UCD GHG Inventory:
Final Report

CCOS
May 16th, 2008

Steve Bernard
Justin Christenson
Andrew Duvall
Dan Guenther
Karen Kronoveter
Rui Liu

Rachelle Macur
Leslie Miller
Andy Pattison
Perry-Elena Segura
Pam Sawyer

UCD GHG Inventory: Agenda

Community Engagement
- Focus Group
- Interviews

Greenhouse Gas Inventory
- Buildings Sector
- Transportation Sector
- Transportation Survey
- Materials Sector

Conclusion
- Integration of Qualitative and Quantitative Data
- Challenges and Future Recommendation

UCD GHG Inventory: Introduction

WRI

Organizational Boundary

Economic Control

Midpoint Impact Assessment

- Scope 1 - Direct emissions
  - Natural Gas (including on-site electrical generation)
- Scope 2 - Indirect emmisions due to power generation of purchased electricity
  - Electricity
- Scope 3 - Indirect (upstream) emissions resulting from the onsite consumption of key materials
- Being conducted to help UCD meet the requirements of the American College & University Presidents' Climate Commitment (ACUPCC)

Institutional Context

- Three campuses: AMC, Downtown, 9 & CO

- Population **2007-08 (est.)**
- Faculty   4,783
- Staff/Administration   1,661
- Post Doc Trainee/Fellows   305
- Students   15,321
- Residents   924
- Total   22,994

UCD GHG Inventory: Community Engagement

UCD Focus Group and Interview Demographics

Focus Group
8 Participants
4 Women
4 Men
3 Students (2 undergrad, 1 grad)
3 Staff
2 Faculty

Interviews
7 Interviewees
5 Women
2 Men
2 Faculty
5 Staff

What do you think of when you hear the word "sustainability"?

... recycling is number one
... zero-waste, carbon neutral, environmental impact
... the ability to use resources wisely and efficiently
... using replenishable resources
... living below the carrying capacity of our environment
... usage of technology and human ingenuity to promote general welfare

PPP:
... People and the Planet are together. Prosperity follows.
... People create prosperity, and overall prosperity promotes upkeep of the world
...People, planet, prosperity: Without the people, who cares?

What do you think of when you hear the words "Climate Change" and "Global Warming?"

... it's very scary and already happening
... we all contribute
... evidence is lacking but has resulted in new technologies that have decreased our fossil fuel consumption
... it's overwhelming until I learn what I can do to help
... we have to be able to trust the media; we can't all be experts

Things that CU can do

... administration should encourage behavior change with making programs available
    > bike security and showers, same RTD pass for staff and faculty as for students, light detectors,
... energy monitoring systems to make people aware and drive competition and a "sense of pride"
... education and marketing
... look to examples by other universities and EPA building
... there is a lack in baseline (minimum) services which discourages people more
... keep it simple and let people see financial incentive (to campus and themselves)
... keep guidelines simple
... as a commuter campus we set the tone for how people live. ... habits learned on campus will transfer to the home
...impliment *policy* at the school and the hospital; make it a perfromance expectation
...frustrated with the current recycling program

What do you think are some of the costs and benefits to sustainability?

... student fee to fund students in any department that want to do projects related to sustainability for the campus

... faculty have volunteered time and are committed already to making a sustainability minor

... first make people aware and encourage them with programs and they will take on small costs

... penetrate "tunnel vision" and overcome laziness

... costs of not being sustainable need to be treated as an unnecessary loss

... our reputation is suffering as a major presence in Denver

If and when you eat on campus, where do you generally purchase your food? …if it was available would you prefer to buy local or organic food?...even if it cost more?

... if good quality, convenient, fast service, some would definitely pay more
... some no, too many options in Denver or bring from home
... students from certain demographics can't afford it
... there's a reason why Whole Foods is in Cherry Creek, and not downtown
... if I knew there was food around that was good for me, stuff that I could take with me, I *would* just so I don't make an extra stop on the way home
...if only we had good venders on campus

How do you feel about the recycling program on campus? Do you use it? Do you think it is convenient? How could we improve it?

... all use it, but unaware that it is single stream
... should recycle batteries, ink cartridges and computers
... internal Craigslist for unwanted office supplies
... not convenient, difficult to get recycling bins
... doubt that cleaning staff isn't throwing it away
... education needs to be part of orientation
... the hospital doesn't care about recycling at all, but we're the same institution
... "broadcast" the we are becoming a zero-waste community and people should be constantly reminded of this expection

How many of your fellow students/colleagues use public transportation? Have they ever expressed why or why not? What do you think is the greatest obstacle to using public transportation?

… if it's accessible to their home, people use it
… take light rail, bus, bike
… drive due to multiple destinations and amount of things to carry
… barriers are: inadequate parking, security, overcrowded trains
… vanpool and car sharing could be beneficial/existing vanpool/bus schedule too restrictive
… waiting late at night, by yourself; it's not the safest neighborhood
… being on-call forces me to drive

We are trying to identify <u>simple</u> changes we all can make on the UCD campus to become more eco-friendly? Can you talk about a few changes that you think would be a good start to this effort?

