2011 GREENHOUSE GAS INVENTORY
BASED ON DATA FROM FISCAL YEARS 2001 - 2011

THE UNIVERSITY OF TEXAS AT AUSTIN
WHAT STARTS HERE CHANGES THE WORLD

Office of Sustainability
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EXECUTIVE SUMMARY

This greenhouse gas (GHG) inventory documents the major emissions from The University of Texas at Austin using established methods. For those emissions sources defined by current voluntary registries as required by reporting (Scope I and Scope II emissions as defined by The Climate Registry), emissions total XXX,XXX metric tons of carbon dioxide equivalent (MT CO$_2$e) for fiscal year 2011, while emissions sources not required by registries (Scope III) are estimated to be an additional XXX,XXX MT CO$_2$e.

This inventory follows the methods described in The Climate Registry (TCR), General Reporting Protocol. The primary inventory boundary is the operational control of The University of Texas at Austin at the Main Campus and Pickle Research Campus. The emissions sources captured in this inventory include the following:

- **Scope I**: natural gas, owned-fleet fuel, and refrigerant fugitive emissions
- **Scope II**: electricity purchased from Austin Energy
- **Scope III**: solid waste, water & wastewater, student/staff/faculty commute, air travel, embodied emissions in purchased goods and services

Data is available, for most emissions sources, from fiscal years 2001 to 2011. Complete data for all required emissions sources is first available for 2004, which will serve as earliest possible baseline year for subsequent inventories. Clean Air-Cool Planet’s (CA-CP) Campus Carbon Calculator v6.75 was used to calculate emissions.

The results on Figure 1 are presented according to Scope categories as defined by TCR’s General Reporting Protocol. Figure 1 also includes current offset and mitigation strategies including: solar thermal systems, photovoltaic systems, and composting strategies. It is important to note that only the compost should be counted as a negative source of emissions because the solar strategies do not sequester carbon, but only reduce the demand for high-carbon energy sources.

![Figure 1. Total emissions and mitigations/offsets by Scope.](image-url)
INTRODUCTION

Carbon dioxide and other greenhouse gases (GHG) naturally trap solar heat, warming our planet’s atmosphere, oceans and surface. This phenomenon has served us well by making the Earth habitable for human beings as well as the millions of other species that depend on our planet’s systems for survival. Through the combustion of fossil fuels, such as gasoline, coal and natural gas, human beings are increasing the concentration of greenhouse gases. Due to human influences, these levels are now greater than at any time in the last 650,000 years.

While the precise extent of the human contribution to global warming is still the subject of scientific inquiry, recent consensus statements by the scientific community assert, with high confidence (greater than 90%), a central role for human-caused emissions. Acting on the scientific consensus regarding the existence and severity of climate change, The University of Texas at Austin joins a growing number of Universities and Colleges that have conducted GHG inventories as a necessary first step in the development of a climate action plan. This document seeks to provide the following insights:

1. Sense of scale
   Determine a sense of scale for the major sources of direct and indirect GHG emissions attributable to the University operations and community.

2. Internal and external benchmarking
   This document will present emissions data to establish GHG emissions baseline for The University of Texas at Austin by which future internal inventories may be compared as well as providing a means of direct comparison to other institutions of similar circumstance.

3. Guidance for future GHG inventories
   This inventory was conducted and reported according to internationally established protocols and full transparency to guide future GHG inventories at The University of Texas at Austin, as well as to inspire and assist other institutions to conduct rigorous and clearly framed inventories as a clear step toward measures to reduce GHG emissions.

Beyond its value as a portrait of where the University stands now, the inventory is also the foundation for any future climate action. Regardless of whether the University decides to participate in existing multi-campus initiatives or other externally driven goal setting, the institution now has a detailed and sophisticated measure of its impacts and risks. Actions to reduce emissions (and thereby lessen impacts, risks and associated costs) now have a necessary baseline and quantitative context.

This inventory captures all emissions sources required by major protocols, as well as many other emissions sources. However, the report excludes a number of sources, and several other sources are estimated with methodologies that could benefit from careful refinement.
METHODOLOGY AND BOUNDARIES

METHODOLOGY

This inventory follows standards set by the World Research Institute and World Business Council for Sustainable Development’s (WRI/WBCSD) Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard with additional guidance provided by the documents included in Table 1.

Table 1: Greenhouse gas inventory protocols referenced or utilized in The University of Texas at Austin GHG inventory.

<table>
<thead>
<tr>
<th>Organization</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Climate Registry</td>
<td>General Reporting Protocol, Version 2 (Draft), 2012</td>
</tr>
<tr>
<td>California Climate Action Registry</td>
<td>General Reporting Protocol, Version 3.1, 2009</td>
</tr>
<tr>
<td>Environmental Protection Agency</td>
<td>Climate Leaders Core Module Guidance</td>
</tr>
<tr>
<td>Department of Energy</td>
<td>Technical Guidelines for the Reporting of Greenhouse Gases</td>
</tr>
<tr>
<td>Intergovernmental Panel on Climate Change</td>
<td>2006 Guidelines for Greenhouse Gas Inventories</td>
</tr>
<tr>
<td>Lewis and Clark College and National Wildlife Federation (Julian Dautremont-Smith)</td>
<td>Guidelines for College-Level Greenhouse Gas Emissions Inventories Version 1</td>
</tr>
</tbody>
</table>

KYOTO GREENHOUSE GASES

Inventory protocols encourage entities to report on all six greenhouse gases (GHG) regulated under the Kyoto Protocol. Each of these gases has an associated global warming potential (GWP). The GWP compares the ability of one mass unit of a particular gas to affect global warming relative to carbon dioxide. In other words, one kilogram of nitrous oxide, which has a GWP of 310, will produce the same global warming as 310 kilograms of carbon dioxide.

Of these six gases, shown on Table 2, carbon dioxide dominates The University of Texas at Austin’s emissions through the burning of fossil fuels. Methane and nitrous oxide also appear in the inventory, although to a considerably lesser extent, also through the combustion of fossil fuels. Hydrofluorocarbons (HFC) are refrigerants and contribute significantly as fugitive emissions from building and transportation air conditioning systems. Perfluorocarbons (PFC) are also used as refrigerants (and in other industries), but are not employed at the University. The sixth and final gas is sulfur hexafluoride (SF), a gaseous insulator used in electrical switchgear in small quantities, and is not included in this inventory.

Table 2: Global warming potential (GWP) of the six greenhouse gases regulated under the Kyoto Protocol.

<table>
<thead>
<tr>
<th>Gas</th>
<th>Chemical Formula</th>
<th>Global Warming Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon dioxide</td>
<td>CO₂</td>
<td>1</td>
</tr>
<tr>
<td>Methane</td>
<td>CH₄</td>
<td>21</td>
</tr>
<tr>
<td>Nitrous Oxide</td>
<td>N₂O</td>
<td>310</td>
</tr>
<tr>
<td>Hydrochlorofluorocarbon</td>
<td>CHF</td>
<td>varies</td>
</tr>
<tr>
<td>perfluorocarbon</td>
<td>PCF</td>
<td>varies</td>
</tr>
<tr>
<td>sulfur hexafluoride</td>
<td>SF</td>
<td>22200</td>
</tr>
</tbody>
</table>

From The Climate Registry’s General Reporting Protocol v2 (Draft) 2012
In many GHG inventory protocols, emissions sources and activities are classified as either producing direct or indirect GHG emissions. Direct emissions are those that stem from sources owned or controlled by a particular organization. Indirect emissions occur because of the organization’s actions, but the direct source of emissions is controlled by a separate entity. To distinguish direct from indirect emissions sources, three “scopes” are defined for traditional GHG accounting and reporting purposes:

- **Scope I** – Direct sources of greenhouse gas emissions that originate from equipment and facilities owned or operated by the reporting entity.
- **Scope II** – Indirect GHG emissions from purchased electricity, heat or steam.
- **Scope III** – All other indirect sources of GHG emissions that may result from the activities of the institution but occur from sources owned or controlled by another company or entity.

