One Step At A Time:

Duquesne University's Fourth Biennial Greenhouse Gas Emissions Inventory

DUQUESNE UNIVERSITY

Center for Environmental Research and Education

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I. Acknowledgements

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II. Executive Summary

This report, assembled by graduate students Philip McConnell, Judy Baker, Megan Morrissey, 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 2012. This period begins July 1, 2011 and ends June 30, 2012. As the fourth such biennial report CERE has issued, it compares the findings with those derived from 2010, 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 2012 were 47,501.95 metric tonnes of eCO_2 before offsets and 39,203.31 metric tonnes of eCO_2 after factoring in offsets. This represents an overall decrease from the previous inventory, and a decrease in the per-student footprint to 3.92 metric tonnes of eCO_2. This total is respectable in comparison to other universities that have completed GHG emissions reports. Figure 1 displays the percentages of various sources of GHG emissions on campus:

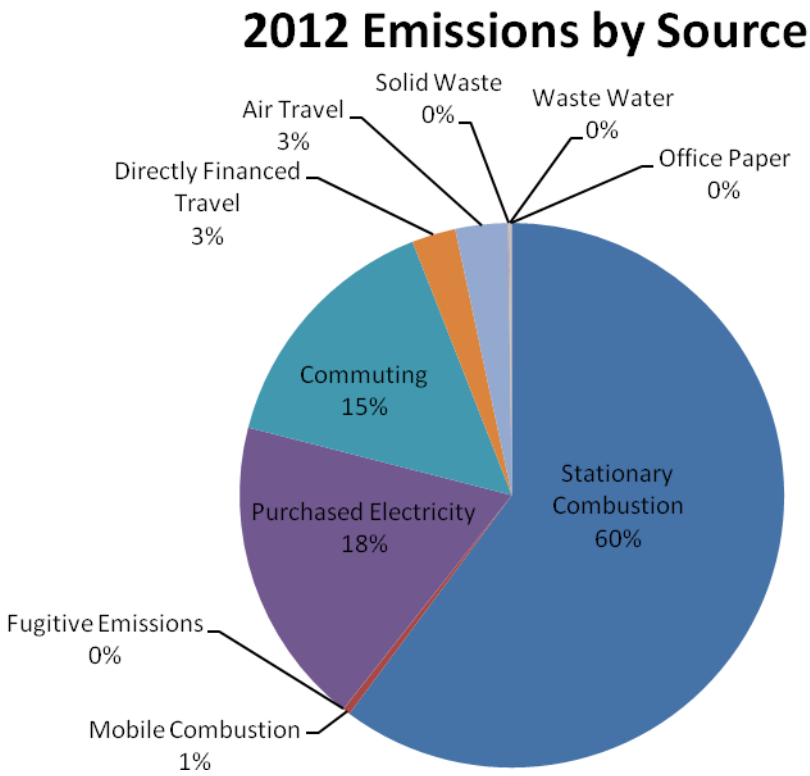

Figure 1: 2012 Emissions by Source

The largest contributor to Duquesne's GHG emissions was on-campus stationary combustion, which contributed 60% of the campus emissions. This includes the natural gas cogeneration plant and auxiliary boilers. Other significant contributers to the overall emissions were: purchased electricity at 18%, commuting at 15%, air travel at 3%, and directly financed travel at 3%. All other sources had minimal effect on the overall totals. While solid waste, waste water, office paper, and fugitive emissions are all depicted as 0% of the whole, they do exist at miniscule levels that are negligable when compared to the rest of the emissions.

This year, Duquesne purchased 12,020 MWh of Green-e Certified Renewable Energy Credits (RECs), which covered 95% of the purchased electricity for the campus. While the cogeneration plant covers much of the electricity needs for the campus, additional power is needed beyond what the cogeneration plant supplies. RECs are purchased to

offset the carbon footprint of this additional electricity. In comparison, 2010 RECs covered 84% of purchased electricity. This results in a reduction in the total carbon footprint due to a higher percentage in offsets compared to total purchased electricity. While the amount of RECs purchased in the 2012 fiscal year was the same as 2010, a decreased electricity usage resulted in a higher percentage of offset by RECs.

