveled		19,974
Directly Financed Travel		$2,283,946	700
Solid Waste (landfill)	2,158 tons	$176,460	618
Wastewater	229,178,224 gal	$1,800,000	230
Paper	473,370 lbs of paper	$430,200	774

Cost of Emission Sources

The figure below shows the emissions and cost percentages of the University's operations that contribute to greenhouse gas emissions. Scope 1, 2, and 3 sources are designated by the orange, blue, and green color ranges, respectfully. Scope 1 represents 25%, Scope 2 represents 54%, and Scope 3 represents 21% of the total emissions from the University. Scope 1 represents 42%, Scope 2 represents 32%, and Scope 3 represents 26% of the total costs associated with emissions from the University.



Scope 1 Emissions Reduction Plan

Project 1 – Bicycle Sharing

The bicycle sharing program is being supported and implemented by the University of Toledo's Auxiliary Services, coordinated by Diana Watts. Auxiliary Services is spending $100,000 to purchase 12 bicycles and the associated infrastructure which includes digital monitoring networks and allows for project expansion. The bicycles are offered on a first-come-first-serve basis with a minor fee for users.

The University of Toledo currently emits approximately 777 MT*e*CO_2 due to the fuels used from direct transportation sources. These sources include the Blue and Gold Bus Loops shuttling across the campus. The Blue Loop runs during the spring and fall semesters for approximately 12 hours per day (7:32 a.m. to 7:24 p.m.) from Monday through Friday, which is approximately 60 hours of bus travel per week for the Blue Loop. The Gold Loop runs during the spring and fall semesters for approximately 13 hours per day (9:09 a.m. to 10:08 p.m.) on Monday through Thursday and for approximately 10 hours (9:09 a.m. to 7:20 p.m.) on Friday, which is approximately 62 hours per week. The combined weekly runtime for the Bus Loops (Blue and Gold) is approximately 122 hours during the spring and fall semesters (the bus runtimes are reduced during the summer semesters due to a lower on-campus student population).

Start Year	Capital Cost	Discounted Payback Time	Annual Reduction ($MTCO_2$)	Annual Operational Savings
2014	$100,000	-	-	-

If the bicycle sharing program is successful, it has the potential to be expanded and with a new mode of on-campus transportation, could reduce the runtime of the bus loops and shuttle services to save on direct transportation costs and emissions. At this point-in-time, the 12 bicycle project is not large

enough to reduce the bus loops. Therefore, the project at its current size does not realize a payback time, reduction in emissions, or reduction in the University of Toledo's operational budget (table above).

Impacts of the program that are not quantified in this report (soft impacts) include community building, image of a bicycle friendly campus, image of a "green" and healthy campus, and utilization of the program as a promotional initiative.

Project 2 – University of Toledo Fleet Upgrade

Upgrading the University of Toledo's fleet is under consideration by Facilities and Construction. According to the Manager of Motor Vehicle Operations at the University of Toledo, Steve Wise, there is no fleet replacement budget and the current timeline for vehicle upgrades depend on one-time funding and is on an as-needed basis.

UT Fleet Summary

Source	Quantity (Gallons)	%
Gasoline	77,862	60
Diesel	36,814	28
B5 Biodiesel	15,100	12
Total	129,776	

UT Fleet Purchased Fuel summary

Type of Vehicle	Quantity	%
Auto	36	22
Light Duty Truck/SUV	57	35
Medium Duty Truck	6	4
Van	51	32
Bus	11	7

The University of Toledo currently emits approximately 777 MT*e*CO_2 due to the fuels used from direct transportation sources, emitted from the 161 vehicles in its fleet.

UT Fleet Upgrade Fuel, Budget, and Emissions Reductions Summary

Itemized List	Quantity	Efficiency (mpg)	Annual Fuel Usage (Gallons)	Annual Fuel Reduction (Gallons)	Annual Operational Savings ($)	GHG Emissions ($MTeCO_2$)
Chevy Volt	3	38	1146	3035	10,312.39	
Ford Transit Connect XL Van	12	26	6697	1434	5,521.14	
Smart Car	2	36	806	588	470.57	
Total	17		8649	5055	16,304.10	48.5

The project proposes to replace 17 existing vehicles in the University of Toledo fleet with newer, more efficient models. Proposed models include 3 Chevy Volts, 12 Ford Transit Connect XL Vans, and 2 Smart Cars. These replacement vehicles have been proposed because of their varying sizes and functionality. For example, for hauling purposes, the Ford XL Van could be used, whereas for transit purposes the Smart Car could be used. Replacing 17 vehicles will upgrade approximately 11% of the University of Toledo's current fleet. The annual reduction in cost and emissions is the difference between the fuel

consumed from the existing fleet and the proposed vehicles. To calculate this difference, the following procedure was used.

1. Annual Fleet Mileage
   It was assumed that the average University of Toledo fleet vehicle has a fuel economy of 18 mpg. The fuel economy of 18 mpg for the current fleet was used to account for the large proportion of 'heavier' vehicles operated by the University of Toledo. Vans, busses, medium duty trucks, and SUVs account for 78% of the total fleet. The total fuel usage and fuel efficiencies result in 2,335,968 miles driven by the University of Toledo fleet in 2010. This equates to 14,510 miles per year per vehicle (using 161 vehicles).

2. Annual Fuel Usage of Proposed Vehicles
   The fuel economies of the Chevy Volt, Ford XL Van, and Smart Car are 38, 26, and 36 mpg, respectively. It was assumed that the annual vehicle miles of these alternatives would be equal to the average miles driven per vehicle per year by the current fleet (14,510 miles per year per vehicle). The annual fuel usage of the vehicles is summarized in the above table.

3. Annual Fuel Reduction
   Comparing the total annual fuel usage of the proposed vehicles and taking the difference from the baseline scenario of 18 mpg (current fleet), one is able to calculate the annual fuel reduction of 5,055 gallons of fuel. The total gallons were then multiplied by the percentages of fuel usage by source (gasoline, diesel, and B5 biodiesel), resulting in reductions of 3,033 gallons of gasoline, 1,434 gallons of diesel, and 588 gallons of B5 biodiesel.

UT Fleet Upgrade Project Summary

Start Year	Capital Cost	Discounted Payback Time	Annual Reduction ($MTeCO_2$)	Annual Operational Savings
2014	$408,000	-	49	$16,304

Annual fuel reductions were then used to estimate the individual reductions in annual cost and greenhouse gas emissions. Cost reductions were estimated using current (2014) market prices for the associated fuels, which were $3.40, $3.85, and $0.80 for gasoline, diesel, and B5 biodiesel, respectively. The annual emission reductions were calculated from the Clean-Air Cool Planet Campus Carbon Calculator, with the annual unit reductions of 179 gallons of gasoline, 85 gallons of diesel, and 35 gallons of B5 biodiesel (reductions are on a unit basis with 17 units). The resulting annual savings shown in the above table in operational spending is $16,604 and an associated reduction in GHG emissions by 50 $MTeCO_2$.