... take stairs, recycle (don't contaminate), turn off lights and computers
... the most important change for indoor air quality would be to use biodegradable cleaners
... magnetic locks on stairway doors to improve walkability and air circulation
... efficient building operations to decrease energy consumption
... when retrofitting, look at sustainable materials and designs
... "green up" the product line (paper products, vendors, caterers, etc.)
... these efforts aren't being implimented fast enough
... misinformation and miscommunication is preventing people

UCD CO2e Inventory: Results

Equation:
- $MFA*EF_{LCA}=CO2e$
  - Buildings energy use
  - Transportation energy use
  - Materials energy use

Buildings GHG Inventory: Introduction

WRI

Organizational Boundary

   Economic Control

Midpoint Impact Assessment

- Scope 1 - Direct emissions
  - Natural Gas (including on-site electrical generation)
- Scope 2 - Indirect emmisions due to power generation of purchased electricity
  - Electricity

Buildings GHG Inventory: Data Sources

- Data Sources
  - Jarrett Smith
  - Pete Bloomquist
  - Scott Roen

- Data Types
  - Natural Gas - MMBtu
  - Electricity - Kwh

Table 1: UCD Buildings and Facilities Energy Use CO2e emissions, FY 2007 Data

Sector/Use	UCD Annual Energy[1]	GHG Emission Factor (EF) [Data Source]	Total GHG Emitted
Scope 1: Natural Gas/Steam MMBtu	CO9: 383,261* AMC: 270,678 DDC: 14,373 **Total: 660,281 MMBtu/yr**	56 kg-CO2e/ MMBtu [ICLEI]	36,976 mt-CO2e
Scope 2: Electricity Kwh (MMBtu)	CO9: 42,487,177 kWh (144,966 MMBtu) AMC: 53,245,715 kWh (181,675 MMBtu) DDC: 4,870,789 kWh (16,619 MMBtu) **Total: 100,603,681 Kwh/yr (343,260 MMBtu/yr)**	0.8 kg-CO2e/ kWh [Xcel, 2005]	80,483 mt-CO2e
Total UCD Buildings and Facilities Sector CO2e emissions: 1,003,541 MMBtu/yr:			**117,459 mt-CO2e**

MMBtu = million BTU units = 1000 kBTU = Deca-therm
1 mt = 1000 kg
*Includes natural gas use for on-site electricity generation and steam production
[1] Data source: UCD Facilities Operations

Table 2: UCD Buildings and Facilities Energy Total kBtu/GSF Compared to National Benchmarks

Campus	Natural Gas Scope 1 (GSF)	Electricity Scope 2 (GSF)	Natural Gas Scope 1 (MMBtu/GSF)	Electricity Scope 2 (MMBtu/GSF)	Total kBTU/ GSF	Benchmark: kBtu/GSF (CBECS: 2003)
CO9	1,586,786	2,280,786	0.242	0.064	306	Health Care: 187.7
AMC	1,573,043	1,582,152	0.172	0.115	287	Inpatient: 249.2
DDC	349,382		0.041	0.048	89	Education: 83.1 Office: 92.9

Note: As noted previously, only the CO9 location allocated different GSF for natural gas and electricity uses to account for the two parking garages. For the AMC, the source of the slight difference between the two GSFs is unknown.

Table 3: UCD Buildings and Facilities Energy Total kBtu/GSF Compared to Applicable Benchmarks

	National		Regional (West)		Sub-regional (Rocky Mountain)	
	Inpatient Hospital	Office	Inpatient Hospital	Office	Healthcare*	Office
Natural Gas	109.8 cf/sf (113 kBtu/sf)	31.8cf/sf (3 kBtu/sf)	108.1cf/sf (111 kBtu/sf)	23cf /sf (24 k Btu/sf)	115.5cf /sf (119 kBtu/sf)	50 cf/sf (52 kBtu/sf)
Electricity	27.5kWh/sf (94 kBtu/sf)	17.2kWh/sf (59 kBtu/sf)	25.3kWh/sf (86 kBtu/sf)	15 kWh/sf (51 kBtu/sf)	25.8 kWh/sf (88 kBtu/sf)	16.3kWh/sf (56 kBtu/sf)

CO9:   Natural Gas: 242 kBtu/sf   Electric: 64 kBtu/sf
AMC: Natural Gas: 172 kBtu/sf   Electric: 115 kBtu/sf
DDC: Natural Gas: 41 kBtu/sf   Electric: 48 kBtu/sf

* Health care: individual inpatient and outpatient quantities not provided
Source of benchmark data: CBECS = Commercial Buildings Energy Consumption Survey

UCD GHG Inventory: Transportation Sector

Transportation GHG Inventory: Introduction

WRI

Organizational Boundary

   Economic Control

Midpoint Impact Assessment

- Scope 1 - Direct emissions (Fiscal Year 2007 (July 01, 2006 To July 01, 2007)
  - Fleet gasoline vehicles
  - Fleet diesel vehicles
- Scope 3 - Indirect emissions
  - Commuter activity
    - Survey conducted March-April 2008
  - Air Travel

Transportation GHG Inventory: Data Sources

- Data Sources
  - Jarrett Smith
  - UCD Transportation Services Department
  - UrbanTrans