Scope I (direct) and Scope II (indirect) emissions are required reporting for voluntary registries. Scope III emissions are indirect and usually considered optional when reporting emissions. However, Scope III emissions serve to clarify an organization’s entire carbon footprint and illuminate the potential physical, regulatory and financial risks an institution may face due to its carbon footprint. Figure 2 represents these three Scopes of emissions.

**Figure 2:** Scope category emissions sources.

**SCOPE I**

220,748 MT CO$_2$e

**SCOPE II**

42,109 MT CO$_2$e

**SCOPE III**

XXX,XXX MT CO$_2$e

**OFFSETS**

-142 MT CO$_2$e

**BOUNDARIES**

A greenhouse gas inventory begins by selecting emissions sources to include and evaluate. One approach to determine inventory boundaries is to answer the following questions:

1. What must be reported according to reporting requirements or regulations?
2. What should be reported based on the climate change impact on mission-critical activities?
3. What can be reported based on personnel time, resources and available data?

This inventory is conducted on behalf of The University of Texas at Austin; as such the boundaries are determined by inventory protocol and the boundaries of operational control. Geographically, this inventory includes the operational control of two main parcels of land: Main Campus (MC) and J.J. Pickle Research Campus (PRC).
2 METHODOLOGY AND BOUNDARIES

DATA COLLECTION

Uncertainty enters a GHG inventory through accuracy of raw data and the methodology used to calculate emissions (which includes scientific understanding of an emissions source). Together, these uncertainties require sensitivity analysis, i.e., an accounting of how the uncertainty might alter the source-by-source and overall results. This section describes the nature of the uncertainty for each emissions source.

Figure 4 is used to outline the sources of uncertainty in the inventory. Figure 4 maps the data and methodological uncertainty by emissions source. The X-axis represents the level of data uncertainty while the Y-axis represents methodological uncertainty.

Figure 4: Data and methodological uncertainty associated with each inventory emissions source.

Data and Methodological Uncertainty, by Emissions Source

Note: Figure 4 expresses the authors’ subjective assessment of the relative uncertainty associated with each of the emissions sources covered in the report. The placement on the axes is not based on calculations of any kind.

For a detailed explanation of data and methodological uncertainties, please see Appendix B.
RESULTS AND ANALYSIS

CORE AND ADDITIONAL EMISSIONS
Core emission sources include: stationary combustion, mobile combustion, refrigerants, purchased electricity and solid waste. All Scope I and Scope II emissions are included in this group. One Scope III source is included in the core emissions due to the high level of control in selecting a disposal site and the low level of uncertainty associated with the raw data.

Additional emissions sources are those outside of the direct control of the University and have a high level of uncertainty associated with the data and/or methods used to estimate emissions. Additional emissions sources include: water/wastewater, commute, air travel, and embodied purchasing emissions for fiscal years 2001 through 2011. Offsets and mitigations are university practices that reduce the university’s overall GHG emission output.

SCOPE I EMISSIONS
The Scope I category includes direct sources of emissions. As a group, Scope I emissions equal 220,748 MT CO$_2$e for fiscal year 2011. All Scope I emissions sources are also included in the core emissions group.

1.01 STATIONARY COMBUSTION
1.02 MOBILE COMBUSTION
1.03 REFRIGERANTS

SCOPE II EMISSIONS
Scope II emissions are indirect but are considered required reporting by voluntary registries. Total Scope II emissions for 2011 are estimated at 42,109 MT CO$_2$e and are included in the core emissions group.

2.01 PURCHASED ELECTRICITY

SCOPE III EMISSIONS
Scope III emissions are indirect. As a group, Scope III emissions are estimated at XXX,XXX MT CO$_2$e in 2011. All Scope III sources are included in the additional emissions category, except solid waste, which is considered a core emission.

3.01 SOLID WASTE
3.02 WATER AND WASTEWATER
3.03 COMMUTE
3.04 AIR TRAVEL
3.05 EMBODIED EMISSIONS
Stationary combustion of natural gas is the largest emissions source at UT, totaling 217,581 MT CO$_2$e, which is approximately 80% of core emissions for fiscal year 2011.

This section covers all GHG emissions that result from the combustion of natural gas on campus. At UT this includes natural gas use at both the Main Campus and the Pickle Research Campus (PRC). At the Main Campus natural gas is used to produce two primary products: electricity and steam, and one secondary product, chilled water at the university’s on-campus Hal C. Weaver Power Plant. As seen in Table 3 the Main Campus uses over 98% of the total natural gas consumed on site at UT Austin and the PRC uses less than 2%. As a result, the Main Campus produces over 50 times more GHG emissions than the PRC.

There are three major greenhouse gases that result from the combustion of natural gas: carbon dioxide, methane, and nitrous oxide. Although the measurable weight of methane and nitrous oxide are very significantly less than that of carbon dioxide, their global warming potential are 21 and 310 times that of carbon dioxide, respectively. However, even given that carbon dioxide still accounts for more than 99% of the global warming impact.

Table 3. Emissions from the various actions at the Hal C. Weaver power plant

<table>
<thead>
<tr>
<th>Unit</th>
<th>2001</th>
<th>2003</th>
<th>2005</th>
<th>2007</th>
<th>2009</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total natural gas used</td>
<td>MMBtu</td>
<td>4,644,282</td>
<td>4,284,815</td>
<td>4,661,162</td>
<td>4,553,734</td>
<td>4,153,462</td>
</tr>
<tr>
<td>Electricity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Emissions</td>
<td>million kWh</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MT CO$_2$e</td>
<td>308.3</td>
<td>301.4</td>
<td>328.3</td>
<td>336</td>
<td>351</td>
<td>352.3</td>
</tr>
<tr>
<td></td>
<td>170,567</td>
<td>159,828</td>
<td>185,146</td>
<td>177,851</td>
<td>170,767</td>
<td>167,336</td>
</tr>
<tr>
<td>Steam</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Emissions</td>
<td>MMBtu</td>
<td>1,060,183</td>
<td>984,329</td>
<td>850,909</td>
<td>930,220</td>
<td>786,020</td>
</tr>
<tr>
<td>MT CO$_2$e</td>
<td>75,204</td>
<td>66,920</td>
<td>61,518</td>
<td>63,128</td>
<td>49,029</td>
<td>46,002</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emissions</td>
<td>MT CO$_2$e</td>
<td>4,823</td>
<td>4,925</td>
<td>4,553</td>
<td>4,578</td>
<td>4,285</td>
</tr>
<tr>
<td>Total Emissions</td>
<td>MT CO$_2$e</td>
<td>250,594</td>
<td>231,673</td>
<td>251,217</td>
<td>245,557</td>
<td>224,081</td>
</tr>
</tbody>
</table>
The complete life cycle of natural gas involves a lot more energy consumption throughout the early stages of extraction, refinement, and distribution. This early stage energy use results in additional GHG emissions, but are not captured by this analysis. However, this exclusion is consistent with existing GHG inventory protocols.

Figure 6 shows the proportion of GHG emissions resulting from stationary natural gas combustion compared to total Core Emissions sources.