Project 3 – Boiler Replacement

For this project the four boilers in Savage hall are proposed to be replaced. The system that is currently in place at Savage produces 10,645 lbs. of steam to heat the building per year. This value equates to 10,645 MMBTU of natural gas which in 2012 cost the University of Toledo an additional $128,808 compared to the proposed 8,000 MMBTU used by the new system. These values can be found in the 2012 University of Toledo Facilities and Construction Energy Summary.

The goal is to install a new boiler which could produce the same heating effect while using less natural gas. The system considered is proposed to be 25% more efficient. This would therefore reduce the MMBTU of natural gas from 10,645 to about the aforementioned 8,000 MMBTU annually.

Boiler Replacement Project Summary

Start Year	Capital Cost	Discounted Payback Time	Annual Reduction ($MTCO_2$)	Annual Operational Savings
2014	$860,000	6 years	566	$128,808

From a cost standpoint, in 2012 the University of Toledo spent $12.01 per MMBTU. Using this value, it is calculated that this system could save $128,808 annually. With an upfront cost of $25,000 for each boiler this system would cost about $860,000 upfront. The projected payback period of this project would be about 6 years. The overall reduction in emissions of 2,661 MMBT is equal to an annual reduction of 566 MTeCO_2 annually.

Project 4 – Steam Plant Efficiencies

Currently, the University of Toledo spends about $2,173,400 on its heating system using 180,966 lbs of steam which equates to 180,966 MMBTUs of natural gas annually.

Ways that we can improve upon the efficiency of this system and cut down on costs include basic maintenance and the prevention of leaks and insulating the underground pipe network to prevent loss of temperature over long distances. It is estimated that in high pressure steam systems there can be a loss of $500 per leak per year and for a low pressure system about $110 per leak. Multiply the possibility of leaks throughout a five mile system, and the University is potentially dumping money into the ground. Therefore, by increasing maintenance and stopping leaks before they happen the University could save money and reduce the steam used, which leads to saving time, energy, fuel, and money.

Steam Plant Efficiencies Project Summary

Start Year	Capital Cost	Discounted Payback Time	Annual Reduction ($MTCO_2$)	Annual Operational Savings
2014	$600,000	7 years	538	$122,364

The other viable option by which to increase the efficiency is to insulate the pipes themselves. A non-insulated pipe loses on average $515 per 100 feet per year. UT has nearly 5 miles of piping underground

which can amount to losses around $135,000+ per year. It is, therefore, recommended to insulate the pipes over long distances and put insulated jackets over valves, flanges and other fittings where the potential for heat loss is greater. If these pipes are properly insulated it is estimated that the overall heat loss can be reduced as much as 90% during the colder months. With optimistic math this could work out to be a savings of $122,000+ per year in natural gas. We used the same rate for natural gas as the boiler system, $12.10 per MMBTU, and the reduction in utilization of natural gas ends up to be 10,112 MMBTUs which equates to 540 $MTeCO_2$ annually.

Project 5 – Fertilizer Replacement

For replacement of the currently used synthetic fertilizer we plan to implement a composting program on campus. This plan would entail using all of the food waste produced on the campus in composting sites and use the by-product to completely replace what is currently used.

Fertilizer Replacement Project Summary

Start Year	Capital Cost	Discounted Payback Time	Annual Reduction ($MTCO_2$)	Annual Operational Savings
2014	-	-	47	$26,306

This would completely cut over 44,200 lbs of synthetic fertilizer on campus saving the University around $26,000 annually and reducing emissions by 47 $MTeCO_2$.

Scope 2 Emissions Reduction Plan

Project 6 – HVAC Reduction Policy

Low cost policy changes are the best way to reduce emissions and energy costs. The proposed policy will begin summer semester of 2014. Currently the University of Toledo runs its HVAC system through all buildings and rooms at 100% through the entire year. In summer months, large amounts of kWh are used to cool large portions of buildings with no occupants, especially during the night.

HVAC Reduction Project Summary

Start Year	Capital Cost	Discounted Payback Time	Annual Reduction ($MTCO_2$)	Annual Operational Savings
2014	-	-	2,779	$220,000

It is proposed that during the summer months, between the hours of 4 p.m. to 6 a.m. the buildings run the HVAC system at 80% letting the heat of buildings creep up during the night time when there are fewer occupants. During the summer months, the cooling days peak in July at a normal of 250 days according to the 2013 Energy Management report. To run the system at just 80% for 16 hours would save the University of Toledo at an estimated 4,000,000 kWh. This kWh is purely an estimate based on number of cooling days normally during the summer semester. There would be no cost to the University of Toledo while also saving close to $200,000 annually. It would decrease the total $MTeCO_2$ by 2,779 annually which is a 3.4% reduction by a policy change as shown in the table above.

Project 7 – HVAC Sensors

Pneumatic HVAC controls are a standard HVAC control. This control is similar to one you see in many classrooms within the University of Toledo. They, on a room-by-room basis, control the temperature of a single room. This room-by-room basis causes unnecessary stress on the HVAC system and draws unnecessary kWh by the constant fluctuation of temperature and personal preferences.

What the University proposes to do is install a new, delicate device called a DDC (Direct Digital Control) device in two buildings experiencing the most stress on its current HVAC structure. The DDC device is an electronic device where all the rooms in their building are controlled by a single device. A sensor is placed in every room, and each sensor relays information to the DDC dashboard, where it automatically fluctuates the HVAC system to bring the room to a standard temperature. The state of the art sensor is based on carbon dioxide levels in the room. If the carbon dioxide levels decrease below a set level, usually around 500 ppm, the sensor will indicate that the room is vacant and turn off the lights and HVAC to that room automatically. These sensors come at a premium of over $250 per sensor, which does not include installation costs.

HVAC Sensors Project Summary

Start Year	Capital Cost	Discounted Payback Time	Annual Reduction ($MTCO_2$)	Annual Operational Savings
2015	$1,500,000	2 years	4,446	$352,000

An estimate from the American Society of Heating places a HVAC retrofit at close to $0.50 per square foot, and another $0.50 for a lighting sensor, for a cost of a $1.00 per square foot, which would not include the sensors. A dashboard would have to be installed, but it would be all controlled from one area. If a DDC system would be placed into a large building, such as University Hall and Bowman-Oddy, the University of Toledo could see up to 6.4 million kWh saved on an annual basis after an initial investment of $1.5 million. This is an estimate of the difference of DDC compared to pneumatic controls. The estimate of 50% reduction in steam, natural gas, and electric is converted to a simple form of kWh. Using the building utility usage for FY 2012 and using a 50% estimate of reduction, it would be a reduction of close to 6.4 million kWh.

