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May 2012

Thursday / April 19 / 2012 12:52 PM

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**DUQUESNE
UNIVERSITY**



ONE STEP AT A TIME: Duquesne University's Third Biennial Greenhouse Gas Emissions Inventory

This report was produced by faculty and students of the Center for Environmental Research and Education (CERE), Duquesne University. CERE's mission is to provide "...multidisciplinary education that prepares students for careers in current and emerging areas of environmental science..." For more information, please visit <http://www.science.duq.edu/esm/cereabt2.html>

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I. Acknowledgements

The authors of this report would like to recognize those who compiled the 2006 report, *One Step at a Time: Reducing Duquesne's Carbon Footprint*, and the 2008 report, *One Step at a Time: Duquesne University's Second Biennial Greenhouse Gas Emissions Inventory*, which served as a basis for our project. They are Lindsay Baxter, Rebecca Day, David Deal, Kelsey Johnson, Jacob Levine, Gretchen Sterba, and Dr. Stanley Kabala.

We would like to thank all whose support and assistance was invaluable to this project:

- ❖ Angela Chirumbolo, *Office of Institutional Research and Planning*
- ❖ Kelly Dougherty, *Office of International Programs*
- ❖ Mary Eberle, *Department of Physical Therapy*
- ❖ Sharon Evans, *Palumbo-Donahue School of Business*
- ❖ Paul Hightower, *Department of Athletics*
- ❖ Rev. Sean Hogan, *Office of Student Life*
- ❖ Dr. Michael Irwin, *Department of Sociology*
- ❖ Coleman Griffin, *Facilities Management Department*
- ❖ Lauren Laudato, *Computing and Technology Services*
- ❖ Kelly D. Marton
- ❖ Lisa Mikolajek, *Center for Environmental Research and Education*
- ❖ Ruth Newberry, *Computing and Technology Services*
- ❖ Linda Roos, *Purchasing Department*
- ❖ Dr. David Seybert, *Bayer School of Natural and Environmental Sciences*
- ❖ Bonnie K. Watson, *AVP Planning, Budget & IR*
- ❖ Bill Zilcosky, *Facilities Management Department*
- ❖ Guy Zupo, *Facilities Management Department*

II. Executive Summary

This report, assembled by graduate students Josh Snedden, Talisha Cox, and Patrick McKee 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 fiscal year 2010. This begins July 1, 2009 and ends June 1, 2010. As the third such biennial report CERE has issued, it compares the findings with those derived from 2008 and 2006 data and assesses trends in Duquesne's GHG emissions. Additionally, the report discusses options for further reducing Duquesne's carbon footprint in the future.

Duquesne University's total GHG emissions for fiscal year 2010 were 50,463.3 metric tonnes of eCO₂, before offsets, and 42,044.4 metric tonnes of eCO₂ after factoring in offsets. This amounts to 4.05 metric tonnes eCO₂ per student. This is a respectable total in comparison to other universities that have compiled GHG emissions reports, but was a 0.05 metric tonne increase per student from 2008. Figure 1 displays the percentages of various sources of GHG emissions on campus:

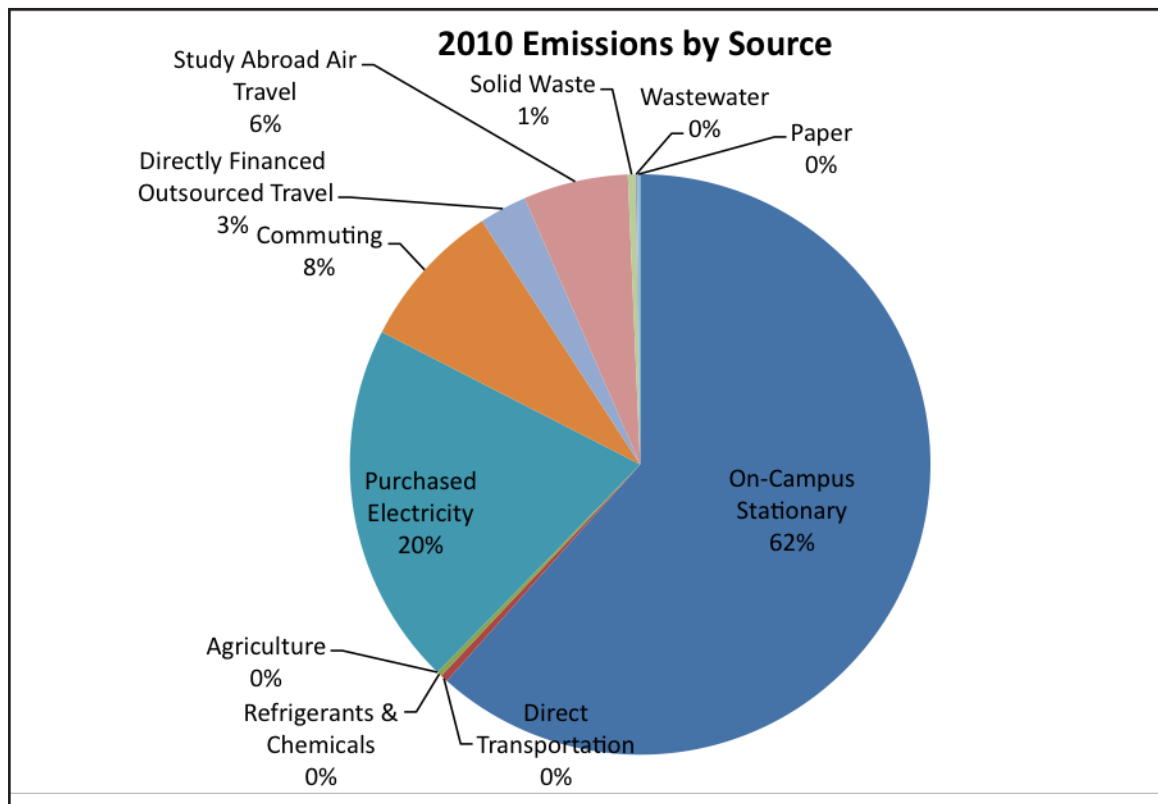


Figure 1: Emissions by Source

The largest contributor to Duquesne's GHG emissions is on-campus stationary sources. This includes the natural gas cogeneration plant and auxiliary boilers. Purchased electricity accounts for 20% of overall emissions and commuting makes up 8%. Air travel contributed to 6% of total emissions, while outsourced travel made up 3%. All other sources had minimal effect on the overall totals.

In comparison to recent years, Duquesne did not purchase 100% Renewable Energy Certificates (RECs) to meet its electricity needs beyond that supplied by the cogeneration plant. This increased the university's carbon footprint. In 2008 Duquesne purchased 100% RECs, offsetting what would have been a higher carbon footprint; however, in 2010 Duquesne purchased only 84% RECs, reducing the impact of offsets in 2010. Figure 1 depicts the overall sources for GHG emissions on the campus. While agriculture, refrigerants & chemicals, and direct transportation are all depicted as 0% of the whole, they do exist at miniscule levels that are negligible when compared to the rest of the pie.

