Center for Environmental Research and Education

Rebecca Day, Graduate Student
Jacob Levine, Graduate Student
Gretchen Sterba, Graduate Student
Stanley J. Kabala, Ph.D., Faculty

June 2009

DUQUESNE UNIVERSITY

ONE STEP AT A TIME:

Duquesne University's Second Biennial Greenhouse Gas Emissions Inventory

This report was produced by faculty and students of the Center for Environmental Research and Education with partial support from The Heinz Endowments.

The Center for Environmental Research and Education resides within Duquesne University's Bayer School of Natural and Environmental Science. Our mission is to provide "...multidisciplinary education that prepares students for careers in current and emerging areas of environmental science..." For more information about the Center for Environmental Research and Education, please visit **http://www.science.duq.edu/esm/cereabt2.html**.

The Heinz Endowments is a philanthropic body dedicated to a mission of helping the southwestern Pennsylvania region "thrive as a whole community – economically, ecologically, educationally, and culturally – while advancing the state of knowledge and practice in [these] fields." For more information on The Heinz Endowments, please visit **www.heinz.org**.

TABLE OF CONTENTS

I. ACKNOWLEDGEMENTS

Special thanks to Guy Zupo, Manager, Energy Center, and Ruth Newberry, Director, Educational Technology. Their constant support and assistance was invaluable to this project.

This project was made possible by funding from The Heinz Endowments.

The authors of this report would like to recognize those who compiled the April 2006 report, *One Step at a Time: Reducing Duquesne's Carbon Footprint*, which served as a basis for our project. They are Lindsay Baxter, David Deal, Kelsy Johnson, and Dr. Stanley Kabala.

Additionally, we would like to thank all those whose contributions made this report possible:

- Angela Chirumbolo, *Office of Institutional Research and Planning*
- Dave DeNardo, *University Controller's Office*
- Kelly Dougherty, *Office of International Programs*
- Mary Eberle, *Department of Physical Therapy*
- Sharon Evans, *Palumbo·Donahue School of Business*
- Coleman Griffin, *Facilities Management Department*
- Paul Hightower, *Department of Athletics*
- Reverend Sean Hogan, *Office of the President*
- Marian Holden, *Office of Institutional Research and Planning*
- Dr. Michael Irwin, *Department of Sociology*
- Lisa Mikolajek Barton, *Center for Environmental Research and Education*
- Deborah Novak, *University Controller's Office*
- Karen Prykull, *Tamburitzans*
- Linda Roos, *Purchasing Department*
- Dr. David Seybert, *Dean of the Bayer School of Natural and Environmental Sciences*
- Robert Volkmar, *Center for Environmental Research and Education*
- Bill Zilcosky, *Facilities Management Department*

II. EXECUTIVE SUMMARY

This report, assembled by graduate students of the Center for Environmental Research and Education (CERE), under the direction of Dr. Stanley Kabala, presents the results of an inventory of Duquesne University's greenhouse gas (GHG) emissions in calendar year 2008. As the second such report that CERE has issued, it compares its findings with those derived from 2006 data and assesses nascent trends regarding Duquesne's GHG emissions. Additionally, the report discusses options over multiple timescales for reducing Duquesne's carbon footprint.

Duquesne's total GHG emissions for 2008 totaled 40,557 metric tonnes of carbon dioxide equivalent (CO_2e)[1] , or approximately 4.0 tonnes per student.[2] As shown in Figure 1, several large sources contributed varying proportions of GHG emissions:

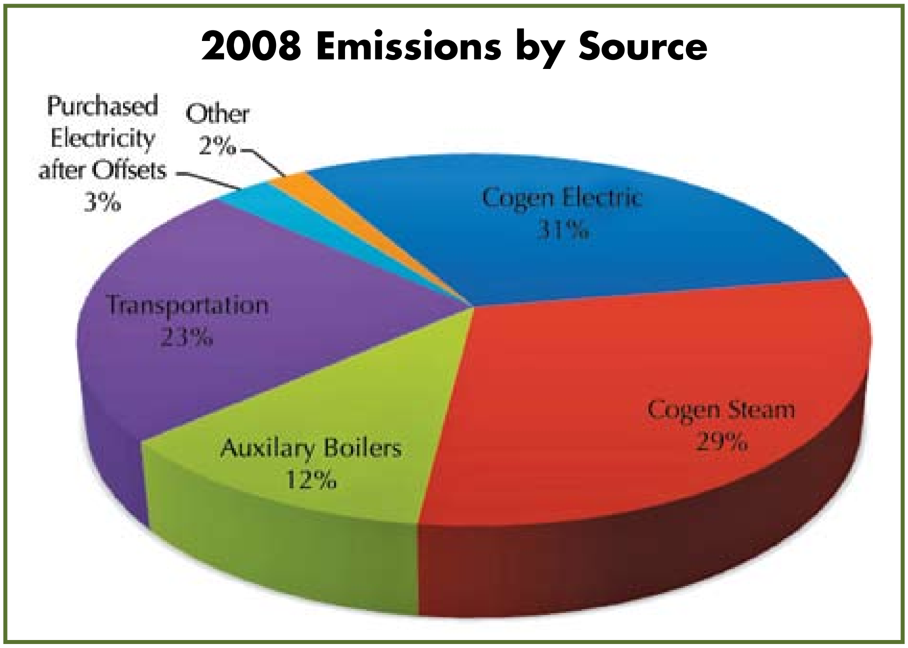

Figure 1: 2008 Emissions by Source

Altogether, heating and electricity contributed 75 percent of Duquesne's GHG emissions. Transportation – including commuting, campus fleet, and university-sponsored travel – accounted for about 23 percent of the footprint. Other sources, such as wastewater, paper usage, and fertilizer application, together made up about two percent of total emissions.

Duquesne's 2008 emissions decreased significantly from the 2006 total of 46,800 tonnes CO_2e, which equals 4.6 tonnes per student. (Those familiar with the 2006 report, *One Step at a Time: Reducing Duquesne's Carbon Footprint*, will remember a different number. See the "Comparison with 2006" section in this report for explanation.) In light of a slight expansion of the student body and the opening of the Power Center in early 2007, which considerably increased campus square footage, a reduction of more than 6,000 metric tonnes of CO_2e is an encouraging development.

[1] CO_2e is a sum of all greenhouse gases emitted, with each gas weighted by its relative greenhouse effect, termed global warming potential (GWP). Carbon dioxide is assigned a factor of one and all other gases are weighted accordingly. For instance, methane has a GWP of 23, so each ton of methane emitted is calculated as 23 tons of CO_2e.

[2] This number of CO_2e per student references total students of both full and part-time status. Various schools use another reference of full-time equivalent (FTE), counting part-time students as half of full-time students. Duquesne's 2006 and 2008 reports use the former denomination.

The overwhelming majority of emissions reductions from 2006 to 2008 resulted from Duquesne's decision in early 2008 to begin purchasing all "imported" electricity using Renewable Energy Certificates (RECs). RECs, delivered from local wind farms to Duquesne through a licensed credit-trading enterprise, effectively displace coal-fired electricity from the regional grid. Switching to 100 percent renewable energy eliminated 11,800 tonnes of CO_2e from Duquesne's total carbon footprint.[3]

Duquesne's biggest opportunity for GHG reduction now lies in improved process and operational energy efficiency (to reduce demand on the cogeneration plant), purchasing carbon offsets for university-sponsored travel, working to change student and faculty commuting habits, and further exploration of on-campus renewable energy.