The University of Toledo currently purchases its electricity at $0.055 per kWh. The payback for the system is close to 2.1 years. Saving 6.4 million kWh would reduce the greenhouse gas emissions by 4,446 MT*e*CO_2 on an annual basis.

Project 8 – HSC Solar Field

A proposed 2.5 MW (megawatt) photovoltaic (PV) solar field on the Health Science Campus (HSC) would produce a large amount of green energy for the University of Toledo to subsidize. The land will be leased to an outside company. They will then front the capital costs to install the PV field. The University will purchase the electricity from the outside company at $0.06 per kWh. The proposed location would be to the east of the main entrance of the Health and Science Campus, off of Glendale Ave. A map of the location is shown in figure 5.2.1.

Using an online PV calculator, estimates are generated for the electricity output of the proposed system. The calculator can be found online at http://pvwatts.nrel.gov/pvwatts.php. The PV System Specifications were based on a standard system with suggested numbers from Dr. Randy Ellingson, Associate Professor of Physics and Astronomy and the Wright Center for Photovoltaic Innovation and Commercialization. The Calculator Inputs and Results are seen below. These results show 2.9 million kWh per year could be generated by this solar field. This is roughly 2.5% of the current electricity usage by the University of Toledo. This would mean 2.5% of the electricity used by the University would be completely "green".

Expected Performance of Solar Field from Online PVWATTS Calculator

Location and Station Identification

Requested Location	toledo
Weather Data Source	TOLEDO EXPRESS AIRPORT, OH (TMY3)
Latitude	41.58° N
Longitude	83.8° W

PV System Specifications *(Commercial)*

DC Rating	2500 kW
DC to AC Derate Factor	0.77
Array Type	Fixed (open rack)
Array Tilt	35°
Array Azimuth	180°

Initial Economic Comparison

Average Cost of Electricity Purchased from Utility	0.06 $/kWh
Cost of Electricity Generated by System	0.12 $/kWh

These values can be compared to get an idea of the cost-effectiveness of this system. However, system costs, system financing options (including 3rd party ownership) and complex utility rates can significantly change the relative value of the PV system.

RESULTS 2,928,775 kWh per Year

Print Results

Month	Solar Radiation (kWh / m² / day)	AC Energy (kWh)	Energy Value ($)
January	2.54	155,665	9,340
February	3.66	206,962	12,418
March	4.29	255,331	15,320
April	5.26	288,929	17,336
May	5.92	327,437	19,646
June	5.78	300,511	18,031
July	6.01	316,385	18,983
August	5.67	304,210	18,253
September	5.18	274,998	16,500
October	3.91	224,068	13,444
November	2.66	152,492	9,150
December	2.01	121,786	7,307
Annual	4.41	2,928,775	$ 175,727

HSC Solar Field Project Summary

Start Year	Capital Cost	Discounted Payback Time	Annual Reduction ($MTCO_2$)	% Total Annual Reduction	Annual Operational Savings
2014	$0	-	2,035	2.5	-

Using the $0.06 per kWh given, the total cost the University of Toledo would pay for this electricity would be approximately $175,000. This $175,000 will be the only cost associated with this project. Eventually, an agreement could be made for the University of Toledo to purchase and operate the field internally. However, it is not included in the calculations. Running these numbers through the Campus Carbon Calculator, the annual emission reductions will be 2,035 MT*e*CO_2, which is 2.5% of total campus emissions. The total cost of the solar field for the University of Toledo would be $14,643 per year. This cost accounts for the extra $0.005 per kWh paid for the PV electricity rather than traditional electricity.

Project 9 – UT Lighting (T12 to T8)

The project includes updating the light-types throughout the University. These changes amount to 4,397 fixture replacements, 883 Compact Fluorescent Light (CFL) Bulbs, 1,074 Occupancy Sensors, and 182 LED exit sign retrofits. The fixture replacements are simply changing the fluorescent light fixtures to accept a new bulb type. The traditional bulb is called a T12. These bulbs are rated at 40 Watts. The new bulbs are

called a T8. These have a smaller diameter and are rated at 28 Watts. The CFLs are a replacement for traditional incandescent bulbs. They are rated for 13 Watts instead of the traditional 60 Watts. The total estimated annual electricity saving is 2,126,845 kWh. This amounts to $108,773.29. The table below shows the payback of 11 years and the $116,976 in annual savings the University of Toledo would realize after implementing this plan.

UT Lighting Project Summary

Start Year	Capital Cost	Discounted Payback Time	Annual Reduction ($MTCO_2$)	Annual Operational Savings
2014	$2,000,000	11 years	1,478	$116,976

Project 10 – Student/Faculty-Led Initiatives

The unit price of electricity is at $0.055 per kWh, and the unit price cannot be adjusted or made more efficient. The most effective way to decrease both greenhouse gas emissions and costs is to simply use less kWh. This can be as easy as turning off a light or shutting down a computer. These actions are ones in which students, staff, and faculty members on campus are able to contribute to.

Student/Faculty-Led Initiatives Project Summary

Start Year	Capital Cost	Discounted Payback Time	Annual Reduction ($MTCO_2$)	Annual Operational Savings
2013	$1,000	-	131	$10,347

As it is currently, there are two specific scope 2 initiatives already in place at the University of Toledo. BlackoUT and Friday Night Lights are initiatives that focus on the average student turning off lights throughout campus buildings when the areas are not in use. With a minimal budget, these initiatives have saved 188,119 kWh, or 131 MT*e*CO_2 on an annual basis. If the University of Toledo were to invest in marketing material for these initiatives, student awareness and participation would increase, and the returns would be immediate.

Many universities estimate that each year, savings from these programs should account for 0.15% to 0.20% of the total kWh. The University of Toledo currently sits at 0.16% of the kWh saved.

Scope 3 Emissions Reduction Plan

Project 11 – Toilet/Urinal Retrofits

The University of Toledo produces 229,178,224 gallons of wastewater per year. This amount of wastewater equates to 229.6 MT*e*CO_2 per year.