Overall, the period 2006-2008 showed a small reduction in emissions, while the period 2008-2010 saw a slight rise, as depicted below:

- **2006:** 46,800.0 tonnes eCO₂ = 4.60 tonnes eCO₂ per student
- **2008:** 40,557.0 tonnes eCO₂ = 4.00 tonnes eCO₂ per student
- **2010:** 42,044.4 tonnes eCO₂ = 4.05 tonnes eCO₂ per student

While Duquesne has taken substantial steps to keep its carbon footprint low, it is possible that emissions can be reduced further. Enhanced energy efficiency, additional purchase of renewable energy, changes in commuting habits, and the purchase of additional offsets are several methods that could be expanded upon to reduce Duquesne's GHG emissions. The campus is continuing to make strides in energy efficiency by purchasing efficient ENERGY STAR® appliances, installing motion activated lights in rooms around the campus, as well as educating students about the importance of energy conservation. The potential for harboring renewable energy on campus (i.e. solar panels) is also a very real possibility; green roofs and green buildings are also attainable options to reduce our carbon footprint.

III. Background

In 2007, graduate students at the Center for Environmental Research and Education (CERE) conducted Duquesne University's first inventory of campus GHG emissions, using data from calendar year 2006. That inventory was the first ever produced by a university in Western Pennsylvania – and the 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 biennially in order to supply current information and uncover long-term trends. CERE graduate students completed the second inventory in June 2009 using data from fiscal year 2008 and the third inventory in November 2011 using data from fiscal year 2010. Data from these three inventories were compared to determine the status of Duquesne's efforts to reduce its emissions.

IV. Methods

CERE's GHG inventories used emissions calculating software developed by Clean Air-Cool Planet (CACP), a nonprofit organization specializing in community and campus sustainability.¹ This particular software uses specialized formulas and algorithms to convert readily available institutional data into emissions figures.

The CACP calculator categorizes data in three broad functional fields.

- ❖ **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).

Scope 1 Sources

An annual energy center summary provided by Duquesne University's Facilities Management Department provided the bulk of the data for the inventory, including the purchased natural gas (in MMBTU) used by the cogen plant. Based on the U.S. EPA's *Climate Leaders Greenhouse Gas Inventory Protocol Core Module Guidance: "Indirect Emissions from the Purchase or Sale of Electricity and Steam"* the efficiency values entered into the software for electricity generation and steam for heating and cooling generation were 35% and 80% respectively.² Facilities Management also provided figures on MMBTU of natural gas consumed in campus auxiliary heating boilers. Facilities Management also assembled information on use of refrigerants and chemicals. The refrigerant most frequently used on campus was R-22. Information on the Global Warming Potential of R-22 was derived from the U.S. EPA article, *Transitioning to Low GWP Refrigerants in Unitary Air Conditioning*.³

The CACP calculator calls for gasoline usage in gallons for all university fleet vehicles; however, this information was unavailable. In 2008, the CERE team used information on average gasoline prices by month and region presented by the U.S. Department of Energy in order to calculate an average gasoline price for their inventory. This task was performed by dividing the total gasoline expenditure by this amount to arrive at the quantity of gasoline used. Since, the dollar amount of gasoline purchased was not available for the 2010 inventory; the CERE team made the assumption that fuel usage was similar from 2008 to 2010.

¹ Clean Air-Cool Planet. "Campus Calculator." *Conduct an Emissions Inventory*. 10 January 2011. Accessed: <<http://www.cleanair-coolplanet.org/toolkit/inv-calculator.php>>.

² U.S. Environmental Protection Agency's Climate Leaders Greenhouse Gas Inventory Protocol Core Module Guidance: "Indirect Emissions from the Purchase or Sale of Electricity and Steam." Accessed: 29 March 2011< http://www.epa.gov/climateleaders/documents/resources/indirect_electricity_guidance.pdf>.

³ U.S. Environmental Protection Agency. "Transitioning to Low GWP Refrigerants in Unitary Air Conditioning." September 2011. Accessed: <<http://nepis.epa.gov/Adobe/PDF/P1008VHZ.PDF>>.

Scope 2 Sources

Scope 2 requires data on purchased electricity, steam, and hot water. Duquesne produces all steam and water on campus. Facilities Management supplied data on the energy budget including kilowatt hours (kWh) purchased for the 2010 fiscal year. The impact was limited because Duquesne purchased 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

Acquiring data for Scope 3 required more effort than the other two scopes due to the calculations of operating emissions. Duquesne's operating emissions are currently comprised of solid waste, wastewater, paper purchasing, study abroad travel, directly financed outsourced travel, commuting, and offsets.

Waste and Wastewater

Information on wastewater disposal and solid waste was provided by Facilities Management and serves in a report detailing the total amount of water coming to the campus from the Pittsburgh Water Authority and a document detailing evaporation credits given to the University from the Allegheny County Sanitary Authority (Alcosan). By subtracting the evaporation credits from the total water purchased the team was able to extrapolate the number of gallons of wastewater discharged to the municipal sewer system and treated by Alcosan. Wastewater contributions to the GHG emissions resulted 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 in Monroeville, PA, which receives Duquesne's waste, recovers the 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. The paper was 15% recycled.

Study Abroad

Information from the Study Abroad Office provided information on student 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.⁴

Directly Financed Outsourced Travel

Duquesne's directly financed outsourced travel includes sports team travel (See below).

Sports Travel

The Athletic Department provided information on sports travel, 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 calculations.

⁴ WebFlyer. "Mile Maker: Mileage Calculator." Accessed: 25 January 2011. <http://www.webflyer.com/travel/mileage_calculator/>.

Faculty and Staff Commuting

To determine faculty and staff commuting habits for the past two inventories, the CERE team acquired from the Office of Institutional Research the number of employees for the fiscal year 2008. The team assumed that the 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.

For the 2010 inventory, the CERE team decided to use a transportation survey to statistically extrapolate the faculty and staff commuting habits (See Appendix B).

Student Commuting

The 2008 team determined that census data does not accurately represent student commuting habits, so they developed a survey to gauge commuting and transportation habits. The 2010 team followed this lead and developed two new and improved surveys. One survey was designed specifically for campus residents, while the other was designed for commuters. The survey was designed and distributed by means 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). 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 & 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 1,800 responses. For commuters, the survey asked questions detailing the amount of miles traveled per day and how many trips per week the student took. These numbers were entered into the software. Also, the data on the resident student's zip codes and number of trips taken home per year, provided by the students, was used to determine the average number of miles traveled per year per by campus residents. In addition, the percent 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 RECs was entered in this section as Green Power Certificates in kWh. Duquesne purchased its RECs from Direct Energy Business, LLC who is a licensed credit-trading enterprise. These credits serve to offset the use of coal-fired power by supporting renewable energy source, specifically wind-power, contributions to the electrical grid.