- Data Types (Scope 1)
  - Gasoline - total fleet gallons
  - Diesel - total fleet gallons

- Data Types (Scope 3)
  - Survey (self reported estimates):
    - Distance traveled
    - Mode
    - Vehicle mpg
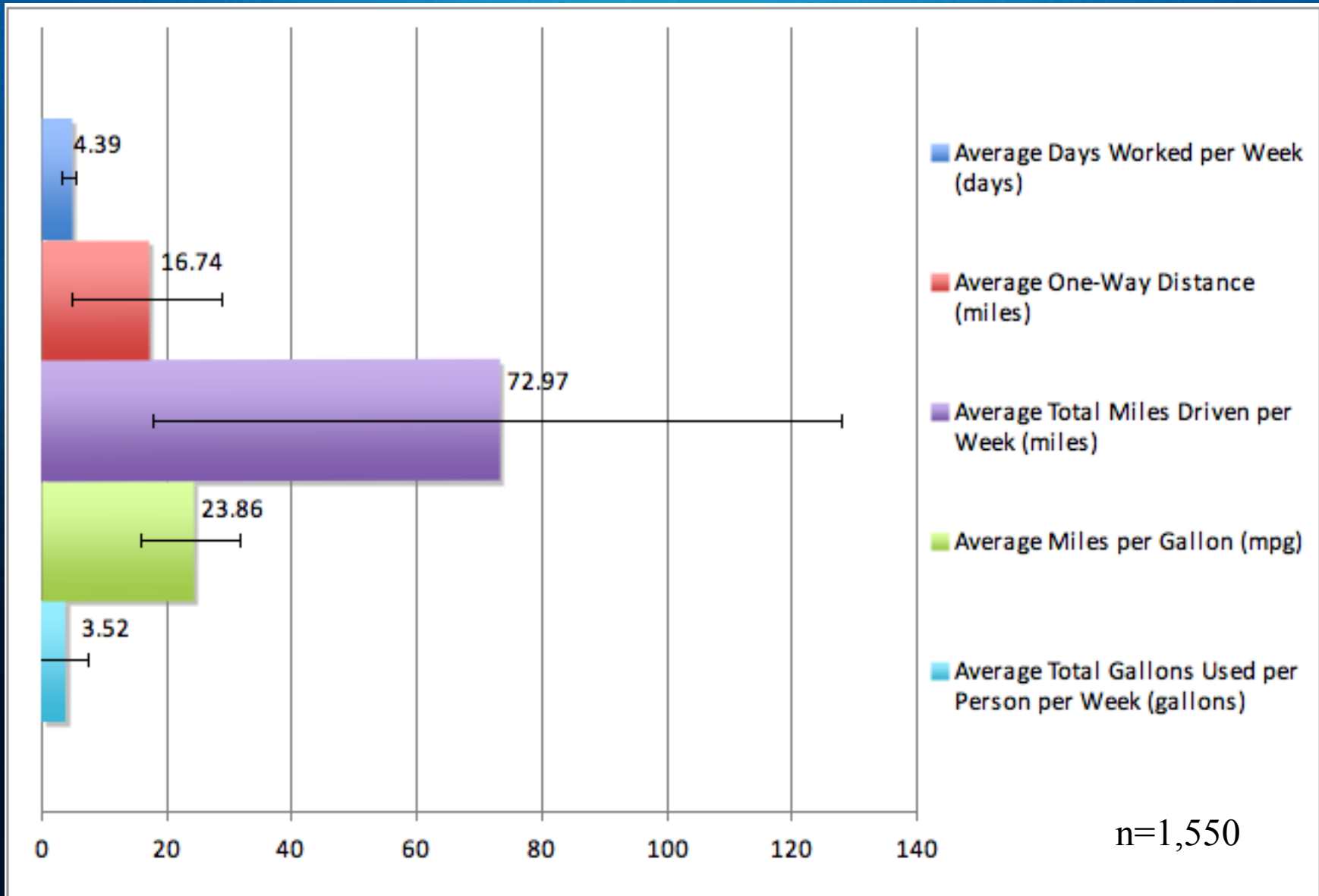   - Number of days traveled to campus by mode