Toilet Retrofit Project Summary

Start Year	Capital Cost	Discounted Payback Time	Annual Reduction ($MTCO_2$)	Annual Operational Savings
2014	$11,626	6.9 years	9	$2,186

Urinal Retrofit Project Summary

Start Year	Capital Cost	Discounted Payback Time	Annual Reduction ($MTCO_2$)	Annual Operational Savings
2014	$2,586	1.6 years	2	$1,735

Currently in Palmer and Nitschke Hall the University uses 1.6-gallon flush toilets and 1-gallon flush urinals. This amount of water is much higher than modern low-flow toilets used today to conserve water. There are a total of 62 toilets and 18 urinals in Palmer and Nitschke. We assume that each toilet is flushed 82.5 times based on a combination of two studies. *The Journal of Environmental Management* authored by D.S. Apul states that 2,200 individuals attend Nitschke and Palmer Halls each day. *The Handbook of Water use and Conservation* authored by Amy Vickers states each individual in an educational building will utilize the toilet/urinal three times a day. Given that 2,200 people attend Nitschke and Palmer in a day we multiply this number by 3 then divide by the number of urinals and toilets in both facilities (80). This gives us a usage of 252,450 gallons of wastewater per year for urinals and 1,391,280 gallons of wastewater per year for toilets. The toilets can be retrofitted with a 1.28-gallon flush valve that would save a total of 278,256 gallons of water per year. The urinals can be retrofitted with a 0.125-gallon flush valve that would save a total of 220,893 gallons of water per year. The combined wastewater savings would be 499,149 gallons of water per year. Currently, the water is purchased at $0.008 per gallon. At this rate the University will save an estimated $3,920.39 per year if the retrofitting occurs. The total capital cost of both projects is $14,212 as shown in the tables above. Based on the annual operational savings from retrofitting, the discount payback time for the toilets will be 6.9 years and 1.6 years for the urinals.

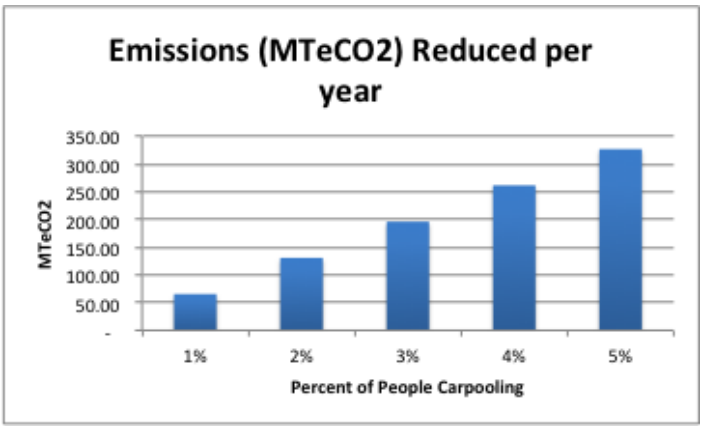
Using an estimated budget of $750,000, the “Kohler manual washout urinal valve .125gpf” to retrofit the urinals and a “Sloan CROWN 111-1.28gpf flush valve, low flow” to retrofit the toilets were selected. The price of the urinal valve is $143.64 and the price of the toilet valve is $187.51, including installation. Allocating one-third of the money to urinals and two-thirds to toilets would allow us to retrofit 1,740 urinals and 2,666 toilets utilizing the entire sum of the $750,000 grant. If we were to retrofit this number of toilets and urinals we would realize a yearly savings on wastewater of $21,320.33 for toilets and $38,054.96 for urinals. This gives us a total savings on wastewater of $59,375.29. This number is derived by converting 2,666 toilets at 1.6 gallons per flush to 1.28 gallons per flush and calculating based on the population of the University (27,489 people based on a 2013 survey done by the University of Toledo) using the facilities 3 times a day (Amy Vicker). The same calculation is done for converting 1,740 urinals from 1.0 gallon per flush to 0.125 gallons per flush.

Project 12 – Carpool Program

A major source of the University of Toledo's emissions is derived from commuters. Carpooling is an effective method that can combine needs for transportation eliminating one or more vehicles commuting in the process. According to a 2013 survey that was performed by the University of Toledo the average number of miles a full time student commutes to the University is 8.06 miles. Reducing this number will be our focus since it translates directly to reduced emissions.

Carpool Program Project Summary

Start Year	Capital Cost	Discounted Payback Time	Annual Reduction ($MTCO_2$)	Annual Operational Savings
2014	-	-	66	-



Carpool Program Implementation Scenarios

The University of Toledo is developing a portal which will be available through the myUT website that will bring potential commuters together. There are 10,573 full time students that commute to the University according to a 2013 survey conducted by the University. If the portal via myUT is implemented and 1% of students frequently carpool (assuming two students per car) the University could notice a reduction of 66 MT*e*CO_2 per year. This is a conservative estimation on the success of the portal. As shown in the chart above, any amount of participation above 1% will have a significantly increased impact on the reduction of emissions.

Project 13 – Paper Reduction

Currently, paper consumption at the University of Toledo accounts for 1.7% of scope 3 emissions and 8.3% of scope 3 spending, indicating that it is a very high cost emission. Those numbers are 774 MT*e*CO_2 and $430,200 respectively, as shown below.

University of Toledo Paper Cost and Associated Emissions

Emission Source	Cost FY2013	Emissions ($MTeCO_2$)
49,535 lbs. of Paper	$430,200	774

The first change that should be made is to ensure that all of the computer labs on campus are outfitted with printers that can print double-sided, and then the settings for each printer in every lab on campus should be set to print double-sided by default. Also, by changing the default print setting to double-sided on already installed printers with this feature, it could theoretically reduce the amount of paper used by up to 50%. Realistically however, there are those who still must print single-sided occasionally, so they would simply have to opt for that.

The second change that should be considered is the reduction of students' print quota allowances. Currently, all students have hundreds of pages available for printing, and this leads to indiscriminate printing, since the large quota lends a feeling that they will never run out. Some students even have multiple different quotas, depending on the college they are in. If the quotas were reduced to a more reasonable limit, students would likely become more conscious of how much they print. These limits should be assigned by the college each student is in, weighted according to how much a student in each respective college typically needs.

Paper Reduction Project Summary

Start Year	Capital Cost	Discounted Payback Time	Annual Reduction ($MTCO_2$)	Annual Operational Savings
2014	-	-	67	$35,000

Finally, in order to reduce paper consumption on campus even further, a sustainability awareness campaign can be launched, encouraging people to become more conscientious of how much paper they use. Methods as simple as hanging signs on printers saying, "Think before you print" can be utilized. Faculty and staff members are also responsible for a significant amount of paper usage. According to Sharon Hunt, the Contract Manager for the University of Toledo, the student laboratories only accounted for 4,550 out of the roughly 100,000 reams of paper used between October, 2012 and November, 2013. As such, faculty and staff-led initiatives to reduce paper consumption could lead to drastic reductions.