Methods Challenges

The ease and precision of producing Duquesne's carbon footprint is essential. A few challenges confronted the 2010 team during the collection of data for the inventory. The team was unable to obtain information regarding faculty business travel. In regard to information on fuel for the fleet vehicles on campus, the team was again unable to obtain this information so we extrapolated from the 2008 inventory. Another challenge was converting the given data from the facility management into required software units. For example, steam was given in Mlbs, whereas the software required MMBTU; this conversion was calculated using the provided document.⁵ A more accurate university recordkeeping system for faculty air miles traveled would be beneficial in further refining Duquesne's greenhouse gas inventory.

⁵ "Convert Fuel Use to Source Energy Worksheet." Accessed: 30 March 2011. <<http://eber.ed.ornl.gov/benchmark/converta.pdf>>.

V. Results

Duquesne University's total greenhouse gas emissions for fiscal year 2010 were 50,463.3 metric tonnes of eCO₂, before offsets and 42,044.4 metric tonnes of eCO₂ after factoring in the university's offsets. Sixty three percent of the university's total GHG emissions, totaling 30,822.4 metric tonnes of eCO₂, came from Scope 1 sources. Twenty percent of the university's emissions, totaling 10,015.4 metric tonnes of eCO₂, came from Scope 2 sources. Seventeen percent of the university's emissions, totaling 9,625.5 metric tonnes of eCO₂, came from Scope 3 sources. The purchased offsets provide the university with a fifteen percent reduction, totaling 8,418.9 metric tonnes of eCO₂, in emissions. These figures are presented in Figure 2.

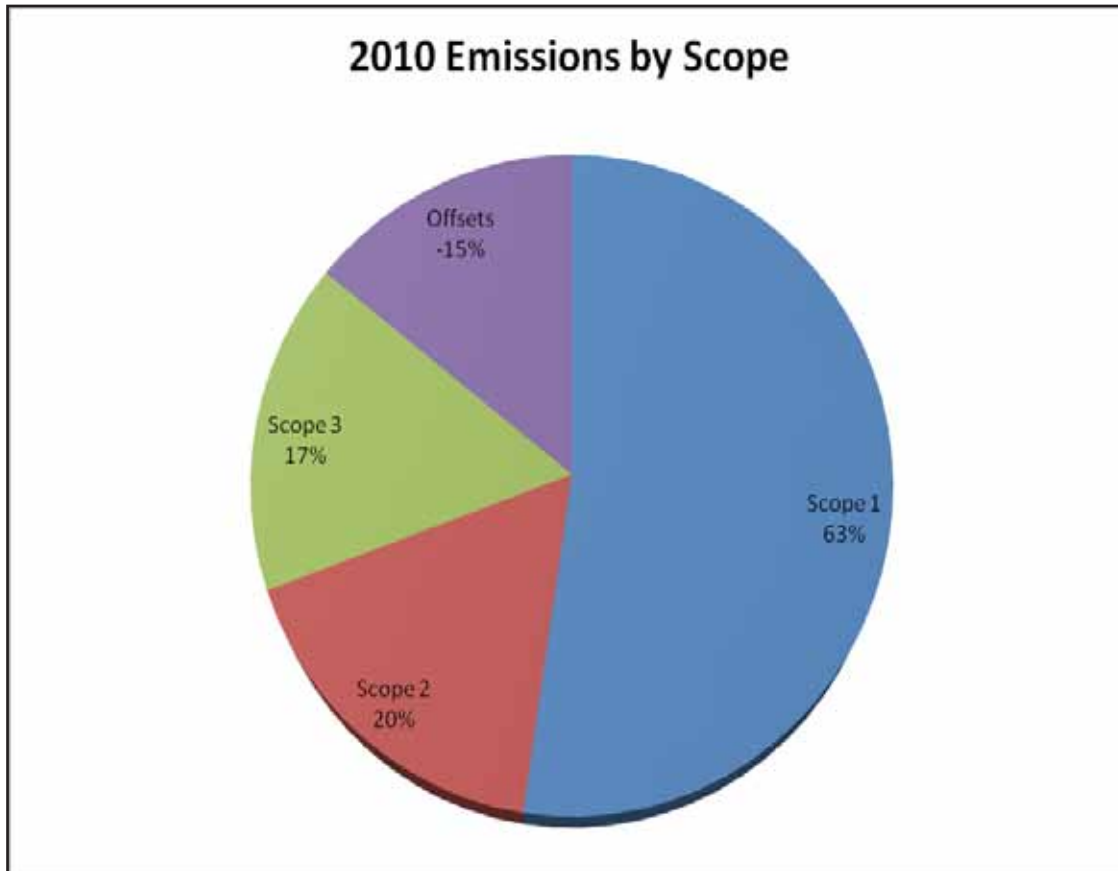


Figure 2 : GHG emissions by Scope

Electricity and Heating

Electricity and heating contributed 78% of Duquesne's total GHG emissions for 2010. The majority of the emissions, which were 59% of the total footprint, 29,496.4 metric tonnes eCO₂, originated from the cogeneration plant. The cogeneration plant consumed 557,386 MMBTU of natural gas to produce 33,260,220 kWh of electricity and 256,078 MMBTU of steam in fiscal year 2010.

In addition to the consumption of natural gas by the cogeneration plant, the university purchased 14,299,369 kWh of electricity in 2010. This purchased electricity did contribute greatly to the campus greenhouse gas emissions because 84% of electricity was purchased using RECs. This increase of emissions resulting from purchased electricity is a direct result to the university's decrease in REC purchases from 100% to 84% from 2008 to 2010. The breakdown of these numbers is detailed in Figure 3.