Although natural gas is the university’s largest emissions source, it is important to recognize the supply-side efficiency, which has decreased the quantity of natural gas consumed per gross campus square foot since. The bars of Figure 6 show the increasing gross Main Campus square footage from 2001 to 2011, and the charted red line shows the natural gas intensity, or the amount of energy consumed per square foot of built space. As can be seen, the natural gas intensity has decreased, which is significant in terms of both greenhouse gas emissions and also in dollars.

The Hal C. Weaver Power Plant is a combined heat and power (CHP) facility. According to the Environmental Protection Agency, combined heating and power generation has a typical efficiency of 75% compared to conventional electricity generation efficiency of 49%. This increased efficiency means more output per unit of energy consumed, which can be viewed as a displacement of emissions that would otherwise be created. This emissions “reduction” is equivalent to a lower emissions factor for electricity than grid provided power generated with the same fuel.

For data sources and methods please see Appendix C.
3 RESULTS AND ANALYSIS

1.02 MOBILE COMBUSTION
UNIVERSITY OWNED FLEET

The total greenhouse gas emissions resulting from fuel usage for all 577 university owned and operated vehicles throughout fiscal year 2011 was 1,872 MT CO$_2$e, or less than 1% of total core emissions.

This section includes the emissions from all university-owned and operated vehicles. In previous reports, this section has included campus shuttle buses, which are now accounted for in Scope III as a part of student, faculty, and staff commute since the shuttles are leased from Capital Metro rather than owned by the university. In 2011 the university-owned fleet included 577 vehicles ranging from passenger vehicles to heavy-duty trucks and ranging in age from 1966 to 2011.

These campus vehicles consumed three types of fuel in 2011: unleaded gasoline, B20 biodiesel, and propane. Each type of fuel has a unique emissions factor (measured in GHG per gallon) associated with its combustion. Table 4 also shows the number of campus vehicles utilizing the various fuel types. The majority of the owned fleet burns gasoline. In 2011 some vehicles traditionally using gasoline have been converted to be ethanol capable, which is expected to lead to a reduction of overall GHG emissions as more of the vehicles do in fact make the switch.

Table 4. University fuel types, associated GHG emission factors and number of vehicles using each fuel in 2011.

<table>
<thead>
<tr>
<th>Fuel Type</th>
<th>Emission Factor kg CO$_2$ / gallon</th>
<th>Fleet Vehicles #</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gasoline</td>
<td>8.7</td>
<td>508 (387)*</td>
</tr>
<tr>
<td>Ethanol</td>
<td>5.56</td>
<td>0 (121)*</td>
</tr>
<tr>
<td>B20 Biodiesel</td>
<td>7.9</td>
<td>47</td>
</tr>
<tr>
<td>Propane</td>
<td>5.74</td>
<td>2</td>
</tr>
<tr>
<td>Diesel</td>
<td>10.0</td>
<td>0</td>
</tr>
</tbody>
</table>

*Number in parentheses represents the number of vehicles if all flex-fuel vehicles used ethanol rather than unleaded gasoline.

Table 5. Fleet fuel consumption and resulting greenhouse gas emissions.

<table>
<thead>
<tr>
<th>Fuel Type</th>
<th>Units</th>
<th>2000 - 2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>Fiscal Year</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gasoline</td>
<td>Use gallons</td>
<td>221,188</td>
<td>1,974</td>
<td>1,866</td>
<td>1,975</td>
<td>1,778</td>
<td>Fiscal Year</td>
<td>181,194</td>
<td>1,616</td>
<td>1,620</td>
<td></td>
</tr>
<tr>
<td>Diesel</td>
<td>Use gallons</td>
<td>18,004</td>
<td>1,182</td>
<td>1,186</td>
<td>120</td>
<td>300</td>
<td>Fiscal Year</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B20 biodiesel</td>
<td>Use gallons</td>
<td>22,222</td>
<td>178</td>
<td>147</td>
<td>197</td>
<td>254</td>
<td>Fiscal Year</td>
<td>32,313</td>
<td>258</td>
<td>250</td>
<td></td>
</tr>
<tr>
<td>Propane</td>
<td>Use gallons</td>
<td>1,205</td>
<td>167</td>
<td>119</td>
<td>92</td>
<td>84</td>
<td>Fiscal Year</td>
<td>1,005</td>
<td>139</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>Total Emissions</td>
<td>MT CO$_2$e</td>
<td>N/A</td>
<td>2,341</td>
<td>2,141</td>
<td>2,478</td>
<td>2,037</td>
<td>Fiscal Year</td>
<td>N/A</td>
<td>1,882</td>
<td>1,872</td>
<td></td>
</tr>
</tbody>
</table>

09 UNIVERSITY OF TEXAS AT AUSTIN - 2012 GREENHOUSE GAS INVENTORY
Data from fiscal year 2000 - 2003 was not included in the existing data from the previous GHG Inventory. Additionally, due to the adoption of a new vehicle inventory tracking system, data for fiscal years 2008 and 2009 was inaccessible. During these missing years the number of vehicles in the university-owned fleet dropped significantly, and PRC vehicles began using exclusively B20 biodiesel in their diesel vehicles.

The university has taken some action toward shifting to a low emission fleet. Certain State and Federal mandates, including the State House Bill 432 and the Federal Energy Policy Act of 1992, govern what types of vehicles can be purchased. Both are aimed at alternative fuels. As new vehicles are purchased these mandates force efficiency to become a factor in decisions. However, fleet selection and purchasing is not a centralized function meaning each department selects and purchases their own vehicles so efficiency may come second to price or functionality as a purchasing criteria.

**Figure 8.** Changes in the management and reporting of university-owned fleet and their effects on emissions.

**Changes made**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>0.05 kg CO₂ / gallon</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2002</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2004</td>
<td>177 MT CO₂e</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td>Average emissions per vehicle dropped by 0.27 MT CO₂e for all MC vehicles from 2005 to 2006 for a total reduction of 177 MT CO₂e</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td>15% vehicles</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>The number of vehicles considered a part of the university-owned fleet dropped by 15% between FY 2007 and FY 2010 while total emissions decreased by 30%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Effects on emissions**

As seen in Figure 8 there have been several incremental changes in the way the university powers their fleet. Figure 8 also illustrates the effects of the changes that have been implemented. Most recently, in the summer of 2011, the university did an ARRA/SECO funded project to convert one of their 8000 underground storage tanks from unleaded gasoline to ethanol. The project wrapped up in mid-September and ethanol has been available since then. The emissions factor for ethanol, 5.56 kg CO₂ / gallon, is significantly lower than that of the unleaded gasoline that it replaced, 8.81 kg CO₂ / gallon. If all flex-fuel vehicles (capable of running on ethanol) did in fact switch to ethanol, and we saw similar distribution of fuel use in 2012, it could result in a reduction of approximately 202 MT CO₂e for fiscal year 2012.

For data sources and methods please see Appendix D.
Total greenhouse gas emissions in calendar year 2011 from fugitive refrigerant loss were equal to 5,115 MT CO$_2$ e, or about 2% of core emissions. Though the losses are infrequent and in relatively small volumes, the global warming potential is so high that refrigerant losses actually account for a significant proportion of total university emissions.

Refrigerants are compounds used in air conditioning and refrigerators. They efficiently absorb heat by undergoing a phase change from liquid to gas, which allows the cooling of indoor areas (especially during hot Texas summers) and provides the ability to store food for long periods. Although refrigerants do have significant impact on emissions when confined in cooling systems, their escape can have significant environmental consequences. The global warming potential of these compounds can have as many as hundreds to thousands of times the warming power of the equivalent quantity of carbon dioxide.