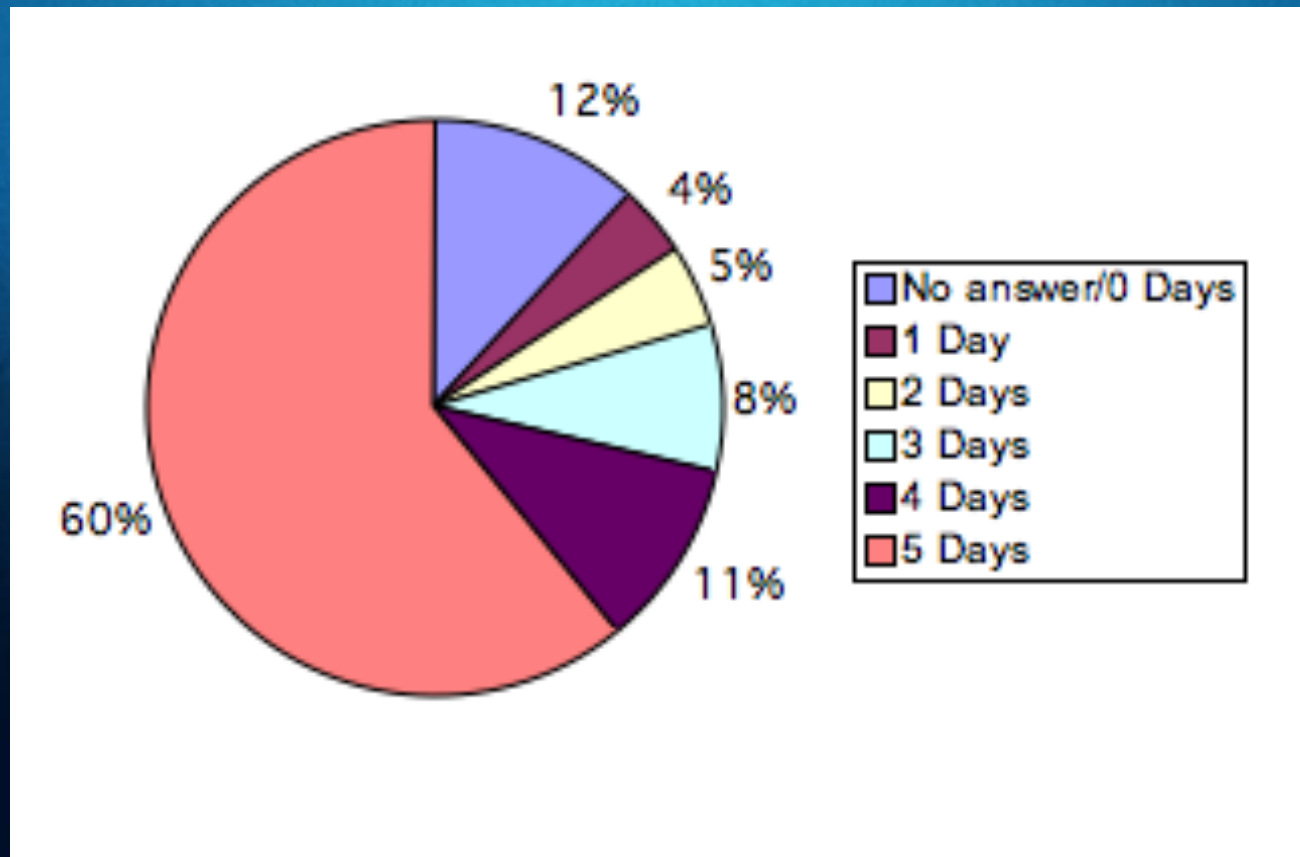# UCD GHG Inventory: Transportation Survey

Survey Results: Downtown
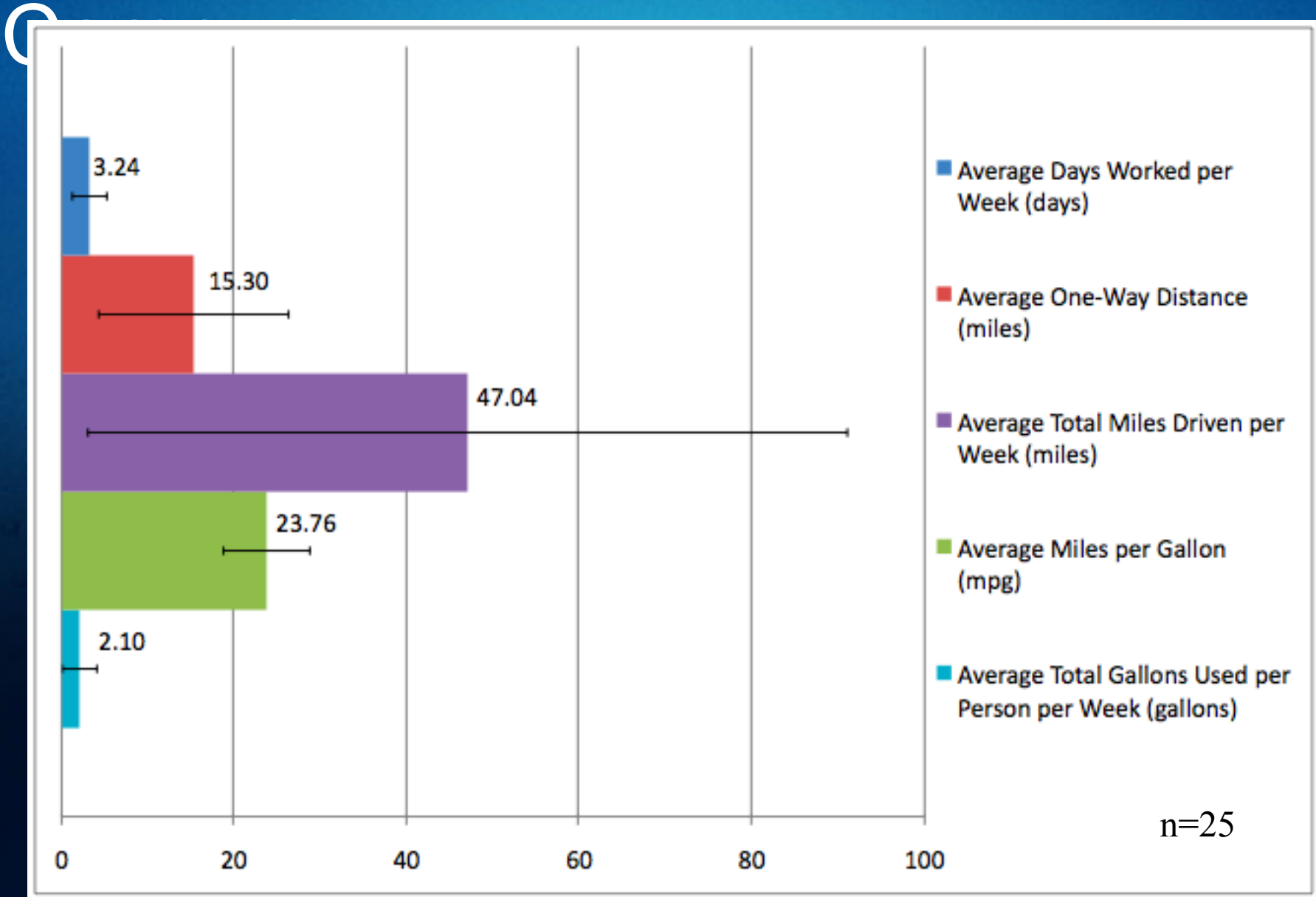
*one way travel