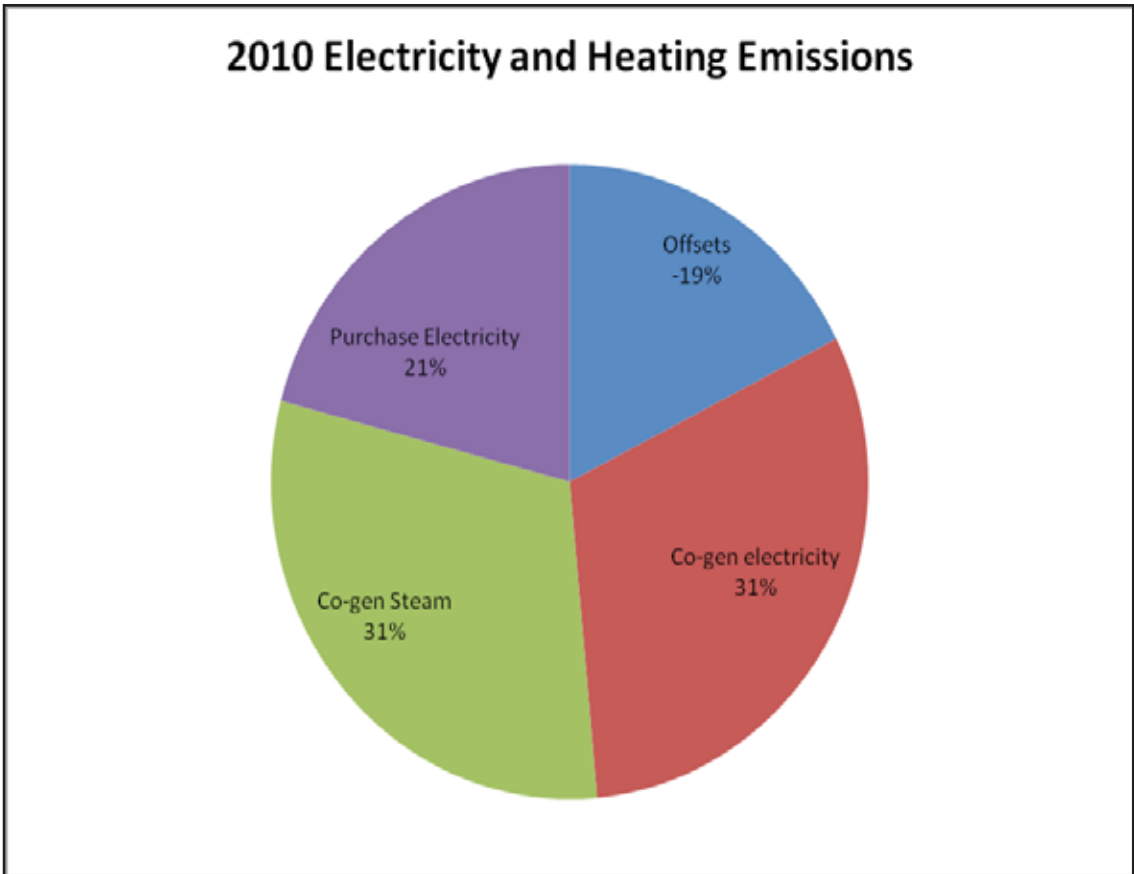


Figure 3: Electricity and Heating Emissions

Transportation

The University’s transportation emissions included commuting, directly financed outsourced travel, and study abroad air travel. These sources accounted for 16.4%, or 8,300.6 metric tonnes eCO₂, of the University’s carbon footprint. The majority of transportation emissions were attributable to student commuting which make up 6 % of Duquesne’s total emissions. Study abroad air travel contributed 5.7 % of the university’s emissions. Directly financed travel and faculty/staff commuting contributed 4.8 % of Duquesne’s total carbon footprint. These figures are presented in Figure 4.

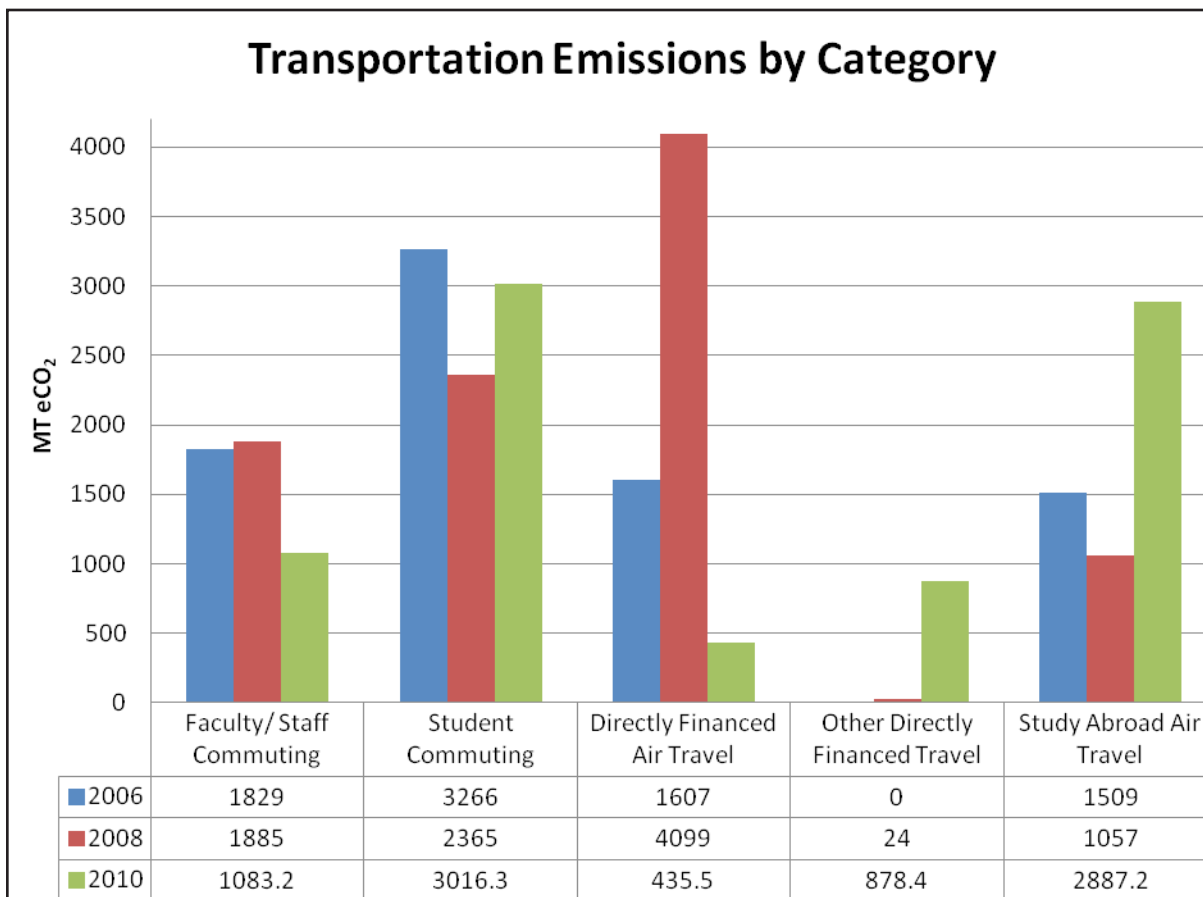


Figure 4 : Transportation Emissions by Category

Miscellaneous

Minor GHG sources collectively contributed 1.4 %, or 679.3 metric tonnes eCO₂, to Duquesne’s total emissions. These included the following:

- Refrigerant use, 139.6 metric tonnes eCO₂
- Fleet vehicle use, 204.7 metric tonnes eCO₂.
- Fertilizer application, 0.7 metric tonnes eCO₂.
- Solid waste landfilling, 206 metric tonnes eCO₂
- Wastewater disposal, 45.4 metric tonnes eCO₂
- Paper usage, 82.9 metric tonnes eCO₂

VI. Comparison with 2006, 2008 and 2010 Adjustments to the 2006, 2008, and 2010 Results

The 2006 report writers presented their results in short tons (2,000 pounds), however the 2008 team decided to change the units to metric tonnes (1,000 kg, or 2,205 pounds); since, other published GHG inventories presented their results using metric tonnes. The 2006 inventory used the Mid-Atlantic Area Council (MAAC), which encompasses New Jersey, half of Maryland, and most of Pennsylvania. However, Pittsburgh, is located in the East Central Area Reliability (ECAR) Region, comprised of Ohio, Kentucky, West Virginia, Indiana, and Southwestern Pennsylvania, hence the adjustment. This correction increased the emissions from purchased electricity by 4,500 metric tonnes eCO₂.