If these steps are taken, and the University of Toledo manages to reduce its paper consumption by 5% annually, that would lead to a cumulative cost savings and emissions reduction of $35,000 and 284 $MTeCO_2$ per year, respectively.

Project 14 – UT SEED Recycling Program

The University of Toledo sends approximately 2,158 tons of solid waste to the landfill every year. That waste accounts for 1.4% of scope 3 emissions and 3.4% of scope 3 spending. Those numbers are 618 $MTeCO_2$ and $176,460 respectively, as shown below. Two categories of waste that require different methods of disposal are recyclable waste and compostable waste.

University of Toledo Solid Waste Cost and Associated Emissions

Emission Source	Cost FY2013	Emissions ($MTCO_2$)
2,158 tons solid waste	$176,460	618

The University of Toledo currently recycles 472 tons of waste each year. While landfill waste costs about $0.04 per pound to dispose of, recycled waste can actually generate revenue. That revenue comes from selling the recycled materials, such as aluminum and plastics, back to manufacturers for reuse. Just last year, the University of Toledo's SEED Recycling Program brought in $38,000. The table below shows the specific prices-per-pound for recycled materials that generated the $38,000 revenue in 2013.

Summary of Recycling Program Revenue

Program Revenue:				
	Pounds	Tons	Revenue	Income per ton
Mixed Plastics	12,380	6.19	$ 1,237.95	$ 200.00
Newspaper	40,309	20.15	$ 1,108.50	$ 55.00
Electronics	189,318	94.66	$ -	$ -
Mixed Metal	71,127	35.56	$ 6,757.07	$ 190.00
Yard Waste	220,000	110.00	$ -	$ -
Cardboard	327,758	163.88	$ 15,568.51	$ 95.00
Aluminum	12,380	6.19	$ 7,427.70	$ 1,200.00
Office Paper	97,465	48.73	$ 5,980.86	$ 122.73
Mixed Paper	2,216	1.11	$ -	$ -
DD	528,838	264.42	$ -	$ -
Total	**1,501,790**	**750.89**	**$ 38,080.59**	

Recycling Project Summary

Start Year	Capital Cost	Discounted Payback Time	Annual Reduction ($MTCO_2$)	Annual Operational Savings
2014	$84,500	1 year	233	$99,500

An example of one of the initiatives currently in the pipeline is the installation of waste management centers in place of conventional garbage bins. These centers will provide options for each different type of recyclable waste, in addition to the standard garbage bin. That way, people will not toss out their recyclable waste in a normal garbage bin due to the lack of convenience. This approach also helps sort the recyclables, making the whole system much more efficient, saving time and money on the processing end.

Project 15 – Composting Program

Currently, the University of Toledo's compostable waste is not diverted from the landfill. Compostable waste primarily consists of food waste, napkins, and specially designed compostable goods.

According to a composting feasibility study conducted by a University of Toledo Civil Engineering Senior Design Team, the University generates approximately 219 tons of food waste every year. At the current landfill cost of $0.04 per pound that food waste costs the University just under $18,000 per year and leads to 67.9 MT*e*CO_2 emissions. If the University of Toledo began to compost its food waste, not only would it eliminate the associated emissions, but could easily lead to cost savings by reducing overall food waste produced by way of increased consumer awareness.

Composting Project Summary

Start Year	Capital Cost	Discounted Payback Time	Annual Reduction ($MTCO_2$)	Annual Operational Savings
2014	-	-	68	-

The plan is to purchase, install, and maintain in-vessel composting systems as part of the University of Toledo facilities. This method would require a large up-front capital investment for the equipment, as well as substantial maintenance costs.

Education Plan

No-idle Policy

As vehicles idle, toxic air pollutants are emitted that may be responsible for many health and environmental problems including respiratory illnesses and global warming. The no-idle policy is set to minimize idling time of vehicle operation by the University of Toledo. A suitable way to minimize idling time of UT busses is to turn off the bus when they are scheduled to wait for more than 5 to 10 minutes at a pick-up or drop-off location.

Energy Dashboard

Energy dashboard is a great way to track energy use. If implemented, it would enable the University to visualize our energy use every hour of every day. Having this addition will promote energy conservation and efficiency in use, and help identify patterns and problems that may be occurring at the time.

Project Summary

Scope 1				Scope 2				Scope 3			
Project	Capital Cost	Annual Savings	Annual GHG Reduction	Project	Capital Cost	Annual Savings	Annual GHG Reduction	Project	Capital Cost	Annual Savings	Annual GHG Reduction
1 Bicycle Sharing	100,000	-	-	6 HVAC Reduction Policy	0	$220,000	2,779	11a Toilet Retrofits	11,626	$2,186	9
								11b Urinal Retrofits	2,586	$1,735	2
2 Fleet Upgrade	408,000	$16,304	49	7 HVAC Sensors	1,500,000	$352,000	4,446	12 Carpool Program	0	-	66
3 Boiler Replacements	860,000	$128,808	566	8 HSC Solar Field	0	$1,750	2,035	13 Paper Reduction	0	$35,000	67
4 Steam Plant Efficiencies	600,000	$122,364	538	9 UT Lighting (T12 to T8)	2,000,000	$116,976	1,478	14 UT SEED Recycling	84,500	$99,500	233
5 Fertilizer Reduction	0	$26,306	47	10 Student/Faculty-Led Initiatives	1,000	$10,347	131	15 Composting	0	$0	68
Total	1,968,000	293,782	1,200	Total	3,501,000	701,073	10,869	Total	98,712	138,421	445
Annual Reductions by Scope											
$ 293,782 from operational budget				$ 701,073 from operational budget				$ 138,421 from operational budget			
1,200 MTCO2e				10,869 MTCO2e				445 MTCO2e			
Total Annual Reductions											
$5,567,712 total capital cost											
$1,133,276 from operational budget											
12,514 MTCO2e											

A special thanks to faculty and students of the Civil Engineering Sustainability Engineering Class Spring 2014: Dr. Defne Apul, Evan Foresthofel, Ryan Hershberger, Rand Jabbo, Daniel Johnson, Robert Phillips, and Scott Williams.

Appendix C: Greenhouse Gas Inventory

Scope 1: All Emission Sources

Scope 1 emission sources include fuel oil, natural gas, steam coal, fuel, and fertilizer. The University of Toledo uses distillate oil for a number of generators located on all campuses and outbuildings. Distillate oil is a general classification for the petroleum fractions produced in conventional distillation operations. UT uses a type of distillate oil called fuel oil. No data was found prior to FY2011; FY2008-10 was estimated to be the same as FY2011.

Natural gas is used on a building level as well as a central steam plant on the Main Campus and on the Health Science Campus. Natural gas has come to place coal which used to be used at the Health Science Campus steam plant until FY2012.