Survey Results: Anschutz Campus

*one way travel

Survey Results: Anschutz and Downtown Campuses
60% of commuters drive alone

Survey Results: Anschutz and Downtown Campuses
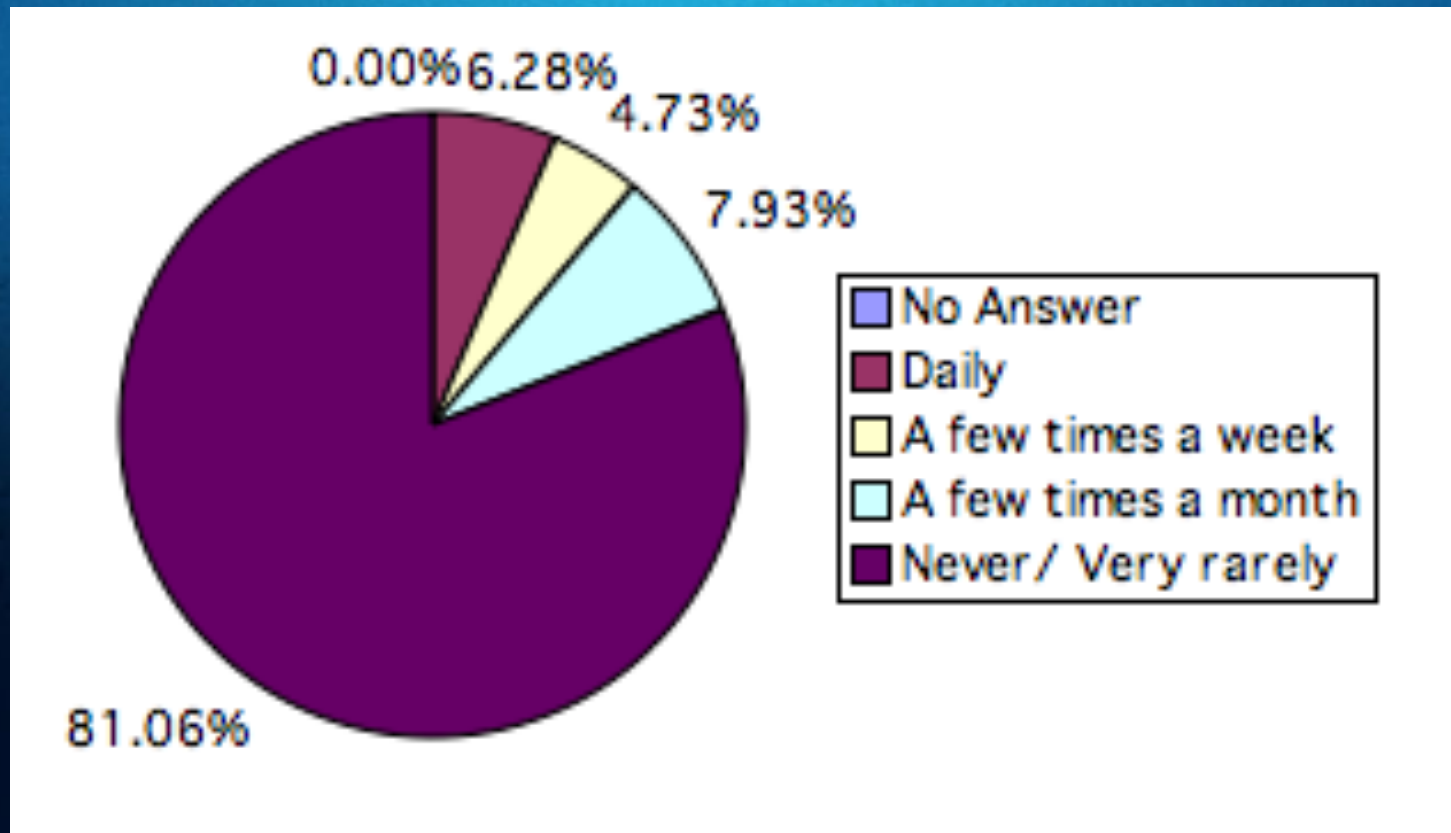## 81.06% Never or rarely use Mass Transit