Another adjustment made was the analysis of the percentage of drivers. The 2008 report entered a percentage of the total campus population, which was corrected from the 2006 report (this report used a percentage of the drivers found on campus and the campus' population).

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 metric tonne increase in emissions. This brings the 2006 total to 46,670 metric tonnes eCO₂. Updating to a new version of the CACP calculator, with its adjusted formulas, accounts for the remaining 130 metric tonne increase to 46,800 metric tonnes (51,574 short tons).

The 2010 team left all of the adjustments made by the 2008 team to the 2006 inventory. The 2008 usage of the electricity-grid region and data units (metric tonnes eCO₂) were maintained in the 2010 report. The 2010 team also adjusted the Transportation Survey so that a more accurate assessment of faculty and staff commuting habits could be made.

Comparison of 2006, 2008, and 2010

By comparing the results of 2006 (adjusted), 2008, and 2010 greenhouse gas campus emissions inventories, Duquesne can now effectively assess its carbon dioxide emissions trends and patterns. Duquesne saw an emissions decrease of 6,200 metric tonnes from 2006 to 2008, and a 1,487.4 metric tonne increase from 2008 to 2010. Figure 5 illustrates this pattern.

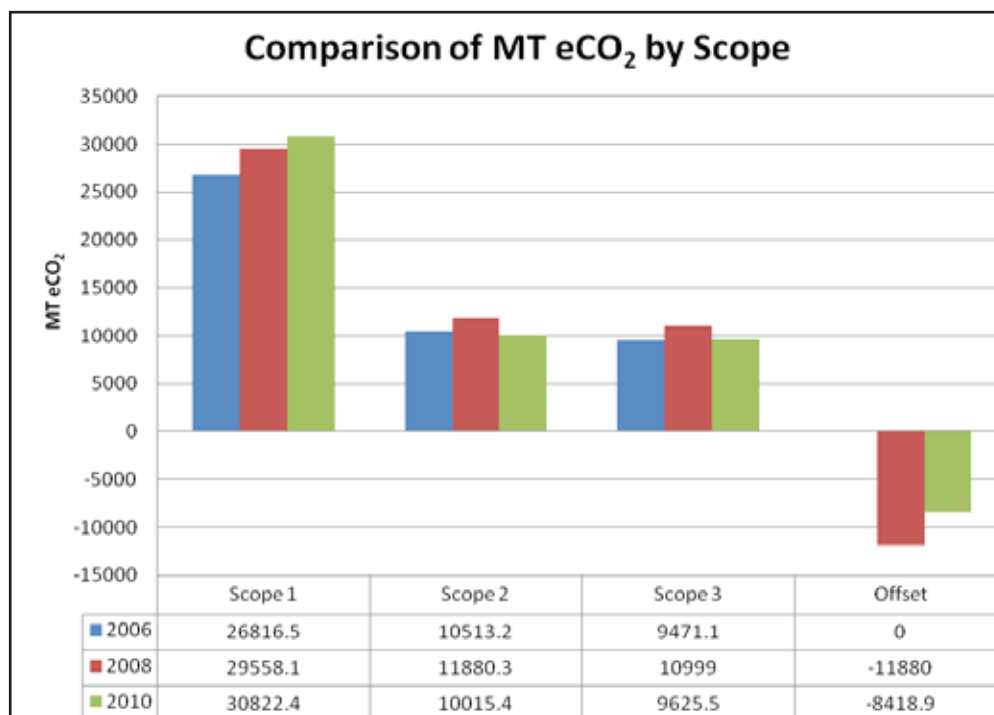


Figure 5: Annual Comparison of Emissions by Scope

Changes Reflecting Variation in Data

The increase in emissions between 2008 and 2010 is attributed to an increase in the square footage of campus buildings, the fact that many of these buildings have older, less efficient mechanical (HVAC) systems, and the fact that Duquesne did not purchase RECs for 100% of its grid purchased electricity as had been done in 2008. Electricity purchased in 2006 was 11,393,404 kWh, in 2008 16,761,071 kWh, and in 2010 14,299,369 kWh.

Changes Reflecting Inventory Methodology

The 2010 team was unable to obtain information regarding university-sponsored air expenses/travel, hence did not include a figure for university-sponsored air expenses/travel. This required a change in the assumptions made by previous teams. The 2010 team conducted transportation surveys as performed by previous teams, with the addition of a faculty/staff survey. The team used the resulting data to determine commuter inputs for the calculator. As a result, GHG emissions attributable to student commuters decreased from 3,265 metric tonnes eCO₂ in 2006 to 2,365 metric tonnes eCO₂ in 2008, but increased in 2010 to 3,016.3 metric tonnes eCO₂. The increase from 2008 to 2010 can be attributed to a more accurate measurement of individual commuting distance and the inclusion of resident student’s yearly commuting habits to their homes. Faculty commuting habits were also determined with a transportation survey for the 2010 report. Methodology did not change for determining study abroad air travel. Figure 6 illustrates how emissions from each travel sector changed between 2006, 2008, and 2010. Note: The estimate of university-sponsored air expenses/travel was obtained by averaging 2006 and 2008 emissions. Those extra emissions, 2,800 metric tonnes eCO₂, were not included in the 2010 report due to uncertainty of mileage conversion factors and calculation methods of the previous teams.