Fleet fuel consumption is also included in Scope 1 emissions. UT's fleet includes cars, light duty trucks/SUVs, medium duty trucks, vans, and buses. UT purchased the first all-electric vehicle in FY2014. The table below shows the fuel consumed and subsequent emissions.

Synthetic and organic fertilizers are included in GHG calculations. The University of Toledo purchases synthetic fertilizer with varying nitrogen content. The table shows the amount of fertilizer purchased each fiscal year and its subsequent emissions. Data for FY2008-10 are estimates.

Scope 1 Sources & Emissions

Fiscal Year	Fuel Oil	Natural Gas (ccf)	Steam Coal	Unleaded Gasoline	Diesel (gal)	Biodiesel B20 (gal)	Fertilizer (lbs)	Emissions (MT
2008	0	32,154,241	10,742	82,000	0	43,000	40,000	734,863
2009	0	38,098,241	10,291	80,400	0	45,500	40,000	747,071
2010	16,000	35,951,341	10,060	47,400	20,600	12,500	40,000	703,964
2011	16,000	58,927,400	8,131	48,069	0	34,635	51,850	727,770
2012	10,000	63,314,300	0	46,193	0	35,212	53,100	337,230
2013	5,862	69,924,600	0	55,902	36,814	15,100	44,200	475,326
2014	4,713	74,160,125	0	64,000	14,000	42,000	36,500	395,223

Scope 2: Purchased Electricity

The only source in Scope 2 that pertains to UT is purchased electricity. The majority of UT's energy is purchased from a primarily coal, natural gas, and nuclear mix provider. The table to the right shows the amount of purchased electricity and subsequent emissions. This also includes renewable energy which produces 25% of Scott Park Campus's energy needs.

- 1.12 MW, 8 acre solar field
- 10 kWh Xunlight paneled roof display
- 80 kWh two-bladed wind turbine
- 4 kWh helical wind turbine

Purchased Electricity & Emissions

Fiscal Year	Electricity (kWh)	Emissions (MT eCO_2)
2008	132,400,000	93,324
2009	130,900,000	90,430
2010	127,000,000	87,736
2011	127,000,000	87,736
2012	123,800,000	85,525
2013	125,500,000	86,700
2014	127,900,000	88,358

Scope 3: Commuting

The commuting data has many assumptions built into it. A survey in spring 2013 provided average trip distance, average number of trips per week, and percentage of modes of transportation including personal car, carpool, bus, bicycle, and walking. These numbers allowed us to estimate the annual number of miles and subsequent emissions per mode and per group: student, faculty, and staff. These survey numbers were used on past fiscal years, making these numbers less accurate. The table below shows the results of the extrapolations from the survey. The numbers vary depending on population per fiscal year.

Commuter Mileage & Emissions

Fiscal Year	Student Commuting (million mi.)					Faculty Commuting (million mi.)					Staff Commuting (million mi.)					Total Emissions
	Bike	Walk	Carpool	Bus	Car	Bike	Walk	Carpool	Bus	Car	Bike	Walk	Carpool	Bus	Car	
2008	2.9	8.0	5.8	3.2	37.7	0.5	0.4	0.1	0.03	9.2	0.9	1.1	1.3	0.7	27.0	37,113
2009	3.1	8.6	6.2	3.5	40.7	0.4	0.3	0.1	0.02	7.0	1.1	1.3	1.6	0.8	33.0	40,568
2010	3.2	8.8	6.4	3.6	41.7	0.7	0.6	0.2	0.04	12.5	0.8	1.0	1.1	0.6	23.3	39,051
2011	3.2	9.0	6.5	3.6	42.5	0.7	0.6	0.2	0.03	12.5	0.7	0.9	1.1	0.5	22.1	37,561
2012	3.0	8.6	6.2	3.5	40.5	0.7	0.5	0.2	0.03	11.6	0.8	1.0	1.1	0.6	23.9	38,255
2013	2.8	8.0	5.8	3.2	37.9	0.5	0.4	0.1	0.03	9.6	0.8	1.0	1.1	0.6	23.3	35,768
2014	2.8	7.8	5.6	3.1	36.8	0.6	0.5	0.2	0.03	10.9	0.6	0.8	0.9	0.5	19.6	33,946

Scope 3: University Funded Travel

University Funded Travel includes all types of travel that would be funded by the University including study abroad, athletic competitions, recruiting, interviews, etc. The calculator allows the entering of a total dollar amount spent on funded travel and then multiplies it by a passenger mileage factor. At the moment, the dollar calculation is only for flights. However, we do not have a way to break UT's dollars spent out into plane, bus, car, etc. Therefore, it is assumed all dollars were spent on flying which results in an overestimate of emissions. Future work with Purchasing will be needed to get more accurate data. The table below shows dollars spent, passenger miles, and subsequent emissions.

University Funded Travel			
Fiscal Year	Dollars Spent ($)	Passenger Miles (mi)	Emissions ($MTeCO_2$)
2008	11,081,301	785,073	462
2009	11,193,703	916,015	359
2010	10,033,120	736,106	433
2011	10,341,560	694,764	409
2012	12,412,731	833,909	491
2013	12,857,942	863,819	509
2014	12,583,303	845,368	498

Scope 3: Wastewater

Records do not exist for the amount of wastewater produced by The University of Toledo. It is therefore assumed that incoming purchased water was equivalent to the outgoing wastewater from UT.

Quantities were derived from UT utility records. The table to the right shows the amount of water used by The University of Toledo and subsequent emissions. It was assumed that all water went through both anaerobic digestion treatment and aerobic treatment as these are the treatment processes of the local water treatment plant.

Wastewater Quantities & Emissions		
Fiscal Year	Quantity (gal)	Emissions ($MTeCO_2$)
2008	239,435,548	240
2009	247,241,676	248
2010	229,784,854	230
2011	232,230,064	233
2012	245,860,868	246
2013	229,178,224	230
2014	232,939,168	233

Scope 3: Solid Waste

To calculate weight, a dumpster's volume was multiplied by the number of weekly pickups, and then multiplied by the number of weeks. There is a different pickup schedule for summer semesters, so those pickups were computed separately from fall and spring semesters. The table below shows the weight of UT's solid waste and subsequent emissions. Data for FY2008-09 could not be determined and was

therefore, assumed to be the same as 2010. How the waste is handled at a landfill affects GHG emissions. The CA-CP calculator asks for the amount of CH_4 not recovered, the amount recovered by flaring, and the amount recovered for electric generation. Each process results in a different amount of emissions.