Table 4: UCD Transportation Energy Use CO2e emissions, FY 2007 Data

Campus	MFA		Tailpipe (P2W) Gasoline EF [Source]	Tailpipe (P2W) Diesel EF [Source]	Total UCD Transportation Sector CO2e emissions
	Gasoline (gallons)	Diesel (gallons)			
Scope 1: UCD Fleet: Tailpipe (P2W)	18,911	16,094	9.3 kg-CO2e/gallon [GREET]	9.5 kg-CO2e/gallon [GREET]	329 mt-CO2e
Scope 3: Air Travel	278,897 gallons jet fuel		9.4 kg CO2e/gallon [GREET]		2,622 mt-CO2e
Scope 3: UCD Personal Commuting	3,023,247 gallons[1]		9.3 kg CO2e/gallon (WTP)		28,116 mt-CO2e
	21,875,627 PMT[2]		0.3 kg CO2e/PMT		6,563 mt-CO2e
Total UCD Transportation Sector CO2e emissions:					**37,630 mt-CO2e**

[1]Summation of driving alone and carpooling subsectors of transportation
[2]PMT = personal miles travels: mass transit
*WTP for jet fuel = WTP for diesel

UCD GHG Inventory: Materials Sector

Materials GHG Inventory: Introduction

WRI
Organizational Boundary
   Economic Control
Midpoint Impact Assessment
Scope 3 - Indirect emissions
- Fuel, WTP
- Water
- Food and Packaging
- Paper
- E-Waste
- Concrete

Materials GHG Inventory: Data Sources

- Data Sources
  - Jarrett Smith
  - UCD Transportation Services Department
  - UrbanTrans

- Data Types (Scope 3)
  - Fuel, WTP - gallons purchasd
  - Water - gallons
  - Food and Packaging - $ spent
  - Paper- $ spent

Total 10: UCD GHG Emissions from Material Sector

Material	Campus-wide Annual Material/Energy Flows	EF [Source]	Total CO_2e emitted
Fuel (WTP)	Fleet Fuel: 18,911 gal gasoline 16,094 gal diesel; Personal commuting: 3,023,247 gal gasoline; Airline Travel: 278,897 gal Jet Fuel	Gasoline(WTP): 2.5 kg-CO2e/gallon Diesel(WTP): 2.0 kg-CO2e/gallon Jet Fuel(WTP): 2.0 kg-CO2e/gallon [GREET][8]	8,196 mt-CO_2e
Water (Potable)	180,932,000 gallons	4.4×10^{-4} kg-CO_2e [Xcel][4]	79.6 mt-CO_2e
Office Paper	248mt	Production: 1,180kg-CO_2e/mt [GWI][5] Landfill: 871 kg--CO_2e/mt [EPA WARM][6]	509 mt-CO_2e
Food	$267,067	2 kg-CO_2e/$ (1997-$) [EIO-LCA][7]	534 mt-CO_2e
Total UCD Material Sector CO_2e emissions			**9,034 mt-CO_2e**

Conclusion

UCD GHG Inventory: Integrating Qualitative and Quantitative Data

Numbers like those provided in this report make sense to those of us who can read them, but they aren't accessible to everyone. If the information contained in this report were presented in an easily understood fashion, it would be of interest to the wider university community.

Interviews and focus groups we conducted for this report demonstrate that UCD's efforts to become a more sustainable institution are important to students, faculty and staff at the university.

However, many interviewees and focus group participants also expressed a desire for more direction, training and information on the University's behalf. Many of the sustainability initiatives that are in place on campus go unnoticed or unused because people are unaware of their existence or don't know how to use them.

- single-stream recyling
- ride-sharing programs at Anchutz campus

UCD CO2e Inventory: Results

The total GHG emissions for UCD in FY 2007, including scopes 1, 2, and 3 in the buildings, transportation, and materials sector were 164,408 metric tons CO2e