Overall, the period 2010-2012 showed a reduction in the total carbon footprint of the campus. There have been slight variations from year to year since the first GHG inventory was conducted, as depicted below:

- **2006**: 46,800.0 tonnes eCO_2 = 4.60 tonnes eCO_2 per student
- **2008**: 40,557.0 tonnes eCO_2 = 4.00 tonnes eCO_2 per student
- **2010**: 42,044.4 tonnes eCO_2 = 4.05 tonnes eCO_2 per student
- **2012**: 39,203.3 tonnes eCO_2 = 3.92 tonnes eCO_2 per student

While Duquesne has taken substantial steps to keep its carbon footprint low, it is possible that emissions can be reduced further. Several methods that could be expanded upon to reduce Duquesne's GHG emissions are enhanced energy efficiency, additional purchase of renewable energy, changes in commuting habits. The campus continues to make strides in energy efficiency by purchasing efficient ENERGY STAR® appliances, constructing LEED-certified buildings, 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, the third inventory in November 2011 using data from fiscal year 2010, and the fourth inventory in December 2014 using data from fiscal year 2012. Data from these four 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, 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 cogeneration 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 generation for heating/cooling were 35% and 80%, respectively.[2] Facilities Management also provided figures on MMBTU of natural gas consumed in campus auxiliary heating boilers.

The CACP calculator calls for gasoline usage in gallons for all university fleet vehicles; the 2012 team assumed that there was no significant change in gasoline usage for these vehicles from the previous inventory, and, therefore, used the same number from 2010. This was determined by dividing the total gasoline expenditure by the average gasoline price for the region, presented by U.S. Department of Energy.

Scope 2 Sources

Scope 2 requires data on purchased electricity, steam, and hot water. Duquesne produces all steam and hot water on campus. Facilities Management supplied data on the energy budget, including kilowatt-hours (kWh) purchased for the 2012 fiscal year. The impact was limited because Duquesne purchased Renewable Energy Certificates (REC)

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[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 Stream." Accessed: 29 March 2011< http://www.epa.gov/climateleaders/documents/resources/indirect_electricity_guidance.pdf>.

from Direct Energy Business, LLC. These RECs were Green-e Certified PA Wind. 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. Duquesne sends its waste to The Waste Management Inc. landfill in Monroeville, PA, which 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 20% 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**.[3]

Directly Financed Outsourced Travel

Duquesne's directly financed outsourced travel includes sports team travel and air travel by faculty and staff. 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.[3]

Because the University records air travel by faculty and staff in dollars rather than mileage, the mileage in this report was calculated using a set price of $0.1959 per mile. This number was obtained from the Standard Industry Fare Level (SIFL) for January 2012 from the Department of Transportation website.[4] The average miles flown by faculty were estimated to fall under the 501-1500mi category. Although the Association for the Advancement for Sustainability in Higher Education recommends that the number provided by the Air Transport Association of America be used, this number is recommended to be increased by 20-50% to account for taxes.[5] The SIFL number already includes the taxes, so the 2012 team concluded that this number is a more accurate representation of the true cost per mile.

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[3] WebFlyer. "Mile Maker: Mileage Calculator." <http://www.webflyer.com/travel/mileage_calculator/>.

[4] Department of Transportation. "S.I.F.L. Fare Formulas; May 15, 1979 to Present." <http://www.dot.gov/sites/dot.gov/files/docs/SIFL_ATTACH_B_0314.pdf>.

[5] Association for the Advancement for Sustainability in Higher Education. "Guidance on Scope 3 Emissions, pt 2: Air Travel." <http://www.aashe.org/blog/guidance-scope-3-emissions-pt-2-air-travel>.

Faculty and Staff Commuting

To determine faculty and staff commuting habits for the 2010 inventory, a transportation survey was conducted (See Appendix B). The 2012 team assumed transportation habits remained the same from the 2010 inventory, and made adjustments for the number of faculty and staff according to the numbers provided by the Office of Institutional Research for fiscal year 2012. Prior to 2010, data was derived from the *2006 University Fact Book* and the U.S. Census Bureau, which reported that the distance of an average one-way trip was 7.4 miles, which was further supported by our 2010 survey. Therefore, this number was used again for the 2012 inventory.