Solid Waste Production & Emissions

Fiscal Year	Total Landfill Weight (short tons)	Total Recycling Weight (short tons)	Total Composting Weight (lbs)	Emissions ($MTeCO_2$)
2008	3,723	500	23	601
2009	3,723	500	23	601
2010	3,723	500	23	601
2011	3,723	500	23	601
2012	3,245	512	23	524
2013	3,837	504	45	619
2014	3,796	653	41	583

Solid waste also includes the amount recycling and composted. The table shows the total weights of recycling commodities. FY2008-1 are estimated to be the same as FY2011 as data could not be found for those years. More detail on UT's recycling program can be found in Appendix D. At UT, only landscape waste is composted. These weights are also shown in Table 6. FY2008-11 are estimated to be the same as FY2012 as data could not be found for those years.

Scope 3: Paper

Printer paper is the only type of paper product included in this inventory. The table below shows the total weights of the different types of paper and the total emissions. Paper purchase is decentralized, meaning each department purchases their own paper. Work with the campus to increase the amount of recycled content in paper is necessary moving forward.

Printer Paper Consumption & Emissions

Fiscal Year	0% Recycled lbs)	10% Recycled (lbs)	25% Recycled (lbs)	30% Recycled (lbs)	50% Recycled (lbs)	100% Recycled (lbs)	Total Weight (lbs)	Emissions ($MTeCO_2$)
2008	509,760	0	0	0	0	0	509,760	703
2009	573,772	0	0	0	0	0	573,772	791
2010	525,875	0	0	0	0	00	525,875	725
2011	528,945	0	0	4,035	1,080	50	534,100	737
2012	510,930	0	0	6,660	0	50	517,640	714
2013	423,810	0	15	42,305	6,490	740	473,360	653
2014	414,355	10	0	13,905	1,660	0	429,930	593

Carbon Offsets

UT has purchased Renewable Energy Credits (RECs) for new construction and major renovation projects under the Leadership in Energy and Environmental Design (LEED) certification program. The table to the right shows the amount of RECs purchased compared to annual purchased electricity. Some of the buildings include Savage Arena and Memorial Field House.

Offsets

Fiscal Year	RECs (kWh)	Purchased Electricity (kWh)	Emissions Offsets from RECs ($MTeCO_2$)
2008	0	132,400,000	0
2009	1,311,601	130,900,000	725
2010	2,623,201	127,000,000	1,450
2011	1,311,601	127,000,000	725
2012	0	123,800,000	0
2013	0	125,500,000	336
2014	0	127,900,000	0

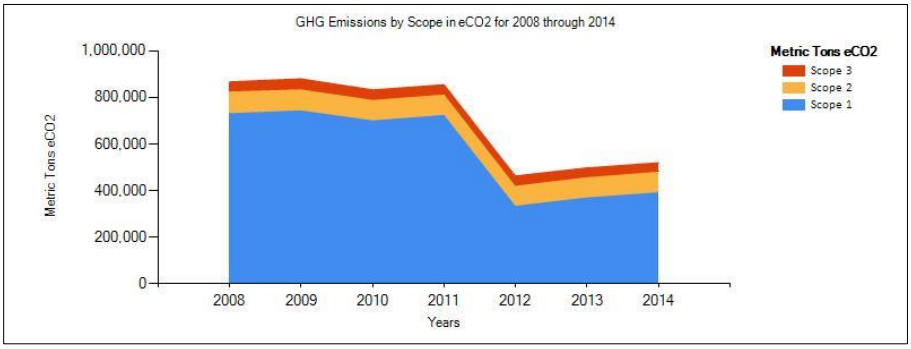
Summary

The table to the right shows annual emissions by the three scopes including the carbon offsets. Scope 1 emissions were consistent for FYs 2008-11 but dropped significantly in FY2012 because the University stopped using coal. On average, Scope 2 emissions have been on a graduate decline since FY2008. Scope 3 emissions have been consistent.