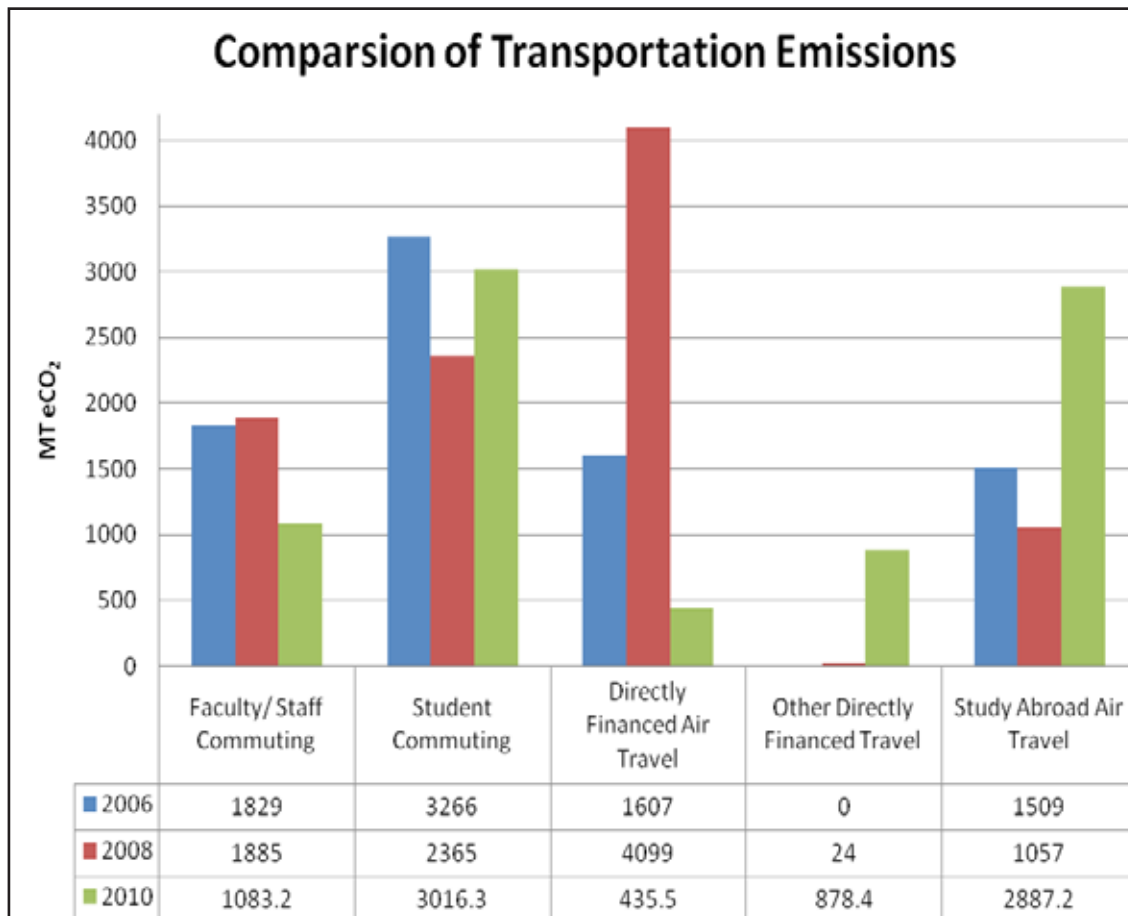


Figure 6: Transportation Emissions by Category

VII. Conclusions

Comparison with Other Universities

Duquesne's total carbon footprint of 4.05 metric tonnes eCO₂ per student compares favorably with those of universities that have published GHG inventories. In order to accurately compare footprints, it is important to be aware that a range of factors affect an institution's footprint. The comparison below was done by exploring the total carbon footprint of the schools located in the *Atlantic 10 Conference* schools with similar attributes such as climate zone, student population, urban or rural setting, physical size, and building use.

Comparison To Atlantic 10 Schools				
School	Year Completed	Total Footprint	Per Student Footprint	Location
Duquesne University	2010	42,044.4	4.05	Pittsburgh, PA
Temple University	2009	233,138	8.33	Philadelphia, PA
Xavier University	2007	37,000	5.6	Cincinnati, OH
University of Massachusetts-Amherst	2007	142,237	5.4	Amherst, MA
George Washington University	2008	128,301	6.3	Washington D.C.

Existing Environmental Assets

Physical Facilities

Duquesne's purchase of Renewable Energy Certificates as well as its cogeneration and ice-cooling plants put it in a position to maintain its low per student carbon footprint. The cogeneration plant plays a dual role in reducing emissions. It supplies approximately 70% of campus electricity by way of a highly efficient generation process that utilizes natural gas. Natural gas is a cleaner burning fuel than the bituminous coal that is the most prevalent fuel for power generation in Western Pennsylvania's electrical grid. The cogeneration plant also supplies the campus with 100% of its chilled water and steam, therefore eliminating the need to purchase any from outside sources. If Duquesne purchased an equivalent amount of electricity and steam from outside sources, its carbon footprint would climb to 87,975.4 metric tonnes eCO₂. Figure 7 illustrates this hypothetical increase in emissions.

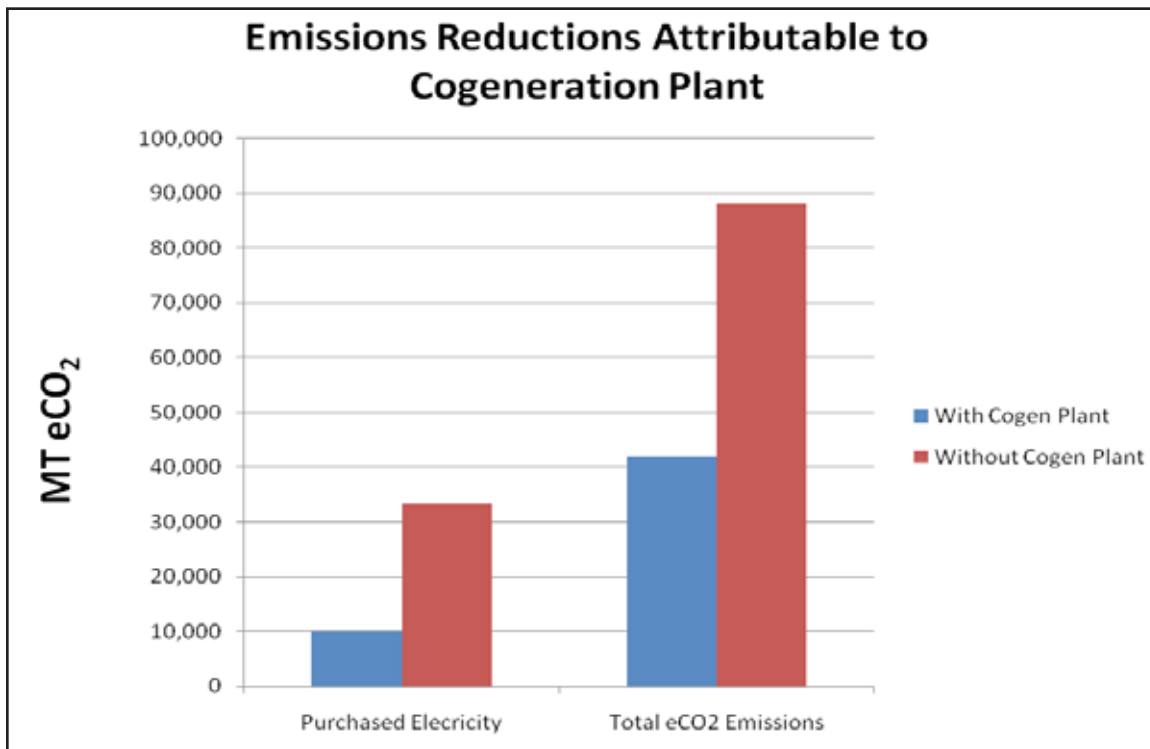


Figure 7: Emissions Reductions Attributable to Cogeneration Plant

Duquesne’s ice making plant is an important emissions-reducing asset not captured directly by the CACP calculator. During off-peak electricity consumption hours, the plant makes ice that is used the following day in cooling systems on campus. Using the cogeneration this way limits the need for electricity purchases from the regional grid for cooling campus facilities. Duquesne’s Facilities Management department has worked diligently to improve campus energy efficiency by implementing lighting and control upgrades in several buildings, roofing projects that include better insulation and reflective coatings to reduce heating and cooling needs, and pursuing design for the Power Center that led to its achieving LEED Silver certification.