III. BACKGROUND

Acceptance of global climate change science has increased dramatically over the last decade. The role of anthropogenic emissions to atmospheric warming is no longer in doubt. Debate now centers on mitigation and adaptation options and policies. Efforts to address GHG reduction have ranged in scale from international treaties to individual lifestyle changes. States, cities, smaller communities, and individual organizations have instituted programs to quantify and address their contributions to global warming.[4]

In 2007, amid growing awareness of climate impacts from college campuses across the country, graduate students at CERE conducted Duquesne University's first inventory of campus GHG emissions, using data from calendar year 2006. That inventory – the first produced by any university in Western Pennsylvania – and subsequent report provided the campus community with an informative snapshot of the size and sources of Duquesne's GHG contribution.

Following the success of the 2006 inventory, CERE decided to update this snapshot every two years in order to keep information current and uncover any long-term trends. CERE graduate students began collecting data for the second biennial inventory – using 2008 figures – in January 2009.

IV. METHODS

Those familiar with Duquesne's first inventory will recall that CERE used emissions-calculating software from Clean Air-Cool Planet (CACP), a nonprofit organization specializing in community and campus sustainability.[5] The CACP software uses specialized formulas and algorithms to convert readily available institutional data into resulting emissions levels.[6]

As a result, much of the inventory entailed contacting the proper university officers and entering the data acquired from them into the calculator database. However, some of the required information was not easily accessible in Duquesne records. In these cases, the inventory authors used the following methodology for locating existing data and converting it into the units needed for the calculator.

[3] Note that 1,175 tonnes CO_2e, or roughly 3 percent of the total emissions, are still attributed to purchased electricity. This figure reflects transmission and distribution losses of electricity as it travels through the grid. These losses are not included in the price of RECs and are thus an important source of GHG emissions even for electricity purchased with the certificates.

[4] For a thorough discussion of climate change science and policy, including climate scenarios, projects and mitigation options, see the Fourth Assessment Report from the United Nation's Intergovernmental Panel on Climate Change. http://www.ipcc.ch/ipccreports/ar4-syr.htm

[5] http://www.cleanair-coolplanet.org/

[6] CERE used the new version 6.1 of the CACP calculator (the 2006 inventory used v5.0). The programmers for this new version added previously unaddressed GHG sources like paper usage and wastewater disposal to its scope and made nuanced changes to many of the equations it uses.

The data input fields in the CACP calculator fall into three broad functional scopes, defined by CACP:

- **Scope 1:** Direct emissions from sources owned or controlled by the university (includes cogeneration plant, auxiliary boilers, university fleet, and refrigerant use)
- **Scope 2:** Indirect emissions from sources neither owned nor operated by the university (includes purchased electricity, steam, and chilled water)
- **Scope 3:** Directly-financed outsourced emissions sources, sources closely linked to campus activities (includes commuting, travel, solid waste and wastewater disposal, and paper usage), and offsets.

The following is a brief description of the inputs required for the CACP calculator, the sources of data, and processing needed to align acquired data with the calculator's specifications.

Scope 1 Sources

An annual energy center summary, provided by the Facilities Management Department, contained most of the information, including the cogeneration plant's MMBTU of natural gas consumed, kWh of electricity produced, and MMBTU of steam produced. Facilities Management also provided figures on MMBTU of natural gas consumed from campus auxiliary heating boilers. Facilities Management also assembled information on refrigerant and chemical use.

The remaining piece of Scope 1 information required processing. The CACP calculator called for gasoline usage in gallons for all university fleet vehicles. That information was not directly available. However, CERE did contact the Purchasing Office to obtain the dollar amount of gasoline purchases for 2008. Using U.S. Department of Energy information on average gasoline prices by month and region,[7] CERE calculated an average gasoline price for 2008 and divided the total gasoline expenditure by this amount to arrive at the quantity of gasoline used.

Scope 2 Sources

Scope 2 required data on purchased electricity. This section of the scope also requires data on steam and hot water purchased. However, Duquesne produces all steam and water on campus. Facilities Management supplied data on the energy budget including kilowatt hours (kWh) purchased for the 2008 calendar year. The impact was limited because Duquesne purchases Renewable Energy Certificates (REC) from Strategic Energy LLC and Community Energy Incorporated, two licensed credit-trading enterprises. This REC data was entered into the Offsets category of Scope 3.

Scope 3 Sources

Scope 3 presented the most complications for data gathering. It includes emissions from sources that are neither owned nor operated by the university but are directly related to its operations. For Duquesne, these include solid waste, wastewater, paper purchasing, study abroad travel, directly financed outsourced travel, commuting, and offsets.

[7] http://www.eia.doe.gov/oil_gas/petroleum/data_publications/wrgp/mogas_history.html
CERE used Cleveland, the closest city listed, as a proxy.

Waste and Wastewater

Information on wastewater disposal and solid waste were available through the Facilities Management Department. The Department supplied reports on each building's water use to determine the gallons of wastewater discharged to the municipal sewer system and treated by the Allegheny County Sanitary Authority (Alcosan). Wastewater contributions to the GHG footprint result from the method of secondary treatment, which at Alcosan consists of aerobic digestion by microbes in an activated sludge process. The Waste Management Inc. landfill at Monroeville, which receives Duquesne's waste, recovers methane produced during decomposition and uses it to generate electricity. Facilities Management provided the quantity in short tons of waste sent to the Monroeville landfill.

Paper Purchasing

The CERE team gathered paper purchasing information from the Purchasing Office. Duquesne purchases 10 percent recycled content, which the team entered as pounds into the inventory.

Study Abroad

The Study Abroad Office provided information on student travel for study abroad experiences. The number of students traveling to different locations was used to calculate miles of air travel round trip using the "Mile Marker" mileage calculator available on **www.webflyer.com**.

Directly Financed Outsourced Travel

Duquesne's directly financed outsourced travel includes sports team travel and faculty business travel.[8]

Sports Travel

The Athletic Department provided sports travel information, including modes of transportation, and number of athletes and athletic staff traveling to sporting events. Using Duquesne's Athletics website to obtain the schedules of the sports teams, the CERE team determined the distances traveled from Duquesne to the destinations using Google Maps for buses and vans. Webflyer.com was once again used for flight mileage.

Faculty Business Travel

Duquesne does not currently track faculty business travel on a mileage basis. In order to determine faculty miles traveled by air, the team contacted the Business School, for data on average miles traveled. The team was able to calculate miles traveled in 2008 by the faculty of the Business School, and average that information for each faculty member in the department. The CERE team multiplied the Business School's average miles per faculty by the number of faculty at Duquesne to obtain the total miles traveled by the Duquesne faculty.

[8] The Tamburitzans, a traveling performance group of Duquesne students, were contacted and considered for inclusion in this category. However, after determining that much of the group's funding comes from donations, and not directly from the University, it was decided that the Tamburitzans do not fall under directly financed outsourced travel, and hence were not included.

The team recognized the potential for error in this "best possible" approach, so to ensure that the number of miles calculated using the Business School's average was plausible, the team employed a statistic called "Average Passenger Yield" from the Bureau of Transportation Statistics. This statistic enables a conversion from dollars spent on air transportation to miles traveled. The Purchasing Department provided figures on dollars spent on air travel to complete this calculation. The miles obtained from the average calculated from the Business Department and from the Bureau of Transportation calculation showed a close correlation. However, the number chosen for use in the calculator was that taken from the latter method, which encompassed the entire faculty.

Faculty and Staff Commuting

To determine faculty and staff commuting habits, the CERE team acquired from the Office of Institutional Research the number of employees for 2008. The team assumed faculty and staff commuting patterns had not changed since the 2006 inventory, therefore relied on the 2006 figure of 7.4 miles per one-way trip. The 2006 team determined one-way trip length by using the *2006 University Fact Book* and used U.S. Census Data to estimate mode of transportation percentages.