The ACUPCC only requires that scope 1 and 2 emissions from the buildings and transportation sector are reported and included in the GHG inventory. The total of these emissions for UCD in FY 2007 were 120,256 metric tons CO2e.
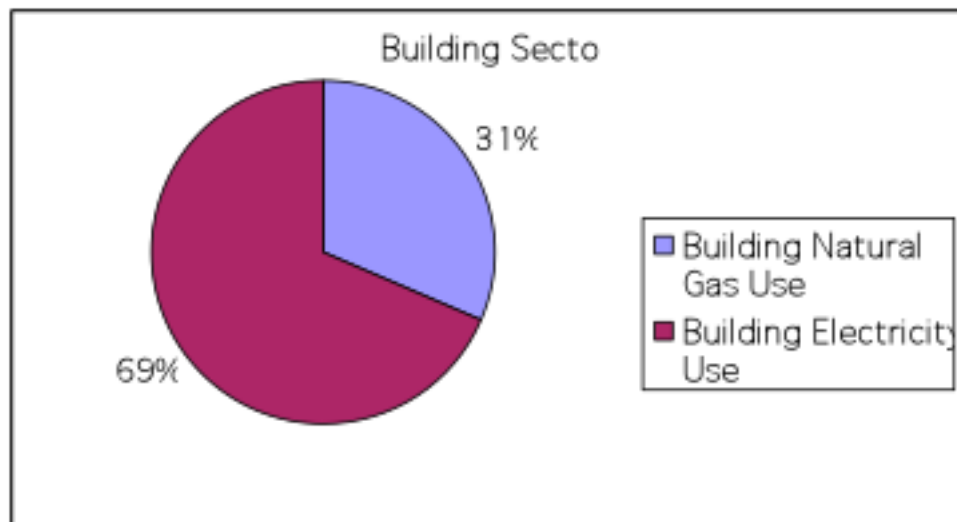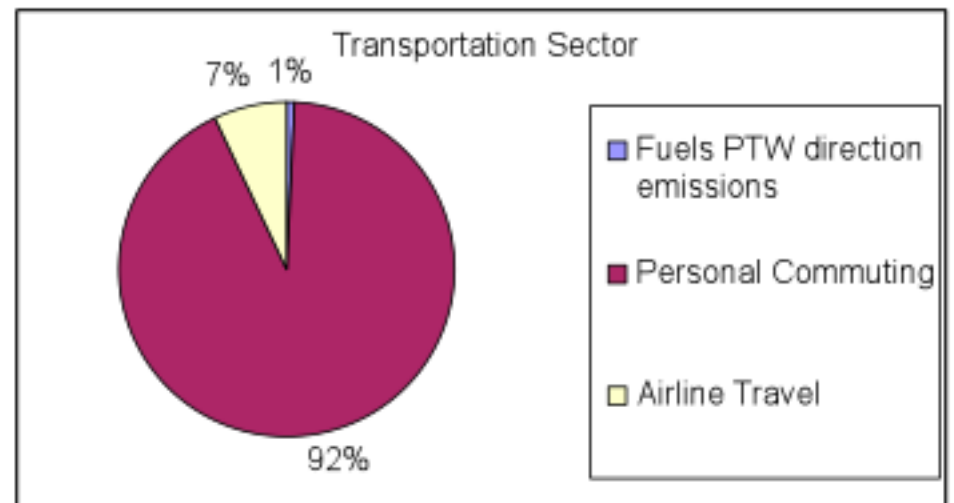
Figure 3 UCD GHG Emissions Building Sector

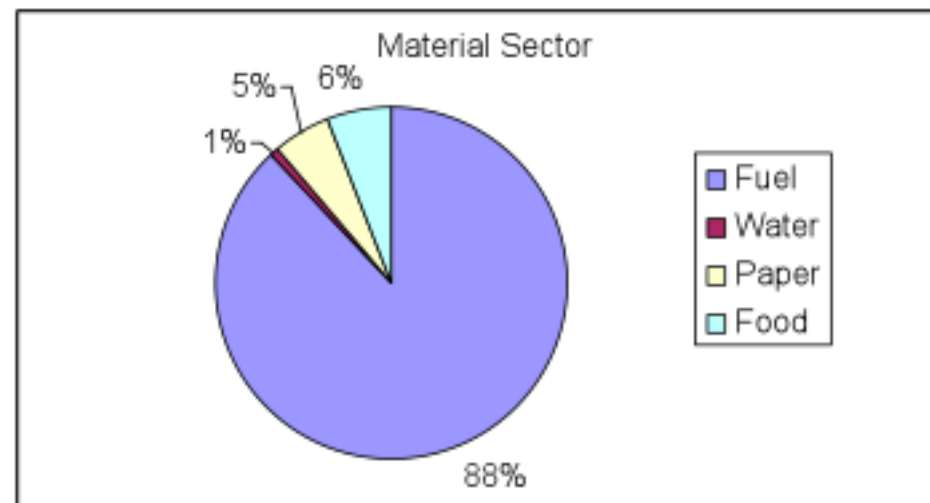Figure 4 UCD GHG Emissions Transportation Sector