Institutional Approaches

Duquesne has engaged in a number of initiatives that support the goal of GHG emissions reduction. It is a member of the Association for Advancement of Sustainability in Higher Education (AASHE), a national coalition of universities and colleges dedicated to environmental responsibility. Duquesne has also recently adopted a policy of following LEED standards in all new construction and renovation on campus. Duquesne has been a partner with Carnegie Mellon University and the University of Pittsburgh in the Heinz-Endowments-funded program *One Step at a Time: Reducing the Campus Carbon Footprint (OSAT)*, in which the three schools shared information and efforts 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 the HECC sub-committee on greenhouse gas inventories. Duquesne has two Sustainability Committees, one responsible for facilities and operations concerns, and one, multidisciplinary in composition, that advances integration of the concepts of sustainability into the university curriculum. CERE, as part of 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 in the public and private sectors. The Business School’s Sustainability MBA program trains future business leaders to integrate responsible climate approaches into sound economic management. This 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 graduate 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 made substantial efforts to keep its carbon footprint as small as possible, but there is potential to reduce emissions further. This section aims to promote discussion and increase awareness of potential reduction strategies. It does not aim to analyze, create, or implement university policy. The areas this team sees for further reductions encompass the following.

Energy Efficiency

The most sensible and cost-effective means of reducing GHG emissions would be to use more energy efficient systems at the university. By lowering its energy usage but still maintaining all of its necessary functions, Duquesne can significantly affect its carbon footprint. The Facilities Management Department has continued to upgrade the energy efficiency of systems through a variety of projects, such as improved insulation and reflective roof coatings on campus buildings. Other potential targets for energy efficiency include purchasing efficient ENERGY STAR® appliances for laboratory and classroom use, installing motion activated lights in rooms around the university (the power center bathrooms currently possess this technology), as well as educating students about the importance of energy conservation in order to engage them in energy-saving behavior.

Renewable Energy on Campus

Renewable energy resources could also lower GHG emissions for Duquesne. Research and feasibility studies on a photovoltaic solar panel installation on campus have been completed. Solar hot water heaters, another feasible source of renewable energy, would be a good choice for on campus use. A renewed push for funded research in this area would be beneficial.

Transportation and Commuting

A significant portion of Duquesne's carbon footprint, 9.75%, results from the commuting habits of its students, faculty, and staff. Reductions in this area could make for a significant decrease in Duquesne's carbon footprint. It is important to note that many emissions-reducing options are already available to students. These include using vehicles with higher fuel efficiency, increased carpooling, or alternative transportation methods, such as bicycling or taking a bus to campus, and using the already highly successful off-campus residential shuttle bus. *Blackboard* allows users to communicate about possible carpooling with their own vehicles and a car-sharing program, called Zipcars. Port Authority Transit buses stop regularly on Forbes and Fifth Avenues and the Boulevard of the Allies on The Bluff. The university is now beginning to send a shuttle bus to the Southside, due to student call for cheaper forms of transportation to and from Duquesne, as heard in the last inventory. This program will hopefully expand and should serve to decrease the university's carbon footprint further by the time of the next inventory.

In a section of the transportation survey conducted by the 2010 team, students were asked if making their student ID a free Port Authority Transit bus pass would make them more likely to use public transit. The response made clear that this would increase their use of public transit. Other suggestions from the survey ranged from scheduling classes in blocks to reducing the number of trips to campus per week by increasing class length. Students in the 2008 transportation survey also voiced support for reduced-price bus passes that would allow them to use Port Authority Transit buses with greater ease.

University-sponsored air travel by faculty and students accounts for a significant portion of Duquesne's total GHG emissions, but collaborating with distant research partners and attending conferences are integral components of the university's academic function. Also, sports travel represents an important element of student life. Hence, reduction in air travel is not a tenable means for addressing GHG emissions. That said, a more accurate system to track faculty and staff air travel is needed to gain an accurate figure for these emissions. The 2010 team suggests including faculty air travel in the transportation survey for the 2012 inventory

Carbon Offsets

One option for addressing levels of GHG emissions resulting from university travel is to purchase carbon offsets for university-sponsored flights. Carbon offsets for air travel typically involve an extra fee that goes towards some form of carbon sequestration. Prices are calibrated so that the purchaser can pay for an amount of sequestration equivalent to the emissions from the flight. TerraPass, an offsets vendor, sells its offsets at a rate of \$11.90 per ton of CO₂.⁶ Further examination of this option could include comparison of offset vendors and prices, and research into the effectiveness of offset purchases versus alternative options in reducing GHG impacts.

Green Building

Green building practices can enable Duquesne to reduce its total carbon footprint. In particular, the installation of green roofs would provide Duquesne with several benefits. While green roofs tend to cost more during installation, they have a life span 2-3 times greater than a traditional roof, and can significantly reduce heating and cooling costs by up to 25 % through increased insulation. Green roofs can garner up to 15 LEED credits. Also, they can contribute to carbon sequestration capability by growing biomass and storing soil carbon. Finally, green roofs can reduce storm water runoff from a building by 65 - 94 % thus reducing urban flooding, which has become a serious concern in the Pittsburgh area.⁸

Conclusion

There are many ways for Duquesne to reduce its carbon footprint. Those the 2010 team considers the most effective are:

- Increased energy efficiency
- Increased use of alternative energy
- Continued changes in campus commuting habits
- Purchasing 100% of its electricity using RECs
- An increase in offset purchasing, to decrease its emissions back to 2008 levels.
- Changes in residential energy use

Duquesne has strived to achieve energy conservation on campus, 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. As with any continuous improvement effort, emissions reduction becomes progressively more difficult to achieve. Further emissions reductions may require expensive, large-scale changes. While the prospect of relatively more difficult reductions might appear daunting, the University should not be deterred from its emissions reductions goals.

⁶ "Buy TerraPass carbon offsets - TerraPass: fight global warming, reduce your carbon footprint." TerraPass. 4 April 2011. <<http://www.terrapass.com/carbon-footprint-calculator/action>>.

⁸ "Green Roofs." Green Building Alliance, Pittsburgh PA. Accessed 19 September 2011.

Appendix A: Glossary of Terms

For the purposes of this paper:

carbon dioxide equivalent (eCO₂)

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 (CO₂e).

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 (CO₂), methane (CH₄), nitrous oxide (N₂O), halogenated fluorocarbons (HCFCs), ozone (O₃), perfluorinated carbons (PFCs), and hydrofluorocarbons (HFCs).

LEED certification

A voluntary national standard developed by the U.S. Green Building Council for rating environmentally 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 Surveys

Did you know that in 2008, Duquesne University became the first institution of higher learning in western PA to complete a greenhouse gas inventory? And that we've completed a second one since? The results of the first inventory show that transportation is a significant part of Duquesne's carbon footprint. Duquesne's Center for Environmental Research and Education (CERE) is now compiling data for the third biennial inventory. CERE would like your involvement to improve the data used in the inventory. Your input in this survey will help us accurately determine and quantify our transportation habits.

If you complete CERE's transportation survey in Black Board, you will be entered in a drawing for a chance to win one of three \$50 gift cards (Starbucks, The Red Ring, Campus Barnes and Noble). For questions or more information please contact Josh Snedden sneddenj@dug.edu or Talisha Cox coxt@dug.edu.