Student Commuting

The 2008 team determined that census data does not accurately represent student commuting habits, so it developed a survey to gauge commuting and transportation habits. The survey was designed with the assistance of the Department of Sociology, distributed by way of the University's *BlackBoard* system with the assistance of the Office of Computing and Technology Services department and the Sociology Department. See Appendix B for a copy of the survey. Survey topics included local zip codes, interest in alternative transportation, round trips per week, and modes of transportation. To encourage student participation, three $50 gift certificates to the Barnes and Noble store on campus, the on-campus Starbucks, and *The Red Ring* campus restaurant were offered.

During three weeks on BlackBoard the survey drew more than 1,000 responses. The data on the local zip codes and number of trips taken per week, provided by the students, was used to determine the average number of miles traveled per week per student. In addition, the percentage of students utilizing each mode of transportation was entered into the calculator to determine total student commuting emissions.

Offsets

As mentioned in Scope 2, data on Renewable Energy Certificates (RECs) was entered in this section as Green Power Certificates in kWh. Duquesne purchases RECs from two licensed credit-trading enterprises, Community Energy Incorporated and Strategic Energy LLC. These credits serve to offset the use of coal-fired power by supporting renewable energy source, specifically wind-power, contributions to the electrical grid.

The ease and precision of producing Duquesne's carbon footprint is essential. A few challenges confronted the 2008 team as it collected data for the inventory. One of the more challenging areas was trying to determine mileage for faculty business travel. The team was able to get the total amount spent for business travel but not the mileage. The reason for this appears to be that many faculty members purchase their own tickets and are then reimbursed for expenditures. In regard to information on fuel for the fleet vehicles on campus, the team needed data in gallons but they had to rely on monetary numbers that then had to be converted to gallons. A more accurate recordkeeping system for these data points based on actual miles would be beneficial in further refining Duquesne's greenhouse gas inventory.

V. RESULTS

Duquesne University's total greenhouse gas emissions for calendar year 2008 were 40,557 metric tonnes of CO_2e. Seventy-five percent of total emissions – 30,313 tonnes – came from campus electricity and heating. Most of the remaining emissions resulted from transportation, which contributed 23 percent of the footprint. Collectively, fertilizer use, land filled waste, wastewater disposal, and paper usage accounted for about two percent of emissions.

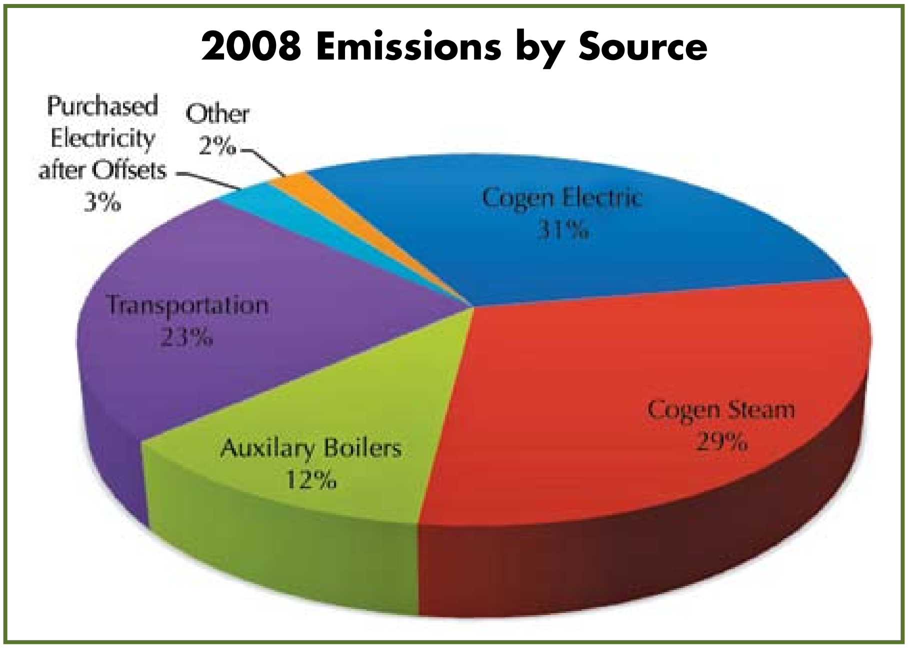

Figure 2: 2008 Emissions by Source

Electricity and Heating

Electricity and heating produced almost three quarters of Duquesne's total emissions. Most of these emissions (60 percent of the total footprint, 24,434 tonnes CO_2e) originated from the cogeneration plant, which used 461,838 MMBTU of natural gas to produce 32,791,389 kWh of electricity and 249,173 MMBTU of steam. Auxiliary boilers used for supplemental heating, contributed an additional 12 percent of the total footprint (4,704 tonnes CO_2e).

The university purchased 16,761,071 kWh of electricity in 2008. However, the GHG contribution from this purchase was only 1,175 tonnes CO_2e because 100 percent of electricity was purchased using RECs.

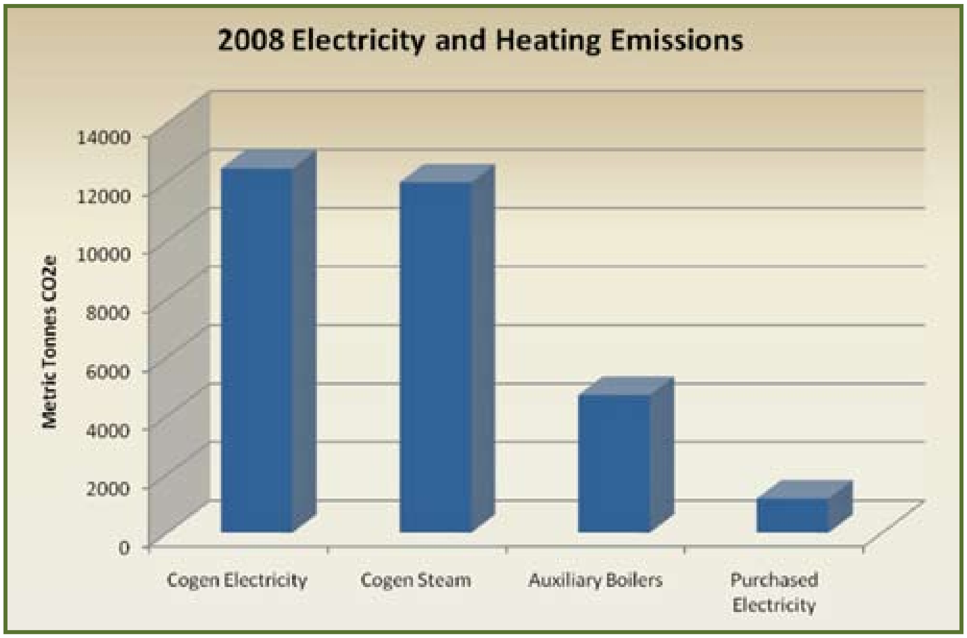

Figure 3: 2008 Electricity and Heating Emissions

Transportation

Transportation emissions include commuting, directly financed outsourced travel, and study abroad travel. These sources accounted for 23 percent (9,430 tonnes CO_2e) of the University's footprint. The majority of the impact from transportation – 10 percent of the total footprint – was from directly financed air travel, which in this case includes faculty business travel and sports team travel. Student commuting contributed 5.8 percent and staff and faculty commuting contributed 4.6 percent of the total footprint. Study abroad air travel contributed 2.6 percent and directly financed outsourced non-air travel (buses and vans used by sports teams) contributed .05 percent of Duquesne's total footprint.