At UT Austin, refrigerants are used in chillers at the Main Campus and Pickle Research Campus. The five types of refrigerants used and their associated GWP, emissions factors and the quantity of each lost annually from 2000 through 2011 are listed in Table 6. As shown, the single, largest refrigerant type lost is CFC-12, which also has the largest GWP of the group.

Table 6: Total annual refrigerant loss in lbs and CO$_2$ equivalent, by refrigerant type, every other year 2001 - 2011.
The large range in annual loss is the result of major cooling system leaks, particularly in older systems that hold CFC-12. The university operates in accordance with internally established leak monitoring policies and procedures, but the condition and age of some systems and the timing of the leaks allow for significant quantities to escape.

In addition to the leak monitoring procedures, a scheduled phase-out plan was established to replace the oldest systems, which typically use refrigerants with the highest global warming potentials (GWP). Figure 9 shows the Main Campus phase-out schedule from 2006 to present, which aimed to eliminate the most destructive refrigerants by the spring of 2010. Almost all replacements were made, but before the final CFC-12 chiller retrofit was delayed due to financial reasons. However, the combined GWP of operating chillers has effectively been reduced by 66%. When all parts of the phase-out plan are complete the combined GWP will be 1,258, which is a reduction of 79% from 2006.

For data sources and methods please see Appendix E.
2.01 PURCHASED ELECTRICITY
ELECTRICITY FROM AUSTIN ENERGY

Total emissions resulting from purchased electricity for fiscal year 2011 are equal to 42,109 MT CO$_2$e, which is 16% of core emissions.

The university purchases electricity from Austin Energy for the Pickle Research Campus (PRC), the Main Campus, Dell Pediatrics, and West Pickle Research Campus (WPRC). As shown in Table 7, the majority of the electricity, approximately 80% of the annual total in 2011, is purchased and consumed at PRC. PRC is not connected to the Main Campus’s Hal C. Weaver Power Plant, therefore, all electricity must be purchased from Austin Energy. Beginning in 2010, the University began purchasing electricity for the WPRC and Dell Pediatric facilities as well.

Table 7. Purchased electricity use and relative GHG emissions.

<table>
<thead>
<tr>
<th>Category</th>
<th>Unit</th>
<th>2001</th>
<th>2003</th>
<th>2005</th>
<th>2007</th>
<th>2009</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Campus</td>
<td>kWh</td>
<td>824,703</td>
<td>521,431</td>
<td>1,859,894</td>
<td>288,116*</td>
<td>1,885,122</td>
<td>9,672,353</td>
</tr>
<tr>
<td>Pickle Research Campus</td>
<td>kWh</td>
<td>40,039,609</td>
<td>41,814,092</td>
<td>44,253,236</td>
<td>49,760,892</td>
<td>67,628,101</td>
<td>76,209,551</td>
</tr>
<tr>
<td>Additional (Dell Pediatrics, WPRC)</td>
<td>kWh</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>9,597,525</td>
</tr>
<tr>
<td>Total kWh</td>
<td></td>
<td>40,864,312</td>
<td>42,335,523</td>
<td>46,113,130</td>
<td>50,049,008</td>
<td>69,513,223</td>
<td>95,479,429</td>
</tr>
<tr>
<td>Total MT CO$_2$e</td>
<td></td>
<td>23,340</td>
<td>21,861</td>
<td>21,569</td>
<td>22,493</td>
<td>28,594</td>
<td>42,109</td>
</tr>
</tbody>
</table>

*missing data

The greenhouse gas emissions from this source are almost entirely (greater than 99%) carbon dioxide (CO$_2$). Smaller contributions are attributed to nitrous oxide (N$_2$O) and methane (CH$_4$). Quantities of these gases were calculated with Clean Air-Cool Planet’s Campus Carbon Calculator.

The distribution of types of GHG that contribute to overall emissions depends on mix of fuel used to generate the electricity. Figure 10 shows the mix of fuels used by Austin Energy.
In addition to the changes that Austin Energy has made in fuel mix choices, there have also been several changes made on campus that affect the emissions coming from purchased electricity. On the Main Campus construction and renovation projects have altered the total area of building space requiring conditioning and the efficiency of building spaces. The expansion of research initiatives at PRC have also led to significant changes in demand resulting in increased emissions. Figure 11 tracks some of these changes and suggests correlational relationships between changes on campus and total emissions.

**Figure 11.** Changes in the purchased energy demand and their effects on emissions.

### Changes made

<table>
<thead>
<tr>
<th>Time</th>
<th>Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004:</td>
<td>New construction not connected to Hal C. Weaver</td>
</tr>
<tr>
<td>2005</td>
<td>MC energy use more than triples</td>
</tr>
<tr>
<td></td>
<td>The amount of electricity purchased from Austin Energy to be used on the</td>
</tr>
<tr>
<td></td>
<td>Main Campus increased from 521,431 kWh to 1,859,894 kWh from 2003 to 2005.</td>
</tr>
<tr>
<td>2007:</td>
<td>Lost data due to changes in data collection protocol</td>
</tr>
<tr>
<td>2007</td>
<td>Sharp drop in MC demand</td>
</tr>
<tr>
<td></td>
<td>In 2007 the data shows that amount of electricity purchased from Austin</td>
</tr>
<tr>
<td></td>
<td>Energy to be used on the Main Campus dropped by 85% for one year.</td>
</tr>
<tr>
<td>2009:</td>
<td>47% increase in MT CO2e</td>
</tr>
<tr>
<td></td>
<td>There were increased emissions with the addition of responsibility for</td>
</tr>
<tr>
<td></td>
<td>purchasing electricity for the Dell Pediatric Research facilities</td>
</tr>
<tr>
<td></td>
<td>and the West Pickle Research Campus.</td>
</tr>
<tr>
<td>2010:</td>
<td>Added Dell Pediatrics and WPRC</td>
</tr>
<tr>
<td>2011:</td>
<td>Expansion of the TACC facility at PRC</td>
</tr>
<tr>
<td>2011</td>
<td>11% increase in MT CO2e from PRC</td>
</tr>
<tr>
<td></td>
<td>With the expansion of the UT System's Texas Advanced Computing Center</td>
</tr>
<tr>
<td></td>
<td>(TACC) came a dramatic increase in the energy demand at PRC.</td>
</tr>
</tbody>
</table>

### Effects on emissions

Figure 11 illustrates critical changes to campus operations that influenced energy demand on both campuses, and how those changes in turn affected the total emissions. In addition to these changes, there has also been the installation of renewable energy strategies in the form of photovoltaic arrays to divert some of the demand for purchased electricity from Austin Energy to be used specifically at PRC. Details on the effects of renewables on overall emissions from purchased electricity are outlined in the Offsets and Mitigations section.

For data sources and methods please see Appendix F.
3 RESULTS AND ANALYSIS

3.01 SOLID WASTE
LOOSE AND COMPACT LANDFILLED WASTE

Throughout fiscal year 2011 3,198 MT CO$_2$e was produced in the disposal of solid waste by the uncapped landfill contracted by the university accounting for just over 1% of core emissions.

The solid waste data in Table 8 includes both the Main Campus (MC) and Pickle Research Campus (PRC). The quantity of annual total waste produced by The University of Texas at Austin has increased, for the most part, over the last seven years. During fiscal year 2011 solid waste disposal resulted in 3,198 MT CO$_2$e. This increase is not the result of dramatic increases in solid waste generation, but due to the landfill’s methane management system.

Table 8. Quantities of solid waste generated and its resulting greenhouse gas emissions.