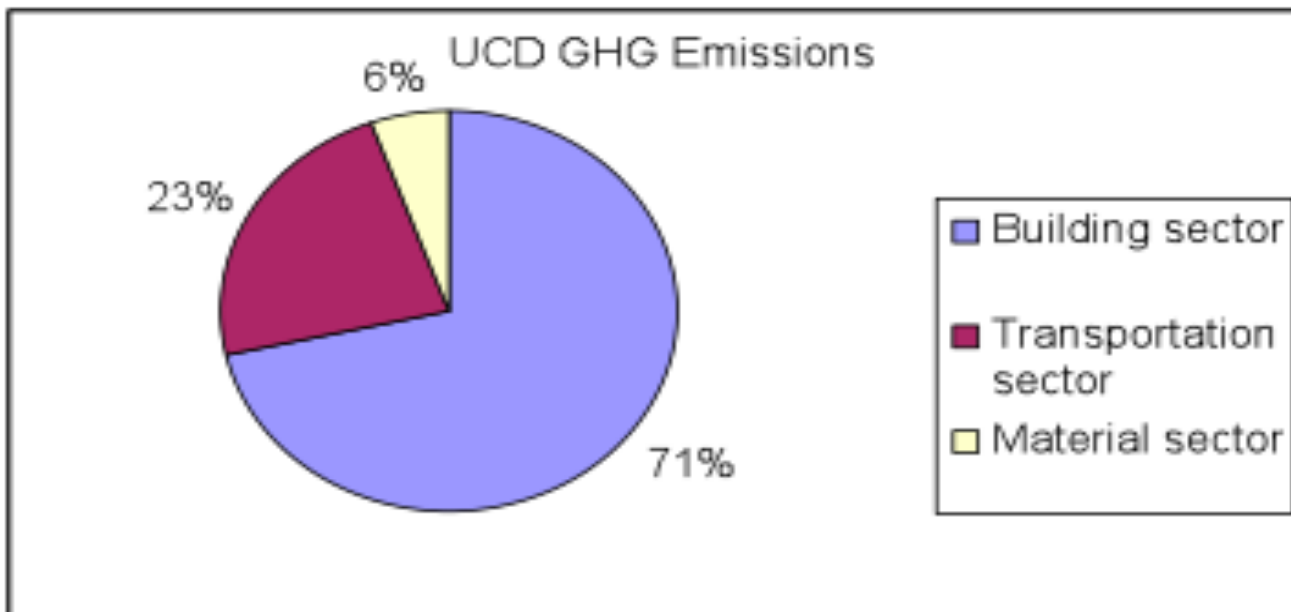Figure 5 UCD GHG Emissions Material Sector

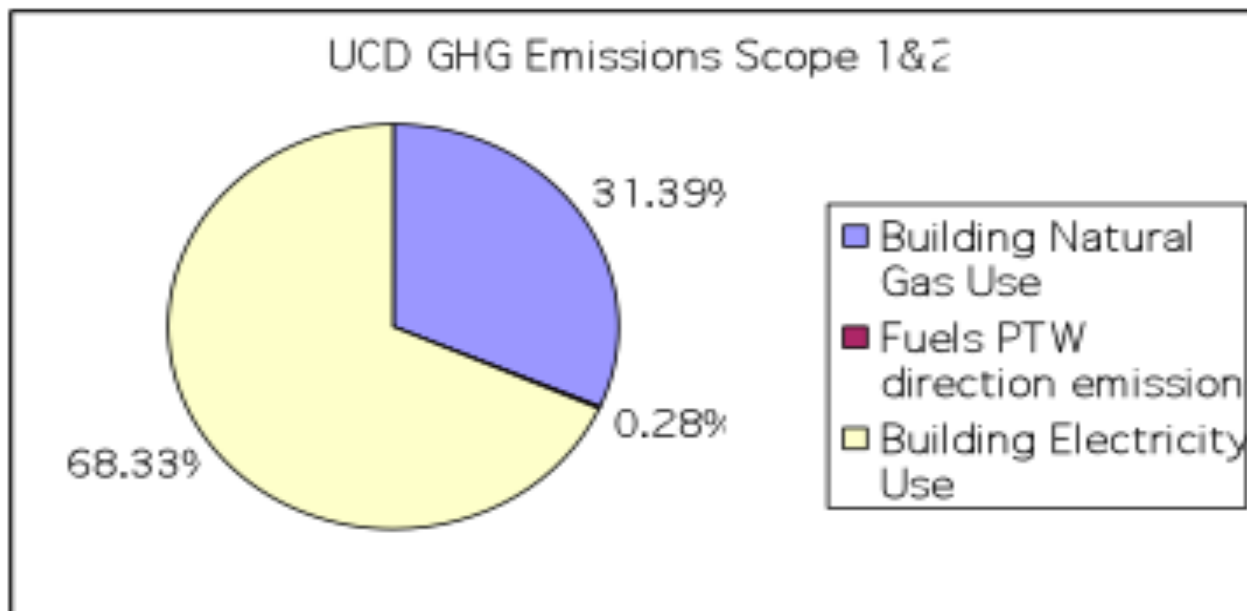Figure 2 UCD GHG Emissions by Sectors

Figure 1 UCD GHG Emissions Scope 1&2

UCD GHG Inventory: Challenges and Future Recommendations

- time was the biggest challenge
- including concrete, perhaps not possible
- including e-waste data
- accounting for landfill emissions and assessing the benefit of the recycling programs that are currently in place.
- wider transportation survey to encompass students, faculty and staff of all campus locations (for scope 3 transportation, tailpipe emissions from commuting)
- further qualitative research - including surveys, focus groups and interviews - will be necessary to create a comprehensive picture of sustainability at UCD
- Per capita emissions (UCD downtown versus AHEC)