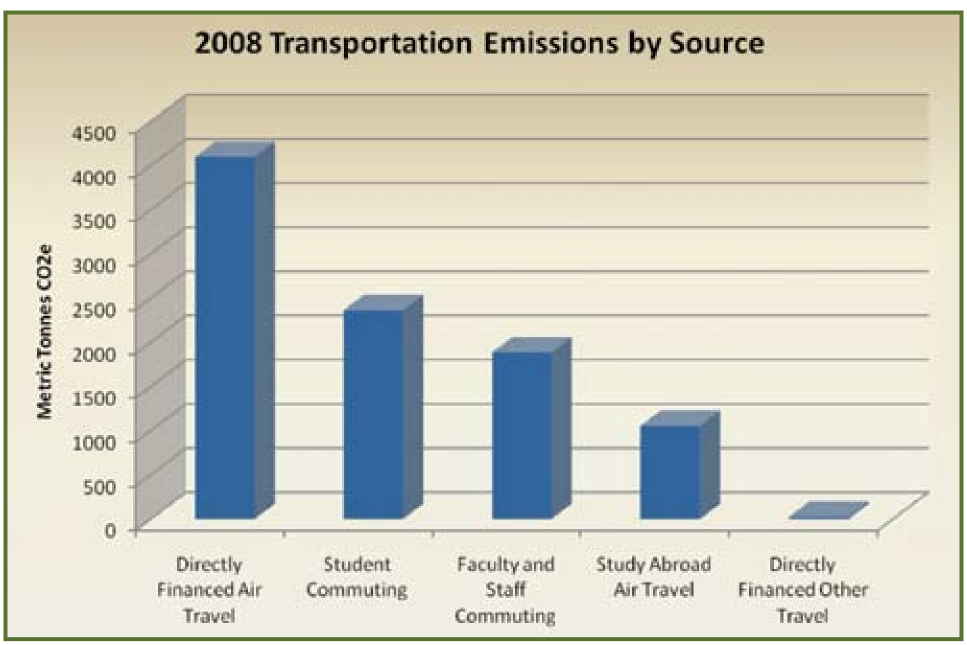

Figure 4: 2008 Transportation Emissions by Source

Miscellaneous

Minor GHG sources collectively contributed two percent (812 tonnes CO_2e) to Duquesne's total emissions. These include refrigerant use (220.4 tonnes), fleet vehicle use (195 tonnes), fertilizer application (2.4 tonnes), solid waste landfilling (211.1 tonnes), wastewater disposal (46.7 tonnes), and paper usage (136.4 tonnes).

VI. COMPARISON WITH 2006

From 2006 to 2008, Duquesne's total GHG emissions dropped from 46,800 tonnes CO_2e (4.6 tonnes/student) to 40,557 tonnes CO_2e (4.0 tonnes/student). This section will examine changes to both Duquesne's environmental policy and this inventory's methodology, as well as how those changes influenced the new emissions total.

Adjustments to the 2006 Results

The results of the 2006 inventory serve as the basis of comparison for this 2008 inventory. However, the 2006 results presented here differ slightly from those published in the corresponding report, *One Step at a Time: Reducing Duquesne's Carbon Footprint*. Important adjustments to the 2006 data are as follows.

First, the 2006 report presented results in short tons (2,000 pounds). However, surveying the multitude of GHG inventories published by other universities, the team noticed that metric tonnes (1,000 kg, or 2,205 pounds) was the more prevalent unit,[9] and switched to that unit. The reported 2006 total of 48,400 short tons converts to 43,920 metric tonnes. It is recommended that future reports also use metric tonnes.

Second, the CERE team also updated the electricity-grid region selection in the calculator. Different electricity grid regions use different ratios of coal, natural gas, nuclear power, hydroelectric dams, wind, and solar to generate electricity, hence producing different rates of GHG emissions per kWh. The 2006 inventory used the Mid-Atlantic Area Council (MAAC), which encompasses New Jersey, half of Maryland, and most of Pennsylvania. Pittsburgh, however, lies in the East Central Area Reliability (ECAR) region, comprised of Ohio, Kentucky, West Virginia, Indiana, and southwestern Pennsylvania. While the mix of MAAC electricity sources average 0.52 kg of CO_2 per kWh, the ECAR region averages 0.92 kg/kWh. This correction increased the emissions from purchased electricity by 4,500 tonnes.

In addition, as noted in the 2006 report, the analysis of commuting in 2006 contained an error. Data on driving alone and carpooling were entered as percentages of drivers, but should have been entered as a percentage of the total campus population. Thus, the inventory reflected twice the amount of driving that actually occurred. Correcting this error reduced GHG emissions by 1,750 tonnes.

The increase in emissions from correcting the electricity grid region and the decrease in emissions from correcting the commuting data transcription nets a 2,750 tonne increase in emissions. This brings the 2006 total to 46,670 tonnes.

Updating to a new version of the CACP calculator, with its adjusted formulas, accounts for the remaining 130 tonne increase to 46,800 metric tonnes (51,574 short tons).

[9] This does not imply that either unit is more valid. The most recent version of the CACP calculator only produces results in metric tonnes, which likely accounts for that unit's preponderance in the literature.

Comparison to the Adjusted 2006 Results

With the 2006 profile properly adjusted as noted above, an accurate assessment of Duquesne's progress began. Duquesne has seen an emissions decrease of 6,200 tonnes from the 2006 inventory to the 2008 update. Figure 5 shows this change by category of emissions. Slight increases in emissions occurred across most categories, with a dramatic decrease occurring in emissions from purchased electricity.

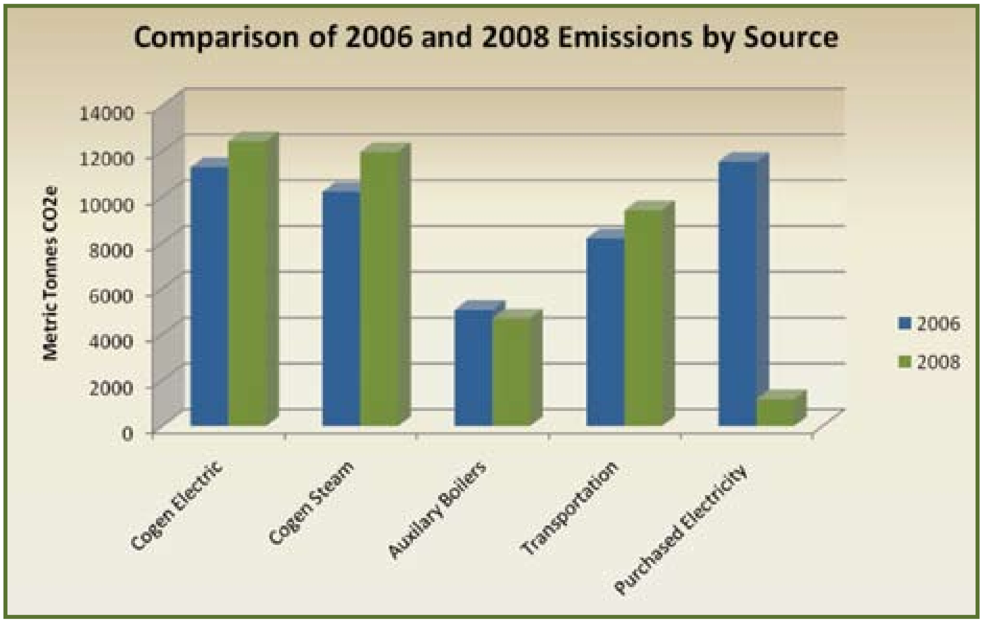

Figure 5: Comparison of 2006 and 2008 Emissions by Source

Changes Reflecting Variation in Data

The dynamics behind this decrease in emissions are quite simple. The switch to green power neutralized an overall increase in demand for electricity. Campus demand for heating and electricity changed under the influence of two competing factors. Various projects to increase energy efficiency on campus reduced the demand, while additions of building space, particularly the recently opened Power Center[10], increased demand.