Student Commuters:

1. What is your local zip code?
2. What is your local county?
 - a. Allegheny
 - b. Armstrong
 - c. Beaver
 - d. Butler
 - e. Fayette
 - f. Greene
 - g. Indiana
 - h. Lawrence
 - i. Washington
 - j. Westmoreland
 - k. Other (please specify in the next question)
3. If you answered "other" to the previous answer, please type your region or county. If your region was listed in the previous question, just write "N/A"
4. On average, how many round trips to and from campus do you make per week?
 - a. 1-3
 - b. 4-6
 - c. 7-9
 - d. <9
5. How many miles do you travel per day (round trip)?
 - a. 0-10
 - b. 10-20
 - c. 20-30
 - d. >30
6. What is your **primary** mode of transportation to and from campus?
 - a. Car- alone
 - b. Carpool
 - c. Bus
 - d. Bike/Walk
 - e. The T
 - f. Other (please specify in the next question)
7. If you answered "other" to the previous question, please type in your response. If you did not answer "other" please just type "none".
8. What other modes of transportation do you use to go to and from campus? (check all that apply)
 - a. Car- alone
 - b. Carpool
 - c. Bus

- d. Bike/Walk
 - e. The T
 - f. Other (please specify in the next question)
9. If you answered "other" to the previous question, please type in your response. If you did not answer "other" please just type "none".
10. If you do not use a mode of public transit, would you use one if your DUQ ID could be used as a pass?
- a. Yes
 - b. No
11. How many times a week would you use your DUQ ID if it were a pass for public transportation?
- a. < 3
 - b. 3
 - c. 4
 - d. > 5
 - e. I would not use my DUQ ID as a pass for public transportation.
12. Will the reduction in bus routes (effective March 27, 2011) require you to use a car for transportation?
- a. Yes
 - b. No
13. If a mode of transportation such as a student-only shuttle were available, would you use it?
If yes, what features would you like to see?
If no, why not?
14. Do you have any further suggestions regarding student transportation at Duquesne University?

Student Residents:

Question 1: What is your home zip code?

Question2: In what region do you live?

- a. Local. One of the following counties: Allegheny, Armstrong, Beaver, Butler, Fayette, Greene, Indiana, Lawrence, Washington, or Westmoreland
- b. Western Pennsylvania: West of Harrisburg
- c. Eastern Pennsylvania: East of Harrisburg
- d. Northeast: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, Vermont
- e. Southeast: Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, West Virginia
- f. Midwest: Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin
- g. Southwest: Arizona, New Mexico, Oklahoma, Texas
- h. West: Alaska, California, Colorado, Hawaii, Idaho, Montana, Nevada, Oregon, Utah, Washington, Wyoming

Question 3: Question How many times per year do you travel home?

- a. 0-4
- b. 5-8
- c. 9-12
- d. >12

Question 4: How do you get home?

- a. Car- alone
- b. Carpool
- c. Bus
- d. Plane
- e. Train
- f. Other (please specify in the next question)

Question 5: If you answered “other” to the previous question, please type in your response. If you did not answer “other” please just type “none”.

Question 6: If Duquesne offered student-only buses to major metropolitan areas for holiday breaks, would you utilize them?

- a. Yes
- b. No

Question 7: Are you aware of Duquesne’s rideshare board on Blackboard?

- a. Yes
- b. No

Question 8: If you do not use a mode of public transit, would you if your DUQ ID could be used as a pass?

- a. Yes
- b. No

Question 9: How many times a week would you use your DUQ ID if it were a pass for public transportation?

- a. <3
- b. 3
- c. 4
- d. >5
- e. I would not use my DUQ ID as a pass for public transportation.

Question 10: Do you have any further suggestions regarding student transportation at Duquesne University?

University Faculty and Staff:

1. What is your primary role at the University?
 - a. Faculty - Part-time/Full-time
 - b. Staff - Part-time/Full-time
 - c. Administrator
 - d. Other
2. What is your local zip code?
3. What is your local county?
 - a. Allegheny
 - b. Armstrong
 - c. Beaver
 - d. Butler
 - e. Fayette
 - f. Greene
 - g. Indiana
 - h. Lawrence
 - i. Washington
 - j. Westmoreland
 - k. Other (please specify in the next question)
4. If you answered “other” to the previous answer, please type your region or county. If your region was listed in the previous question, just write “N/A”
5. On average, how many round trips to and from campus do you make per week?
 - a. 1-3
 - b. 4-6
 - c. 7-9
 - d. <9

6. How many miles do you travel per day (round trip)?
 - a. 0-10
 - b. 10-20
 - c. 20-30
 - d. >30
7. What is your **primary** mode of transportation to and from campus?
 - a. Car- alone
 - b. Carpool
 - c. Bus
 - d. Bike/Walk
 - e. The T
 - f. Other (please specify in the next question)
8. If you answered "other" to the previous question, please type in your response. If you did not answer "other" please just type "none".
9. What other modes of transportation do you use to go to and from campus? (check all that apply)
 - a. Car- alone
 - b. Carpool
 - c. Bus
 - d. Bike/Walk
 - e. The T
 - f. Other (please specify in the next question)
10. If you answered "other" to the previous question, please type in your response. If you did not answer "other" please just type "none".
11. If you do not use a mode of public transit, would you use one if your DUQ ID could be used as a pass?
 - a. Yes
 - b. No
12. How many times a week would you use your DUQ ID if it were a pass for public transportation?
 - a. < 3
 - b. 3
 - c. 4
 - d. > 5
 - e. I would not use my DUQ ID as a pass for public transportation.
13. Will the reduction in bus routes (effective March 27, 2011) require you to use a car for transportation?
 - a. Yes
 - b. No
14. Do you have any further suggestions regarding student transportation at Duquesne University?

Appendix C: Inventory Data

Emissions by Source, 2008-2010 (metric tonnes eCO₂)

Fiscal Year		2006	2008	2010
Scope 1	Cogen Electricity	11,310	12,452	14,843.3
	Cogen Steam	10,238	11,983	14,653.1
	Other Stationary	5,077	4,705	981.1
	Fleet	190	196	
	Refrigerants		220	139.6
	Agriculture	1.2	2.4	0.7
Scope 2	Purchased Electricity	10,512	11,880	10,015.4
	Purchased Steam			
Scope 3	Faculty/ Staff Commuting	1,829	1,885	1,083.2
	Student Commuting	3,266	2,365	3,016.3
	Directly Financed Air Travel	1,607	4,099	435.5
	Other Directly Financed Travel		24	878.4
	Study Abroad Air Travel	1,509	1,057	2,887.2
	Solid Waste	221	211	206
	Wastewater		47	45.4
	Paper Purchasing		136	82.9
Offsets	Additional			
	Non-Additional		-11880	-8,418.9
Net Emissions		46,800	40,557	42,044.4

Fiscal Year 2000 2001 2002 2003 2004 2005 2006 2007* 2008

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