<table>
<thead>
<tr>
<th>Category</th>
<th>Units</th>
<th>Fiscal Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Campus</td>
<td>short tons</td>
<td>2,460</td>
</tr>
<tr>
<td></td>
<td>MT CO$_2$e</td>
<td></td>
</tr>
<tr>
<td>Pickle Research Campus</td>
<td>short tons</td>
<td>300</td>
</tr>
<tr>
<td></td>
<td>MT CO$_2$e</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total short tons</td>
<td>2,760</td>
</tr>
<tr>
<td></td>
<td>Total MT CO$_2$e</td>
<td>430</td>
</tr>
</tbody>
</table>

Greenhouse gases resulting from municipal solid waste disposal vary greatly depending on the disposal facility’s system of methane management. Methane has a global warming potential 23 times that of carbon dioxide and is produced when carbon-based waste decomposes under anaerobic conditions. The University of Texas at Austin current landfill facility, Texas Disposal Systems, is an uncapped landfill without a system to manage methane. In contrast, the landfill used from 2000 through 2005, BFI is a capped facility with a methane-to-power generation facility.

For data sources and methods please see Appendix G.
3.02 WATER AND WASTEWATER
PUMPING AND TREATMENT OF WATER

Electricity and treatment emissions are added to determine the total water-related emissions, which are estimated at 1,633 MT CO\textsubscript{2}e for fiscal year 2011. This included the transport and treatment for 874 million gallons of water and 308 million gallons of wastewater.

This section provides an estimation of the emissions associated with The University of Texas at Austin’s consumption of water and generation of wastewater. The estimation method covers electricity consumed from pumping water and wastewater and the emissions from the wastewater treatment based on MT CO\textsubscript{2}e estimations per million gallons for each energy-using step in the transport and treatment of water and wastewater.

Table 9 shows water data beginning in fiscal year 2007 and going through 2011. In fiscal year 2011, the university released 1,119 MT CO\textsubscript{2}e as a result of the 874,100,000 gallons of water that was consumed and generated 307,817,750 gallons of wastewater that required pumping and treatment resulting in 514 MT CO\textsubscript{2}e.


<table>
<thead>
<tr>
<th>Category</th>
<th>Units</th>
<th>Fiscal Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2007</td>
<td>2008</td>
</tr>
<tr>
<td>Water Consumption</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electricity Use</td>
<td>Mgal</td>
<td>739</td>
</tr>
<tr>
<td></td>
<td>MT CO\textsubscript{2}e / Mgal</td>
<td>1.41</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1,041</td>
</tr>
<tr>
<td>Wastewater Disposal</td>
<td>Mgal</td>
<td>282</td>
</tr>
<tr>
<td>Electricity Use</td>
<td>MT CO\textsubscript{2}e / Mgal</td>
<td>1.66</td>
</tr>
<tr>
<td></td>
<td></td>
<td>469</td>
</tr>
<tr>
<td>Total emissions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MT CO\textsubscript{2}e</td>
<td>1,510</td>
<td>1,529</td>
</tr>
</tbody>
</table>

The total emissions were calculated using levels reported by Austin Water Utility rather than the California standard that was used in the previous report. This resulted in higher emission levels, but more confidence in the methodology. It is also important to note that the City of Austin has shifted to AE Green Choice in October 2011, which should lead to a dramatic decrease in the emissions associated with the transport and treatment of water. An estimated 85% drop in emissions is expected for fiscal year 2012 with approximately 0.1 MT CO\textsubscript{2}e/Mgal for water and 0.5 MT CO\textsubscript{2}e/Mgal for wastewater.

For data sources and methods please see Appendix H.
3.03 COMMUTE
FACULTY, STAFF, AND STUDENT COMMUTE

It is estimated that emissions from faculty, staff, and student commuting in 2009 was 65,088 MT CO$_2$e based on a 2009 transportation survey. The per capita emissions from 2009 are extrapolated here resulting in 2011 emissions of 70,819 MT CO$_2$e.

The total campus population at UT consists of over 60,000 students, faculty and staff who commute to campus regularly. Although many students choose to walk or bike to campus, there are more commuters traveling in automobiles or buses, both of which consume fossil fuels and therefore generate significant greenhouse gas emissions. The university has less control over the emissions that result from commuting activity, it is still important to understand the relative size of this emissions source with regard to the total emissions for the university. The method used, estimates commute emissions and will provide a sense-of scale range of emissions, not an exact quantity.

The estimation method utilized transportation survey conducted in 2009. The survey includes data on commute origin zip code and the numbers of daily trips, which allow the estimation of a range of annual round-trip commute miles by mode of transportation. Based on the survey results, approximately 60% of students, faculty, and staff that commute to campus on a regular basis live in one of twelve zip codes (or the “top 12 zip codes”) seen in Figure 13, and average 0.48 MT CO$_2$e per person annually. The remaining 40% of commuters based on the sample live in other zip codes ranging from 2 to 100 miles from campus, and average 1.90 MT CO$_2$e per person annually. Calculations were made by estimating miles to gallon fuel efficiency using the median values for each mode, seen in Table 14.
The following assumptions were made to extrapolate the survey data to the university population in fiscal year 2011: full time students make 320 trips/year, part time students make 160 trips/year, summer school students make 80 trips/year, faculty and staff each make 500 trips per year.

Using 2011 campus population data, it is estimated that emissions from commuting activity totaled 70,819 MT CO$_2$e in 2011.

For data sources and methods please see Appendix I.
3 RESULTS AND ANALYSIS

3.04 AIR TRAVEL
FACULTY, STAFF, AND STUDENT TRAVEL

In fiscal year 2011, UT faculty, staff, and students traveled a total of XXX,XXX,XXX miles through the university travel agency, chartered flights, and study abroad travel. This activity resulted in an estimated XXX,XXX MT CO$_2$e in 2011.

MISSING DATA
MISSING DATA
3 RESULTS AND ANALYSIS

3.05 PURCHASED GOODS

EMBODIED ENERGY IN PURCHASED GOODS AND SERVICES

MISSING DATA
MISSING DATA
LANDSCAPE COMPOST
MITIGATIONS FROM COMPOSTED LANDSCAPE WASTE

Composting landscape waste mitigated 117 MT CO$_2$e of the 2011 total emissions. From 2000 through 2011, composting reduced the university’s emissions by a total of 1,245 MT CO$_2$e.

When managed properly, compost results in some carbon storage (associated with application of compost to soils) instead of generating methane in the anaerobic conditions of a landfill. The increase in composted material in 2006, as shown in Table XX, is attributed to increased efforts by the landscape services management in emphasizing the importance of capturing this material to landscape maintenance staff. In Table XX the landscape waste from leaves are composted on site whereas the waste included in the limbs category are from collected brush, which is processed into mulch by a private vendor.