This net increase in demand does not affect the cogeneration plant and auxiliary boilers, whose operating capacities constrain natural gas usage, as well as electric and steam outputs. Increased demand translates quite directly, however, into purchased of "imported" electricity. Total electricity purchased in 2008 was 16,761,071 kWh, an increase of approximately 5.4 million kWh above the 2006 figure of 11,393,404 kWh.

This fact makes the switch to 100 percent REC purchases for electricity the critical factor in the overall reduction of Duquesne's carbon footprint from 2006 to 2008. As shown in the graph below, 2008 emissions from purchased electricity without RECs would total 13,055 tonnes CO_2e, up from 10,513 tonnes in 2006. With the RECs, the only greenhouse gas contribution from purchased electricity came from transmission and distribution losses (see footnote 2) and totaled a mere 1,175 tonnes CO_2e.

[10] Though the Power Center, Duquesne's new recreation center and convention space, represents a sizeable new source of electricity and heating demand, it should be noted that the building was constructed according to LEED Silver standards and is certified as such. It is one of the most energy-efficient buildings on Duquesne's campus.

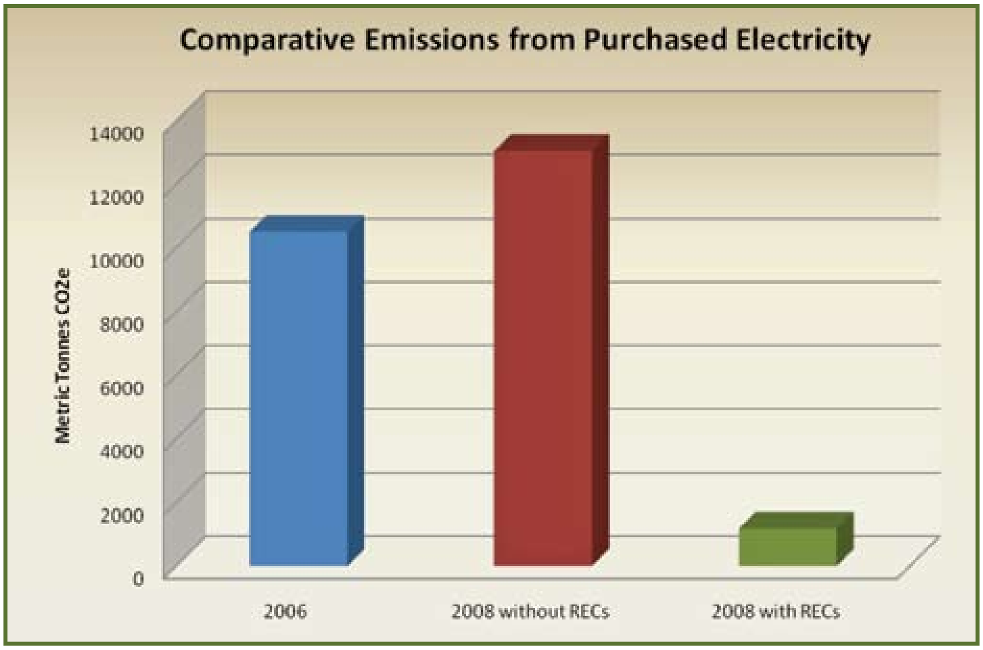

Figure 6: Comparative Emissions from Purchased Electricity

Changes Reflecting Inventory Methodology

In addition to the aforementioned changes, several methodological changes in this survey influenced the results. The biggest difference stemmed from a change in calculating directly financed air travel. As in 2006, the CERE team relied on data on university air travel expenditures, because direct information on destinations and mileage was not available (see Scope 2 section of Methods). Total air travel miles financed by the university increased from 2,069,893 miles in 2006 to 4,630,781 miles in 2008 with resulting emissions increasing by 2,493 tonnes (155 percent). Being uncertain of the conversion factors used by the 2006 team, it is unclear why this notable change occurred. It may reflect an actual increase in university-sponsored air travel, a change in accounting and reporting of university expenditures on air travel, or a change in the conversion factor.[11]

Another important methodological difference occurred regarding student commuting statistics. The 2006 inventory used U.S. Census Bureau information on commuting habits to determine the modes of student transportation. The 2008 team conducted a survey (see "Methods" section for full details) that tapped comments of more than 1,000 Duquesne students and used the resulting data to determine commuter inputs for the calculator. This produced changes to percentages of various transportation modes, number of trips made per week, and average distance traveled per trip. As a result of these changes, the GHG emissions associated with student commutes dropped from 3,265 tonnes CO_2e in 2006 to 2,365 tonnes CO_2e in 2008.

Methodology did not change for determining faculty commuting patterns and study abroad air travel. The minor increase in GHG emissions from faculty and staff commuting reflects a slight increase in the size of the faculty and staff. Decreases in study abroad air travel emissions most likely reflect fewer students studying abroad or students studying in closer locations. Figure 7 illustrates how emissions from each travel sector changed from 2006 to 2008.

[11] Both the 2006 and 2008 reports referenced the U.S. Department of Transportation's Bureau of Transportation Statistics. The 2008 report used a particular statistic called average passenger yield, which describes the average dollar amount spent per passenger mile.

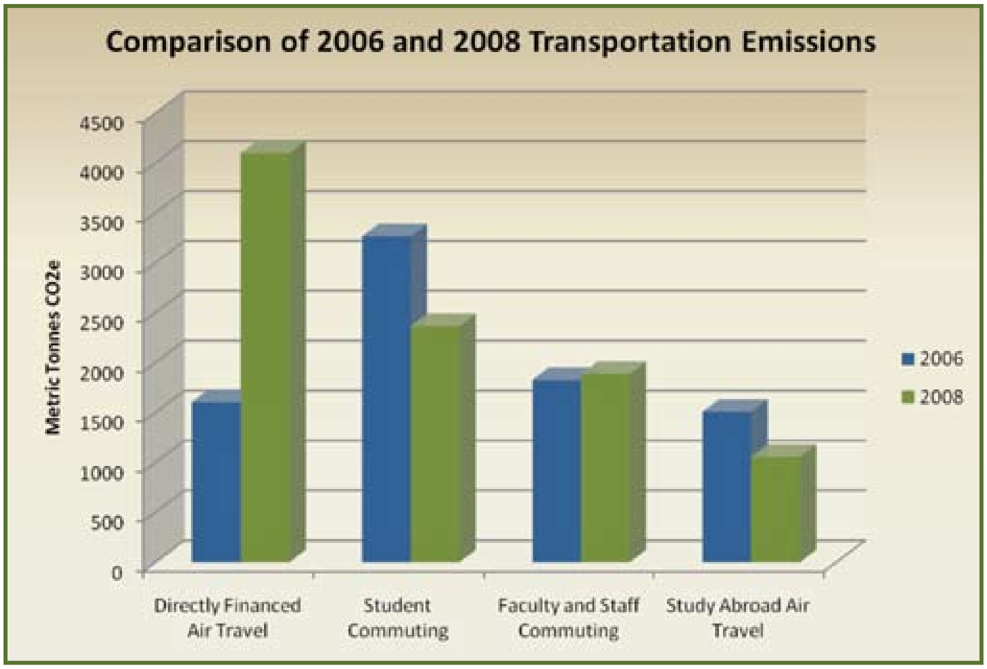

Figure 7: Comparison of 2006 and 2008 Transportation Emissions

VII. CONCLUSIONS

Comparison with Other Universities

Duquesne's total carbon footprint of 4.0 tonnes per student compares favorably with other universities that have published GHG inventories. In order to compare footprints accurately, it is important to be aware of the many factors affecting an institution's footprint. The main factors include climate zone, location in an urban or rural setting, student population, physical size (building square footage and acreage), and building usage, such as research laboratories. We have compared Duquesne with schools in the *Atlantic 10 Conference* to show the relationship between schools located in similar climate zones. We have also compared our footprint with a nationwide selection of schools in order to show the wide range of results. For consistency, all schools chosen calculated their footprint using the CACP calculator.