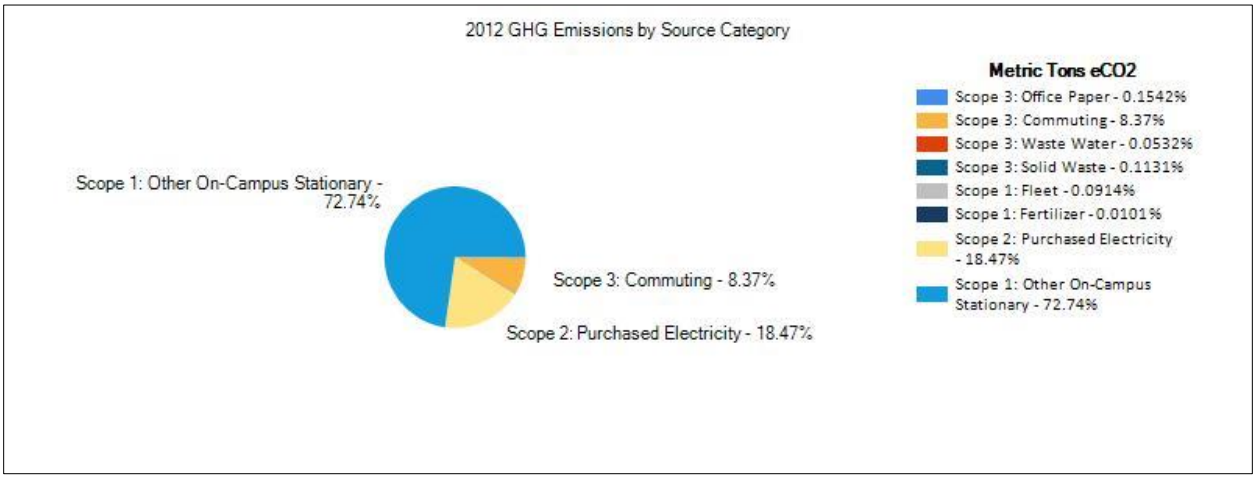
Total Emissions

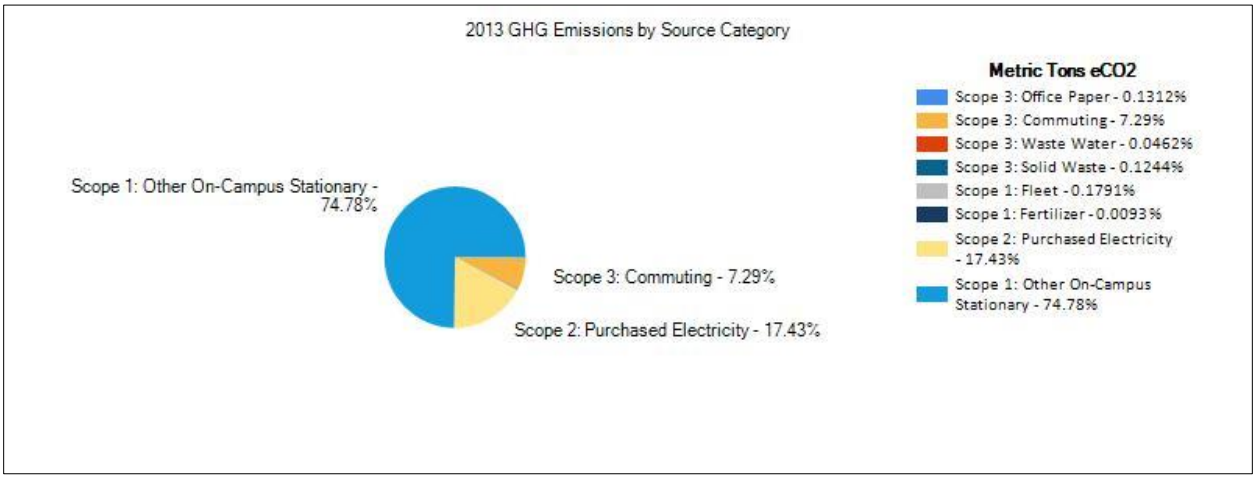
Fiscal Year	Scope 1 ($MTeCO_2$)	Scope 2 ($MTeCO_2$)	Scope 3 ($MTeCO_2$)	Offsets ($MTeCO_2$)	Total Emissions ($MTeCO_2$)
2008	734,863	93,324	39,118	0	867,305
2009	747,071	90,430	42,747	-725	879,523
2010	703,964	87,736	41,040	-1450	831,291
2011	727,770	87,736	39,540	-725	854,322
2012	337,300	85,525	40,230	0	463,055
2013	475,326	86,700	37,778	-336	599,468
2014	395,223	88,358	35,853	0	519,433

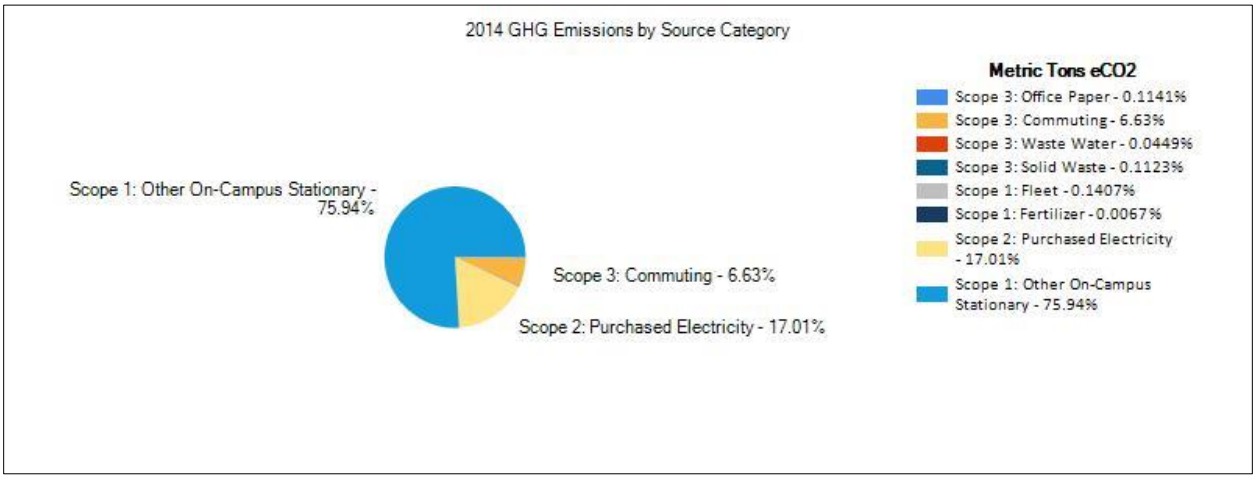
The figure below graphs total emissions for each fiscal year with scope breakdowns. RECs were not included in this graph because their effect is minimal on overall emissions. The graph shows on average, a general decrease in emissions since FY2008. From the baseline year to the present, emissions reduced by 40%. FY2012 was record low.



Insight can be gained by looking at the difference in percentages of source emissions each fiscal year. Below pie charts for FY2012, FY2013 and FY2014 are shown for comparison purposes. The top three producers are on-campus stationary (natural gas and fuel oil), followed by purchased electricity, and then total commuting.







Appendix D: Solid Waste and Recycling Data

Campus	FY2011 (Lbs/yr)	FY2012 (Lbs/yr)	FY2013 (Lbs/yr)	FY2014 (Lbs/yr)
HSC (all year)	737,631.80	18,848.00	556,560.00	556,560.0
Main/SP (Fall/Spring)	5,486,234.58	5,066,306.58	7,116.720.00	5,044,812.0
Main/SP (Summer)	1,232,141.41	705,821.41	Included in MC/SP	705,821.4
Totals	7,446,007.80	6,490,976.00	7,637,280.00	6,307,193.4

The above table shows the data for the amount of trash sent to the landfill by UT. It is broken down into three groups by campus and time of year. To calculate weight for the solid waste category, a dumpster's volume was multiplied by the number of weekly pickups by number of weeks. There is a different pickup schedule for summer semesters, so those pickups were computed separately from fall and spring semesters. Once all dumpsters were estimated, they were combined to get a total volume per year. A cubic yard of compressed solid waste weighs on average 150 lb. This was used as the conversion factor to convert volume to pounds. Then pounds were converted to short tons.

Materials	FY13 Commodity Totals (lbs.)	FY14 Commdity Totals (lbs.)
Mixed Office Paper	138,224.0	148,701.00
Magazine & Mixed Paper	16,217.0	(included in category above)
Newspaper & Phonebooks	53,872.0	12,698.00
Bottles & Cans	44,613.0	Separated into categories below
Plastic	0	2,919.00
Plastic Film (LDPE)	0	14,620.00
Aluminum	0	3,495.00
Cardboard	258,653.0	370,564.00
Document Destruction	378.072.0	120,557.60
Electronics	120,931.2	97,107.50
Others	34,475.0	0
Metal	41,261.2	51,779.89
Total Recycled	**1,086,318.4**	**1,402,611.39**

The table above breaks down the amount recycled by category for FY13 and FY14. The table below calculates the percent recycled for FY13 and FY14.

Campus	FY13 (Lbs./yr)	FY14 (Lbs./yr)
Landfill HSC (All Year)	556,560.0	556,560.0
Landfill Main/SP (Fall/Spring)	5,044,812.4	5,044,812.0
Landfill Main/SP (Summer)	705,821.4	705,821.4
Recycling (All Year)	1,086,318.4	1,402,611.39