Table XX: Compost weights and the associated net reduction in GHG emissions.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaves</td>
<td>volume weight</td>
<td>-0.1833</td>
<td>cubic yards</td>
<td>1,000</td>
<td>3,600</td>
<td>3,600</td>
<td>3,600</td>
<td>3,600</td>
<td>2,400</td>
<td>2,400</td>
</tr>
<tr>
<td></td>
<td>weight emission</td>
<td></td>
<td>short tons</td>
<td>175</td>
<td>630</td>
<td>630</td>
<td>630</td>
<td>578</td>
<td>420</td>
<td>420</td>
</tr>
<tr>
<td></td>
<td>reduction</td>
<td></td>
<td>MT CO$_2$e</td>
<td>-32</td>
<td>-116</td>
<td>-116</td>
<td>-116</td>
<td>-106</td>
<td>-77</td>
<td>-77</td>
</tr>
<tr>
<td></td>
<td>volume weight</td>
<td>-0.1833</td>
<td>cubic yards</td>
<td>1,300</td>
<td>1,440</td>
<td>1,460</td>
<td>1,460</td>
<td>1,460</td>
<td>1,440</td>
<td>1,440</td>
</tr>
<tr>
<td></td>
<td>weight emission</td>
<td></td>
<td>short tons</td>
<td>195</td>
<td>216</td>
<td>219</td>
<td>219</td>
<td>186</td>
<td>210</td>
<td>216</td>
</tr>
<tr>
<td></td>
<td>reduction</td>
<td></td>
<td>MT CO$_2$e</td>
<td>-36</td>
<td>-40</td>
<td>-40</td>
<td>-40</td>
<td>-34</td>
<td>-39</td>
<td>-40</td>
</tr>
<tr>
<td></td>
<td>Total short tons</td>
<td></td>
<td></td>
<td>370</td>
<td>846</td>
<td>849</td>
<td>849</td>
<td>764</td>
<td>630</td>
<td>636</td>
</tr>
<tr>
<td></td>
<td>Total MT CO$_2$e</td>
<td></td>
<td></td>
<td>-68</td>
<td>-155</td>
<td>-156</td>
<td>-156</td>
<td>-140</td>
<td>-116</td>
<td>-117</td>
</tr>
</tbody>
</table>

* Landscape waste volume for years 2000 - 2005 are expertly estimated by a department manager and are estimated to be the same until 2006 when maintenance protocol changed.

The numbers for the leaves composted are based on estimated size of the compost piles after the spring leaf fall. The numbers for the brush are a little more accurate as we place our brush in a 40 yard dumpster and keep track of how many times it is pulled during the year, but the leaf waste reported is an estimate that is representative of the true volume collected.

For data sources and methods please see Appendix L.
FOOD COMPOST
MITIGATIONS FROM COMPOSTED FOOD WASTE

The university first adopted food composting practices in 2010 when they began working with Texas Disposal Systems to commercially compost food waste. Since then, the university has mitigated 25.1 MT CO$_2$e of the total emissions in fiscal year 2011 through composting.

When managed properly, compost results in some carbon storage (associated with application of compost to soils) instead of generating methane in the anaerobic conditions of a landfill. The increase in composted material in 2006, as shown in Table XX, is attributed to increased efforts by the landscape services management in emphasizing the importance of capturing this material to landscape maintenance staff. In Table XX the landscape waste from leaves are composted on site whereas the waste included in the limbs category are from collected brush, which is processed into mulch by a private vendor.

Table XX: Compost weights and the associated net reduction in GHG emissions.

<table>
<thead>
<tr>
<th>Category</th>
<th>Emission factor</th>
<th>Units</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food Waste weight</td>
<td></td>
<td>short tons</td>
<td>6.97</td>
<td>24.2</td>
<td>15.8</td>
<td>3.9</td>
<td>20.9</td>
<td>20.0</td>
<td>5.8</td>
<td>6.6</td>
<td>0</td>
<td>13.6</td>
<td>7.7</td>
</tr>
<tr>
<td>emission reduction</td>
<td>-0.2</td>
<td>MT CO$_2$e</td>
<td>-1.4</td>
<td>-4.8</td>
<td>-3.2</td>
<td>-0.7</td>
<td>-4.2</td>
<td>-4.0</td>
<td>-1.2</td>
<td>-1.3</td>
<td>0</td>
<td>-2.7</td>
<td>-1.5</td>
</tr>
</tbody>
</table>

* No data for September 2010 because the university first started composting in October 2010.

The DHFS composting program diverted an estimated 8% of the total waste stream, and it is expected that there will be continued success as the division continues to monitor sorting stations and provide education for students, staff, and faculty about how and why food composting should be done. DHFS also plans to expand the reach of their composting program to administrative offices, break rooms, and hopefully to residence halls in the near future. (http://www.utexas.edu/sustainability/symposium2011/6/)

For data sources and methods please see Appendix L.
The various renewable energy projects on campus divert approximately 309,827 kWh of energy demand from on campus natural gas combustion (0.025% of total demand) and 222,528 kWh from demand from Austin Energy (0.29% of total demand). The combined emission avoidance of these strategies is 156 MT CO$_2$e.

There are two kinds of systems that utilize solar power to reduce the demand for electricity from nonrenewable energy sources currently in place at the University of Texas. These include both a solar thermal system on the Main Campus and two photovoltaic systems at the Pickle Research Campus. The solar hot water array on the Norman Hackman Building reduces the quantity of natural gas needed to heat the building in the winter and reheating dehumidified air in the summer. The extent to which emissions are mitigated is relatively insignificant to the total campus demand, but is significant relative to the building loads.

The two photovoltaic systems at PRC contribute to the overall electricity needs of the campus, therefore reducing the dependence on the coal-based electricity that is purchased from Austin Energy. One array is located in a field adjacent to the Microelectronics Research Center (MER). This array has provided 209,595 kWh of power and has mitigated emissions by 92.45 MT CO$_2$e since its installation in November 2011. The other array is integrated into the shading structure for the Bureau of Economic Geology (BEG). It has provided 12,932 kWh and mitigated emissions by 5.70 MT CO$_2$e since November 2011.

For data sources and methods please see Appendix L.
FUTURE STRATEGIES

Although the university does not currently participate in any formal carbon offset or mitigation programs, it is interested in developing guidelines for purchasing offsets in the future.

The university is considering the following offset programs:

(1) Study Abroad travel on-location carbon offsets.
   The university is considering a new program in which those students, faculty or staff who travel abroad to take action in their destination by participating in some kind of local carbon offset in the community.

(2) Football game day emissions and weatherization of homes.
   UT football games have relatively large carbon footprints, and the athletics department hopes to work in collaboration with local weatherization non-profits to counter their emissions by weatherizing homes throughout Austin. This kind of offset strategy not only addresses the issue of atmospheric carbon and climate change, but also encourages local business growth and building social capital in the Austin community.
5 NEXT STEPS

NEXT STEPS

The University of Texas at Austin is committed to reducing the environmental impact of the action and decisions of their faculty, staff, and students. There are several steps the university plans to take in the near future to help reduce their environmental impact further.

INTENDED USE OF THIS REPORT

This report will be made available to the public on the University of Texas's Office of Sustainability website for reference. Hopefully it will become a platform for discussing issues of climate change on campus and help guide research to be conducted on campus to advance our environmental initiatives.

DEPARTMENT-LEVEL REPORTING PROTOCOL

The UT Office of Sustainability is currently developing a system for individual departments on Campus to partake in calculating their environmental impact through a department-level greenhouse gas inventory. Interested departments will simply contact the Office of Sustainability with an inquiry into the GHG reporting protocol, and the Office of Sustainability staff will work in collaboration with members of the interested department to collect new data, access existing data, and produce a summary report complete with total emissions broken down by emission source and recommendations for reducing their carbon footprint at the departmental level.

We hope that this new addition to the evaluation of environmental performance will help improve the accuracy and scope of future university-wide greenhouse gas reduction efforts. Additionally, we hope that it will encourage faculty, students, and staff to take action against climate change through altering their own behaviors while on campus and at home.

Those interested in learning more about the new departmental-level greenhouse gas reporting program, please contact the Jim Walker, Director of Sustainability, at jim.walker@austin.utexas.edu.