COMPARISON TO *ATLANTIC 10* SCHOOLS

School	Year Completed	Total Footprint	Number of Students	Per Student Footprint	Location
Duquesne University	2008	40,557	9,485	4.3	Pittsburgh, PA
University of Massachusette-Amherst	2007	142,237	26,360	5.4	Amherst, MA
Xavier University	2007	37,000	6,646	5.6	Cincinnati, OH
George Washington University	2008	128,301	20,220	6.3	Washington D.C.
Temple University	2008	216,012	28,237	7.6	Philadelphia, PA

Figure 8: Comparison to *Atlantic 10* Schools

COMPARISON TO NATIONWIDE SAMPLE OF SCHOOLS					
School	**Year Reported**	**Total Footprint**	**Number of Students**	**Per Student Footprint**	**Location**
San Francisco State	2006	61,184	28,800	2.1	San Francisco, CA
University of California–Santa Barbara	2004	46,000	20,909	2.2	Santa Barbara, CA
Marymount Manhattan College	2007	4,348	1,937	2.2	Manhattan, NY
College of Charleston	2001	38,712	11,000	3.5	Charleston, SC
California State Polytechnic University–Pomona	2005	59,771	16,295	3.6	Pomona, CA
Duquesne University	2008	40,557	9,485	4.3	Pittsburgh, PA
The Evergreen State College	2006	22,112	4,400	5	Olympia, WA
University of New Hampshire	2005	68,324	13,349	5.1	Durham, NH
Utah State University	2007	121,818	23,623	5.2	Logan, UT
SUNY Geneseo	2007	28,380	5,274	5.4	Geneseo, NY
Connecticut College	2006	11,181	1,900	5.9	New London, CT
University of Connecticut	2007	193,912	28,677	6.8	Storrs, CT
Oregon State University	2007	151,287	19,753	7.7	Corvallis, OR
Williams College	2008	21,848	2,185	10	Williamstown, MA
University of Maryland–College Park	2007	352,000	32,467	10.8	College Park, MD
University of Illinois–Chicago	2006	240,466	21,841	11	Chicago, IL
Colby College	2007	20,372	1,846	11	Waterville, ME
Carleton College	2004	24,200	1,900	12.7	Northfield, MN
Smith College	2004	33,025	2,550	13	Northampton, MA
University of Pennsylvania	2006	320,000	23,743	13.5	Philadelphia, PA
Middlebury College	2002	35,000	2,350	14.9	Middlebury, VT
Wellesley College	2002	41,000	2,228	18.4	Wellesley, MA
Vanderbilt University	2007	302,000	12,093	25	Nashville, TN
Duke University	2003	380,000	13,457	28.2	Durham, NC

Figure 9: Comparison to Nationwide Sample

Existing Environmental Assets

Physical Facilities

Duquesne is well positioned to maintain a low carbon footprint due to its energy-efficient infrastructure, particularly its cogeneration plant and ice-cooling plant.

The cogeneration plant limits GHG emissions in two important ways. It supplies two-thirds of campus electricity by way of a highly efficient generation process that uses cleaner-burning natural gas, with the net effect of producing far less GHG than the bituminous coal that is the most prevalent fuel in Pittsburgh's electrical grid. It then uses the residual steam from the generating process for campus heating and cooling purposes, eliminating the need to supply additional heat and cooling through potentially GHG-intensive outside sources of energy. Without the cogeneration plant, if Duquesne purchased an equivalent amount of electricity and steam, the university's carbon footprint would climb to 61,441 tonnes CO_2e, a 50 percent increase. Figure 10 illustrates this hypothetical increase by sector.

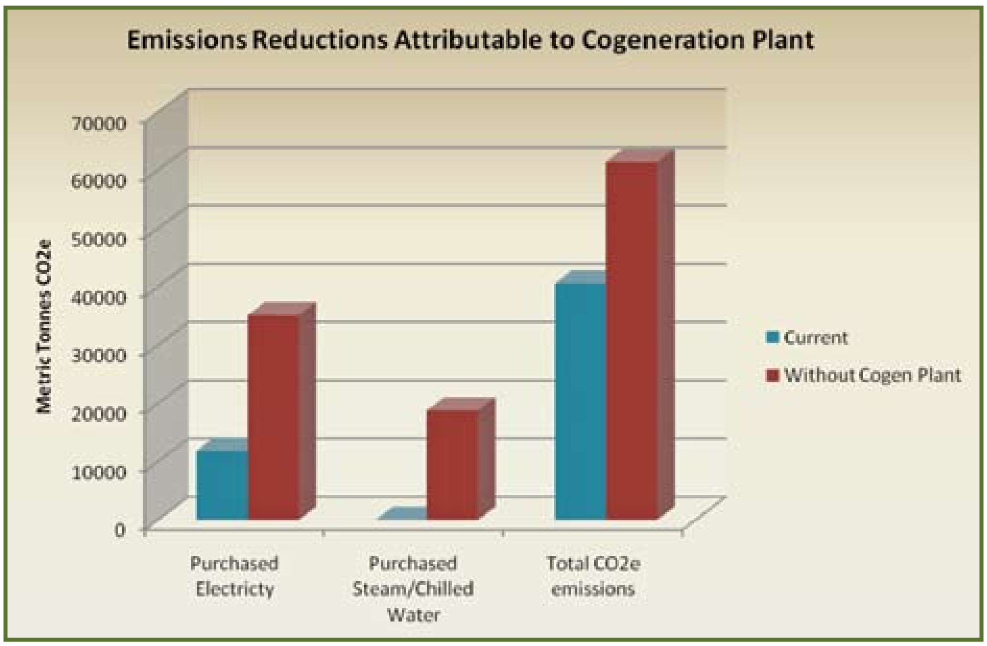

Figure 10: Emissions Reductions Attributable to Cogeneration Plant

An important environmental asset not directly captured in the calculator is Duquesne's new ice cooling plant. The plant makes ice at off-peak hours, which then melts and cools campus facilities throughout the day. By using energy at off-peak hours when demand is low, this process alleviates pressure on the electrical grid during times of higher demand. This helps limit the need for new energy-generating capacity in the region.

Duquesne's Facilities Management department has worked diligently in recent years to improve campus energy efficiency. Projects completed include the highly efficient ice-cooling plant, lighting and control upgrades in 14 buildings, roofing projects that include better insulation and reflective coatings to reduce heating and cooling needs, and the Power Center's LEED certification.

Institutional Approaches

Duquesne University has implemented a number of environmental policies and hosts a plethora of groups and programs that support the goal of carbon emission reduction. The university has joined the Association for Advancement of Sustainability in Higher

Education (AASHE), a national coalition of universities and colleges dedicated to environmental responsibility. Duquesne recently adopted a policy stating that all new construction and renovation on campus must follow LEED standards. Duquesne has been a partner with Carnegie Mellon University and the University of Pittsburgh in the program *One Step at a Time: Reducing the Campus Carbon Footprint* (OSAT), in which the three schools share information and discuss progress towards climate-related goals. Duquesne is a member of the Higher Education Climate Coalition (HECC), a working group of colleges and universities in the Pittsburgh region that serves the goals of the Pittsburgh Climate Protection Initiative adopted by Pittsburgh City Council in 2008. Duquesne heads up the HECC sub-committee on greenhouse gas inventories. Duquesne has two Sustainability Committees, one responsible for facilities and operations concerns, and one, multi-disciplinary in composition, that is exploring means of integrating sustainability themes into the university curriculum.

CERE, within the Bayer School of Natural and Environmental Sciences, conducts applied research directed toward the critical environmental problems of southwestern Pennsylvania and beyond and educates environmental professionals for the public and private sectors. The Business School's Sustainable MBA program trains future business leaders to integrate responsible climate approaches into sound economic management. The program is ranked eighth globally for their commitment to environmental and social issues by the Aspen Institute. The Business School is home to *Net Impact*, an environmental organization of MBA students. *Evergreen*, an undergraduate student group under the Spiritan Campus Ministry, works to establish a green community on and off campus, through education and engagement.

VIII. RECOMMENDATIONS

Duquesne has put forth a substantial effort and made considerable inroads in reducing its carbon footprint. There remains, however, potential to curb emissions further. The aim of this section is to promote discussion and increase awareness of potential reduction strategies. It does not aim to analyze, create, nor implement University policy. Broadly speaking, areas for further reduction include energy efficiency, renewable energy, commuting habits, offset purchases, and institutional changes.

Energy Efficiency

Energy efficiency offers the most cost-effective means of reducing GHG emissions. By achieving the same levels of heating, cooling, and other critical functions with reduced use of electricity and natural gas, Duquesne can not only lower its carbon footprint but also save substantial amounts on its utility bills. As previously mentioned, Facilities Management has upgraded energy efficiency through a variety of projects, such as improved insulation and reflective roof coatings. Other potential targets for energy efficiency include purchasing efficient ENERGY STAR® appliances for laboratory and classroom use, as well as encouraging increased awareness about energy conservation among students.

Renewable Energy on Campus

Another potential source for emissions reduction is investment in on-campus renewable energy resources. Research and feasibility studies on a photovoltaic solar panel installation on the campus bluff have been completed. Other options, such as solar hot water heaters, remain open for exploration.

Transportation and Commuting

A large portion of the University's carbon footprint, 10.4 percent, results from student, faculty, and staff commuting. The potential for reductions in this area is great, whether from improved fuel efficiency of vehicles, increased carpooling, or alternative transportation methods, such as bicycling or taking a bus to campus. Many of these options are currently available. Zipcars, a car-sharing program, has several cars located on campus, available for student and faculty rental. A rideshare board is accessible through BlackBoard, which allows users to communicate about possible carpooling. Port Authority Transit buses stop regularly on Forbes and Fifth Avenues and the Boulevard of the Allies on The Bluff. Raising awareness of these options could serve to encourage and increase their use.

In a section of the student commuter survey created by the 2008 team, students had the opportunity to make suggestions for reducing the number of commuters who drive alone. Suggestions ranged from scheduling classes in blocks to decreasing the number of trips to campus per week to having a shuttle available for neighborhoods that house high concentrations of students, such as the Southside. Such a shuttle would not only decrease the campus's footprint but also alleviate on campus parking problems. Students also voiced support for reduced or free bus passes, allowing them to use Port Authority Transit buses with greater ease.

University-sponsored air travel by faculty and students accounts for roughly 10 percent of Duquesne's total GHG emissions. Collaborating with distant research partners and attending conferences are integral components of the university's academic mission, while sports travel represents an important student life activity. Hence, reduction in air travel is not a tenable means for addressing GHG emissions.

Carbon Offsets

As an alternative, Duquesne could purchase carbon offsets for university-sponsored flights. Carbon offsets for air travel typically involve an extra fee that goes towards tree-planting or other forms of carbon sequestration. Prices are calibrated so that the purchaser can pay for an amount of sequestration equivalent to the emissions from the flight. One carbon offset vendor, TerraPass, sells its offsets at a rate of $13.09 per metric tonne of CO_2. With 4,100 tonnes of emissions stemming from university-sponsored air travel, Duquesne would have to purchase $53,669 in offsets to achieve carbon neutrality in this area. Further examination of this option would include comparison of offset vendors and prices, and research into the effectiveness of offset purchases versus alternative options in reducing GHG impacts.

Conclusion

While these suggestions are not the only way for Duquesne to reduce its footprint, they are some of the most effective options available. Through a combination of increased energy efficiency, alternative energy strategies, changes in campus commuting, and increased offset purchasing, Duquesne could realistically see a decrease in its footprint at the time of the next CACP survey.

Duquesne has achieved much in the area of energy conservation and there exist opportunities to achieve even more. However, it is important to remember that as this process continues to move forward, so do the challenges associated with it. With each successive survey, it is likely that the reduction in the campus footprint will become smaller. As with any continuous improvement effort, incremental gains become more difficult to achieve. Duquesne's progress may slow as the emissions reductions resulting from major projects have already been achieved. Further reduction may require expensive, large-scale changes that do not directly correlate to major reductions. While this potential slowing in reductions seems daunting, we should not be deterred. As shown by the projects already implemented and their corresponding emissions reductions, Duquesne is dedicated to reducing its carbon footprint. This campus-wide commitment can serve to overcome the challenges to further progress.

Appendix A: Glossary of Terms

For the purpose of this paper:

carbon dioxide equivalent (CO_2e)

A metric measure used to compare the emissions from various greenhouse gases based upon their relative greenhouse effect, or global warming potential (GWP). The carbon dioxide equivalent for a gas is derived by multiplying the tonnes of gas by the associated GWP.

carbon footprint

The total amount of greenhouse gases produced to directly and indirectly support human activities, usually expressed in tonnes of carbon dioxide equivalents (CO_2e).

cogeneration

Production of two useful forms of energy such as high-temperature heat and electricity from the same process. For example, while boiling water to generate electricity, the leftover steam can be used for industrial processes or space heating.

greenhouse gas

Any gas that absorbs infrared radiation in the atmosphere. Greenhouse gases include water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), halogenated fluorocarbons (HCFCs), ozone (O_3), perfluorinated carbons (PFCs), and hydrofluorocarbons (HFCs).

LEED certification

A voluntary national standard developed by the U.S. Green Building Council for rating sustainable, high performance buildings.

photovoltaic cell

A semiconductor device that converts the energy of sunlight into electric energy.

renewable energy certificates (RECs)

Tradable certificates issued to provide proof that 1 MWh of renewable energy was produced. They represent the environmental and other non-power attributes of renewable energy production and can be sold separately from the actual energy produced. For more information see the EPA's Green Power Partnership document on RECs at **http://www.epa.gov/grnpower/documents/gpp_basics-recs.pdf.**

Appendix B: Transportation Survey

Please complete the following survey for a chance to win one of three $50 gift cards (Starbucks, The Red Ring, Campus Barnes and Noble).

Did you know that in 2008, Duquesne University became the first institution of higher learning in western PA to complete a greenhouse gas inventory?

The University's Center for Environmental Research and Education (CERE) is now compiling data for the second biennial inventory. CERE would like your involvement to improve the data used in the inventory.

The results of the first inventory show that transportation is a significant part of Duquesne's carbon footprint.

Your input in this survey will help us accurately determine our transportation habits. For questions or more information please contact Rebecca Day (dayr@duq.edu), Jake Levine (levinej1@duq.edu), or Gretchen Sterba (sterbag@duq.edu).

Thank you for your help.