POTENTIAL RESEARCH TOPICS

As a large research university, UT has the resources to encourage student and faculty research that will further the analysis provided in this report. The following is a short list of potential research topics that would support the mission of this report:

(1) Performing lifecycle analyses of individual buildings on campus
(2) Determining the carbon footprint of all paper use on campus
(3) Lifecycle analysis of the on-campus food supply
(4) Carbon sequestration rates/totals for all on-campus vegetation
(5) Cost-benefit analyses for the installation of renewable energy production systems
(6) Impacts of recycling and the displaced embodied emissions of materials
EXPANDING TO BRANCH LOCATIONS

In future iterations we hope to include all areas under the operational control of the university, which would include adding the following:

(1) the McDonald Observatory
   With its state of the art equipment, the observatory uses a significant amount of energy from the grid, and with its rural, exposed location may have the potential to reduce its carbon footprint with the installation of photovoltaics. Including this facility in the next overall University of Texas GHG inventory would help determine the relative impact of implementing such strategies.

(2) the Winedale Center for American History
   This center for collaborative learning could

(3) Marine Science Institute
   Like the observatory, the high quantities of energy these facilities require indicates that a rigorous analysis of its current carbon footprint and suggested strategies for emission reduction could make a significant difference.

GUIDELINES FOR PURCHASING CARBON OFFSETS

A few carbon offset strategies have been suggested (see OFFSETS AND MITIGATIONs, page 26), however this inventory could also serve as a resource when developing a carbon offset purchasing policy for the university. Integrating local social and economic considerations with the goals of emission reduction could help the university do more good in the local community.
APPENDIX A
INSTITUTIONAL DATA SUMMARY

DATA SUMMARY:
Institutional data includes total building square footage and total population head count (students, faculty, and staff). This data is made available by the Office of Information Management and Analysis in their yearly Statistical Handbook. The reports reflect totals for each academic year (August - September), and for the purposes of this report were matched to the corresponding fiscal year (September - August).

DATA SOURCES:
2001-2006: Good Company, existing data files
APPENDIX B
DATA UNCERTAINTY

DATA SUMMARY:
The structure of this section is based on the 2009 GHG Inventory authored by Good Company. The content of this section is highly subjective, and is based on personal observation in the collection and interpretation of the data provided.

<table>
<thead>
<tr>
<th>EMISSIONS SOURCE</th>
<th>DATA PROVIDED</th>
<th>DATA UNCERTAINTY</th>
<th>METHODOLOGICAL UNCERTAINTY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stationary combustion</td>
<td>Monthly consumption in MMBTU for MC and PRC (FY 2001-2011)</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Mobile combustion</td>
<td>Fiscal year total fuel use by vehicle and fuel type (FY 2004-2011, excluding FY 2008 and 2009)</td>
<td>More certainty than 2009 report – does not include shuttle fleet, does include construction fleet</td>
<td>Ability of emissions factors used to accurately estimate emissions</td>
</tr>
<tr>
<td>Refrigerant losses</td>
<td>Calendar year fugitive losses in pounds for MC and PRC</td>
<td>Accuracy of recording of emissions</td>
<td>More certainty than 2009 report – fewer changes to the GWP based on scientific literature</td>
</tr>
<tr>
<td>Purchased electricity</td>
<td>Monthly electricity use in kWh for MC and PRC (FY 2001-2011)</td>
<td>More certainty than 2009 report – added all MC use instead of just standby</td>
<td>Inability to determine the effect of power demand on emissions by grid-connected power sources</td>
</tr>
<tr>
<td>Solid waste</td>
<td>Monthly solid waste in short tons for MC and PRC (FY 2001-2011)</td>
<td>None</td>
<td>Ability of emissions factors used to accurately estimate emissions</td>
</tr>
<tr>
<td>Commute</td>
<td>2009 Commute Survey including zipcode, mode of transportation and status (faculty, staff, or student)</td>
<td>Small sample</td>
<td>Assumptions regarding vehicle fuel economy, work days, and trip distance</td>
</tr>
<tr>
<td>Air travel</td>
<td>Waiting on data</td>
<td>Waiting on data</td>
<td>Waiting on data</td>
</tr>
<tr>
<td>Purchased goods</td>
<td>Waiting on data</td>
<td>Waiting on data</td>
<td>Waiting on data</td>
</tr>
</tbody>
</table>
APPENDIX C

STATIONARY COMBUSTION DATA SOURCES AND METHODS

DATA SUMMARY:
The data provided for this section included monthly total MMBTU natural gas consumed at both the Main Campus and the Pickle Research Campus for fiscal years 2001-2011. The data from the Main Campus on-campus stationary combustion also included the electricity and steam output that resulted from the natural gas consumption at the Hal C. Weaver power plant.

MAIN CAMPUS DATA SOURCES:
2000 - 2006: Existing monthly data provided for previous inventory by Ricardo Medina
2007 - 2011: Recent monthly data until the end of calendar year 2011 provided by Ricardo Medina

PICKLE RESEARCH CENTER DATA SOURCES:
2000 - 2006: Existing monthly data provided for previous inventory by Juan Nunez
2007 - 2011: Recent monthly data until the end of calendar year 2011 provided by Rey Torres

METHODOLOGY:
(1) Combine total MMBtu of natural gas used at both the Main Campus and the Pickle Research Center
(2) Calculate total missions in MT CO2e:
   (a) Find CO2 emissions
   (b) Find CO2e from CH4 emissions
   (c) Find CO2e from N2O emissions
(3) Combine all emissions and convert to MT CO2e
   \[ \text{MT CO2e} = \text{MT CO2} + (\text{MT CH4} \times \text{GWP(CH4)}) + (\text{MT N2O} \times \text{GWP(N2O)}) \]
APPENDIX D
MOBILE COMBUSTION DATA SOURCES AND METHODS

DATA SUMMARY:
The data provided for this section included annual fleet fuel use by fuel type and vehicle type for all vehicles used at both the Main Campus and the Pickle Research Campus. Data was provided for FY 2004-2011 excluding FY 2008 and 2009 due to a switch in software, which made it impossible to access past data. The data included fuel use for all university-owned fleet vehicles including the construction fleet, but excluded shuttle buses (which were included in the previous report) because they are now owned by Capital Metro.

MAIN CAMPUS DATA SOURCES:
2003 - 2006: Existing annual data provided for previous inventory by Mark Smyth
2010 - 2011: Recent annual data from FY 2010 and 2011 provided by Mark Kaligian
2010 - 2011: Construction fleet data from FY 2010 and 2011 provided by Jeff Basile

PICKLE RESEARCH CENTER DATA SOURCES:
2004 - 2006: Existing annual data provided for previous inventory by Juan Nunez
2010 - 2011: Recent annual data from FY 2010 and 2011 included in the data provided by Mark Kaligian

METHODOLOGY:
(1) Sort annual data according to fuel type used and record total consumption in gallons for each fuel type
(2) Use the following formula to calculate the total MT CO2

\[ \text{MT CO}_2 = \text{Gallons of fuel} \times \frac{\text{kg CO}_2}{\text{Gallon of Fuel}*} \times \frac{\text{MT CO}_2}{\text{kg CO}_2} \]

*kg CO2 / gallon of fuel is listed in Table XX
APPENDIX E
REFRIGERANT DATA SOURCES AND METHODS

DATA SUMMARY:
The data provided for this section was available only in calendar years. The data represents the fugitive losses of all types of refrigerants used on campus as estimated by operations staff. Because quantity does not depend on steady consumption, there is a great deal of variation from year to year.