1. *Do you live on campus?* ❍ yes *(skip to question 6)* ❍ no

   If no: ______________________________

   ____

2. *What is your local zip code?* ______________________________

3. *On average, how many round trips to and from campus do you make a week?* ______________

4. *What is your mode of transportation to and from campus?*

   ❍ car-alone ❍ carpool ❍ bus ❍ bike/walk ❍ the T

   ❍ other *(please specify)* ______________________________

5. If a mode of transportation such as a student only shuttle were available, would you utilize it?

   ❍ yes ❍ no

   If yes, what features would you like to see: ______________________________

   ____

6. *How many times a year do you travel home?* ______________________________

7. *What is your home zip code?* ______________________________

8. *How do you get home?*

   ❍ car-alone ❍ carpool ❍ bus ❍ plane ❍ train

   ❍ other *(please specify)* ______________________________

   ____

9. *If Duquesne offered a student only bus to major metropolitan areas for holiday breaks, would you utilize them?*

❍ yes ❍ no

10. *Are you aware of Duquesne's rideshare board on BlackBoard?*

❍ yes ❍ no

11. *Do you have any further suggestions regarding student transportation at Duquesne University? (please specify below)*

Appendix C: Inventory Data

Emissions By Source, 2000-2009 (Tonnes CO_2e)

*No data was collected for 2007

FISCAL YEAR		2000	2001	2002	2003	2004	2005	2006	2007*	2008
Scope 1	Cogen Electricity	11,928	11,485	11,604	12,305	12,381	11,599	11,310		12,452
	Cogen Steam	11,023	10683	10,526	9,756	9,501	10,664	10,238		11,983
	Other Stationary	4,378	4,604	3,765	3,953	3,603	5,228	5,077		4,705
	Fleet						190	190		196
	Refrigerants									220
	Agriculture						0.1	1.2		2.4
Scope 2	Purchased Electricity	7,703	8,790	8,090	7,579	7,805	10,176	10,512		11,880
	Purchased Steam									
Scope 3	Faculty/Staff Commuting					1,793	1,839	1,829		1,885
	Student Commuting					3,100	3,183	3,266		2,365
	Directly Financed Air Travel					1,607	1,607	1,607		4,099
	Other Directly Financed Travel									24
	Study Abroad Air Travel							1,509		1,057
	Solid Waste			215	226	221	207	221		211
	Wastewater									47
	Paper									136
	Scope 2 Transmission Losses	761.9	869	800	750	772	1,006	1,040		1,175
Offsets	Additional									
	Non-Additional									-11880
Net Emissions		35,794	36,431	35,000	34,569	40,783	45,699	46,800		40,557

GREENHOUSE GAS EMISSIONS BY SOURCE, 2000-2008 (KG)

CARBON DIOXIDE EMISSIONS

	Cogeneration	Auxiliary Boilers	University Fleet (Gasoline)	University Fleet (Diesel)	Purchased Electricity	Faculty/Staff Commute	Student Commute	Air Travel –Staff	Air Travel –Students	Other Student Travel	Study Abroad Travel	Electricity Transmission Losses
2000	22,884,544	4,365,063			7,679,642							759,525
2001	22,103,970	4,590,752			8,762,790							866,650
2002	22,066,302	3,754,257			8,064,352							797,573
2003	21,997,245	3,942,014			7,555,478							747,245
2004	21,818,983	3,592,455	87,066	99,870	7,780,581	1,751,512	3,030,854	1,601,206				769,508
2005	22,298,638	5,213,217	87,066	99,870	10,145,310	1,795,726	3,111,220	1,601,206				1,003,382
2006	21,486,358	5,062,124	87,066	99,870	10,480,839	1,786,185	3,192,447	1,601,206			1,503,064	1,036,567
2007	0	0	0	0	0	0	0	0			0	0
2008	24,364,606	4,691,093	190,832	0	11,832,745	1,840,983	2,311,753	3,582,232	502,290	12,369	1,053,196	1,170,272

METHANE EMISSIONS

	Cogeneration	Auxiliary Boilers	University Fleet (Gasoline)	University Fleet (Diesel)	Purchased Electricity	Faculty/Staff Commute	Student Commute	Air Travel –Staff	Air Travel –Students	Other Student Travel	Study Abroad Travel	Landfill Waste w/ CH4 recovery	Electricity Transmission Losses
2000	2,288	436			41								4
2001	2,210	459			46								5
2002	2,206	375			43							9,366	4
2003	2,199	394			40							9,820	4
2004	2,182	359	17	6	41	333	552	16				9,617	4
2005	2,230	521	17	6	54	341	567	16				8,989	5
2006	2,148	506	17	6	55	339	582	16			15	9,624	5
2007	0	0	0	0	0	0	0	0			0	0	0
2008	2,436	469	38	0	81	350	423	35	5	3	10	9,177	8

NITROGEN DIOXIDE EMISSIONS

	Cogeneration	Auxiliary Boilers	University Fleet (Gasoline)	University Fleet (Diesel)	Synthetic Fertilizer	Purchased Electricity	Faculty/Staff Commute	Student Commute	Air Travel –Staff	Air Travel –Students	Other Student Travel	Study Abroad Travel	Wastewater Treatment-Aerobic	Electricity Transmission Losses
2000	46	9				77								8
2001	44	9				88								9
2002	44	8				81								8
2003	44	8				76								7
2004	44	7	6	3		78	115	192	18					8
2005	45	10	6	3	0	102	118	198	18					10
2006	43	10	6	3	4	105	118	203	18			17		10
2007	0	0	0	0	0	0	0	0	0			0		0
2008	49	9	13	0	8	154	121	147	41	6	1	12	158	15

Appendix D: Bibliography

"ACUPCC Reports - 2008 GHG Report for Temple University." ACUPCC Reports - Reporting Institutions. 10 June 2009. <http://acupcc.aashe.org/ghg-report.php?id=541>.

"ACUPCC Reports - 2008 GHG Report for Xavier University." ACUPCC Reports - Reporting Institutions. 10 June 2009. <http://acupcc.aashe.org/ghg-report.php?id=524>.

"BTS - First-Quarter 2008 System Airline Financial Data: Network Passenger Airlines Report Second Consecutive Quarterly Loss Margin." RITA - Bureau of Transportation Statistics (BTS). 10 June 2009. .<http://www.bts.gov/press_releases/2008/bts030_08/html/bts030_08.html>.

"Buy TerraPass carbon offsets - TerraPass: fight global warming, reduce your carbon footprint." TerraPass. 10 June 2009. <http://www.terrapass.com/carbon-footprint-calculator/action>.

"Campus Greenhouse Gas Emissions Inventories - Association for the Advancement of Sustainability in Higher Education (AASHE)." AASHE: Association for the Advancement of Sustainability in Higher Education - Empowering Higher Education to Lead the Sustainability Transformation. 10 June 2009. <http://www.aashe.org/resources/ghg_inventories.php>.

"Clean Air - Cool Planet : Climate Change Solutions for the Northeast." Clean Air-Cool Planet. 10 June 2009. <http://www.cleanair-coolplanet.org/toolkit/inv-calculator.php>.

"Green Power Partnership: Renewable Energy Certificates." U. S. Environmental Protection Agency. 10 June 2009. <www.epa.gov/grnpower/documents/gpp_basics-recs.pdf >.

Pachauri, R.K., and A. Reisinger. "IPCC Fourth Assessment Report: Working Group I Report 'The Physical Science Basis'." IPCC - Intergovernmental Panel on Climate Change. 10 June 2009. <http://www.ipcc.ch/ipccreports/ar4-syr.htm>.

"Sustainability-The George Washington University." The George Washington University. 10 June 2009. <http://www.sustainability.gwu.edu/ghg_inventory.html>.

"U.S. Gasoline Historical Prices." Energy Information Administration. 10 June 2009. <www.eia.doe.gov/oil_gas/petroleum/data_publications/wrgp/mogas_history.html >.

"UMass Amherst CO2 Emissions." University of Massachusetts Amherst. 10 June 2009. <http://www.umass.edu/epac/carbon.htm>.

"WebFlyer - MileMarker." WebFlyer - The Frequent Flyer Authority. 10 June 2009. <http://webflyer.com/travel/milemarker/>.