MAIN CAMPUS DATA SOURCES:
2000 - 2006: Existing annual calendar year data provided for previous inventory by Michael Manoucheri
2010 - 2011: Recent annual calendar year data provided by Michael Manoucheri

PICKLE RESEARCH CENTER DATA SOURCES:
2004 - 2006: Existing annual calendar year data provided for previous inventory by Juan Nunez
2010 - 2011: Recent annual data until the end of calendar year 2011 provided by Rey Torres

METHODOLOGY:
1) Combine fugitive losses per refrigerant type from both the Main Campus and the Pickle Research Campus
2) Calculate total emissions in MT CO2e for each refrigerant type using:
   \[ \text{MT CO2e} = \text{MTrefrigerant} \times \text{GWPrefrigerant} \]
3) Combine CO2e emission totals for each refrigerant type
APPENDIX F
PURCHASED ELECTRICITY DATA SOURCES AND METHODS

DATA SUMMARY:
The data provided for this section includes all purchased energy used at the Main Campus (standby and regular grid dependent buildings), the Pickle Research Campus, the West Pickle Research Campus, and the Dell Pediatrics Research facilities. All emissions were adjusted using the Austin Energy specific grid mix provided.

MAIN CAMPUS DATA SOURCES:
2003 - 2006: Existing monthly data provided for previous inventory by Ricardo Medina
2010 - 2011: Recent monthly data until the end of calendar year 2011 provided by Ricardo Medina
2001 - 2011: Austin Energy grid mix provided by Tom Hilde

PICKLE RESEARCH CENTER DATA SOURCES:
2004 - 2006: Existing monthly data provided for previous inventory by Juan Nunez
2010 - 2011: Recent monthly data until the end of calendar year 2011 provided by Rey Torres

METHODOLOGY:
(1) Combine standby electricity purchased for the Main Campus and electricity purchased for Pickle Research Campus
(2) Determine total MT CO2e using the CA-CP Campus Carbon Calculator

\[
\text{MT CO}_2\text{e} = \text{kWh purchased} \times \frac{\text{pounds CO}_2\text{e}}{\text{kWh}} \times \frac{\text{MT CO}_2\text{e}}{\text{pounds CO}_2\text{e}}
\]
APPENDIX G
SOLID WASTE DATA SOURCES AND METHODS

DATA SUMMARY:

MAIN CAMPUS DATA SOURCES:
2000 - 2006: Existing monthly data provided for previous inventory by Ken Limbrick
2010 - 2011: Recent monthly data provided by Jeff Basile (also includes PRC)

PICKLE RESEARCH CENTER DATA SOURCES:
2004 - 2006: Existing monthly data provided for previous inventory by Juan Nunez
2010 - 2011: Recent monthly until the end of calendar year 2011 included in data from Jeff Basile

METHODOLOGY:
Used CA-CP Campus Carbon Calculator to determine MT CO2e based on short tons given.
APPENDIX H
WATER AND WASTEWATER DATA SOURCES AND METHODS

DATA SUMMARY:

COMBINED DATA SOURCES:
2000 - 2006: Existing monthly data provided for previous inventory by Ricardo Medina
2007 - 2011: Recent monthly data until the end of calendar year 2011 provided by Ricardo Medina
2007 - 2011: Austin Water Utility emissions factors provided by David Greene

METHODOLOGY:
Use Austin Water Utility emission factors for each water and wastewater to determine MT CO2e based on millions of gallons consumed or produced.
APPENDICE I
COMMUTE DATA SOURCES AND METHODS

DATA SUMMARY:

MAIN CAMPUS DATA SOURCES:
2000 - 2006: Existing data from 2000 survey extrapolated for 2006 GHG Inventory from PTS
2007 - 2011: New data from 2009 survey extrapolated for current GHG Inventory from Blanca Juarez

METHODOLOGY:
(1) Determine the top zip codes - those that account for 2% or greater the sample size (and therefore theoretically of the total campus population)
   (a) Determine the average distance from each zip code to campus using Google Maps
   (b) Determine the percentage of trips per mode of transportation for each zip code
   (c) Determine the percentage of respondents who are students v. faculty/staff per mode
   (d) Estimate # miles traveled per zip code per mode
      Student annual trips: 2 (times / day) x 5 (days / week) x 32 (weeks / year) = 320 trips
      Faculty/staff annual trips: 2 (times / day) x 5 (days / week) X 50 (weeks / year) = 500 trips
      
      # miles traveled per mode = (% students x 320 trips x # respondents x % of trips per mode) + (% faculty/staff x 500 trips x # respondents x % of trips per mode)

   (e) Estimate gallons of fuel used based on the fuel efficiency of each mode and number of miles traveled (see Table XX)

   A = miles traveled per mode x fuel efficiency factor

   (f) Estimate emissions in MT CO2e based on emission factor (see Table XX)

   MT CO2e = gallons of fuel used x emissions factor
(2) Divide remaining zip codes into zones (0-4.9 miles, 5-9.9 miles, 10-19.9 miles, 20-29.9 miles, 30-39.9 miles, 40-49.9 miles, 50-59.9 miles, 60-69.9 miles, 70+ miles)

(a) Determine the average distance from each zip code subgroup to campus using Google Maps
(b) Determine the total number of miles traveled by respondents per zone

<table>
<thead>
<tr>
<th>Zone</th>
<th>Respondent miles traveled*</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-4.9 miles</td>
<td>488</td>
</tr>
<tr>
<td>5-9.9 miles</td>
<td>1,042</td>
</tr>
<tr>
<td>10-19.9 miles</td>
<td>6,282</td>
</tr>
<tr>
<td>20-29.9 miles</td>
<td>3,434</td>
</tr>
<tr>
<td>30-39.9 miles</td>
<td>1,862</td>
</tr>
<tr>
<td>40-49.9 miles</td>
<td>1,244</td>
</tr>
<tr>
<td>50-59.9 miles</td>
<td>162</td>
</tr>
<tr>
<td>60-69.9 miles</td>
<td>120</td>
</tr>
<tr>
<td>70-100 miles</td>
<td>948</td>
</tr>
</tbody>
</table>

*Sum of one-way trips for the zone

(c) Determine the percentage of trips per mode of transportation for each zip code

\[
\text{% of trips per mode} = \frac{\# \text{ respondents per mode}}{\text{total number of respondents}}
\]

(d) Determine the percentage of commuters who are students v. faculty/staff
(e) Estimate # miles traveled per zip code per mode

Student annual trips: 2 (times / day) x 5 (days / week) x 32 (weeks / year) = 320 trips
Faculty/staff annual trips: 2(times / day) x 5 (days / week) x 50 (weeks / year) = 500 trips

\[
\# \text{ miles traveled per mode} = (\% \text{ students} \times 320 \text{ trips} \times \# \text{ respondents} \times \% \text{ of trips per mode}) \\
+ (\% \text{ faculty/staff} \times 500 \text{ trips} \times \# \text{ respondents} \times \% \text{ of trips per mode})
\]

(f) Estimate gallons of fuel used based on mode and number of miles traveled (see Table XX)

\[
\text{gallons of fuel} = \# \text{ miles traveled per mode} \times \text{fuel efficiency factor}
\]

(g) Estimate emissions in MT CO2e based on emission factor (see Table XX)

\[
\text{MT CO2e} = \text{gallons of fuel used} \times \text{emissions factor}
\]

(3) Extrapolate to entire campus population

\[
\text{total campus MT CO2e} = \frac{(\text{top 12 MT CO2e} + \text{other MT CO2e}) \times \text{total campus population}}{\text{sample population}}
\]
APPENDICES

APPENDIX J
AIR TRAVEL DATA SOURCES AND METHODS
APPENDIX K
PURCHASED GOODS DATA SOURCES AND METHODS
APPENDIX L
OFFSET AND MITIGATION DATA SOURCES AND METHODS