Student Commuting

Previous teams determined that census data does not accurately represent student commuting habits, so a student transportation survey was conducted in 2010 to better reflect distances traveled and modes of transportation. 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 and the Sociology Department. The survey was available for three weeks on *Blackboard*, during which time it drew more than 1,800 responses. The survey asked questions detailing the amount of miles traveled per day, mode of transportation, and number of trips per week (See Appendix B). For the 2012 inventory, the CERE team used this survey data in combination with commuter numbers provided by the Office of Institutional Research. The data was then entered into the CACP 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, a licensed credit-trading enterprise. These credits serve to offset the use of coal-fired power by supporting renewable energy sources, specifically wind-power.

Methods Challenges

The ease and precision of measuring Duquesne's carbon footprint is essential. A few challenges confronted the 2012 team during the collection of data for the inventory. One such problem is that records for air travel by faculty are kept in monetary values rather than in mileage. To convert these totals into mileage, the team used the Standard Industry Fare Level from the Department of Transportation website,[6] which may result in inaccuracies in actual mileage flown. A more accurate university recordkeeping system for faculty air miles traveled would be beneficial in further refining Duquesne's greenhouse gas inventory. Moreover, in regards to information on fuel for the fleet vehicles on campus, the team was again unable to obtain this information so we extrapolated from the 2010 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.[7]

Another challenge encountered comes from the continuing changes in the methodology of conducting the inventory, as well as the change of hands from one inventory team to the next. These can be resolved by more accurate record keeping by each team of how numbers were obtained and calculated, and by maintaining a consistent method for data calculation.

[6] Department of Transportation. "Standard Industry Fare Level Formulas; May 15, 1979 to Present." <http://www.dot.gov/sites/dot.gov/files/docs/SIFL_ATTACH_B_0314.pdf>.

[7] "Convert Fuel Use to Source Energy Worksheet." <http://eber.ed.ornl.gov/benchmark/converta.pdf>.

V. Results

Duquesne University's total greenhouse gas emissions for fiscal year 2012 were 47,501.95 metric tonnes of eCO_2 before offsets and 39,203.31 metric tonnes of eCO_2 after factoring in the university's offsets. With a student population (full and part time students) of 10,009, the carbon footprint per student is 3.92 metric tonnes of eCO_2. Sixty-one percent of the university's total GHG emissions, totaling 28,843.51 metric tonnes of eCO_2, came from Scope 1 sources. Eighteen percent of the university's emissions, totaling 8,742.44 metric tonnes of eCO_2, came from Scope 2 sources, and twenty-one percent of the university's emissions, totaling 9,916.00 metric tonnes of eCO_2, came from Scope 3 sources. These figures are presented in Figure 2.

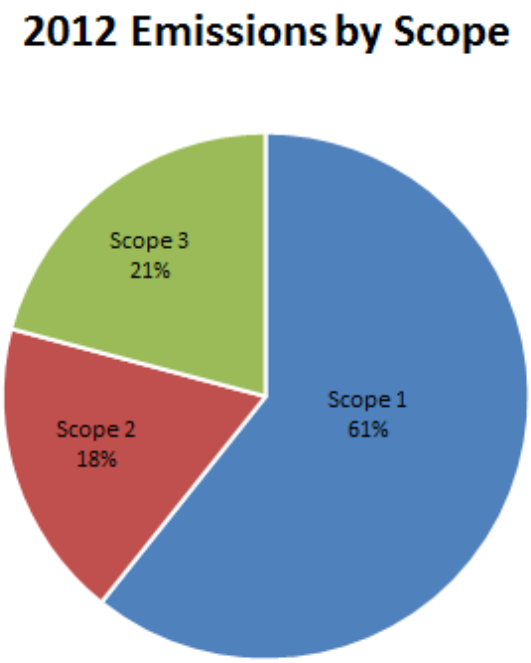


Figure 2 : 2012 GHG emissions by Scope

It should also be noted that the purchased **offsets** provided the university with a seventeen percent reduction, totaling -8,298.64 metric tonnes of eCO_2. This covered a total of ninety-five percent of scope 2 emissions.

Electricity and Heating

Electricity and heating contributed 79% of Duquesne's total GHG emissions for 2012. The majority of the emissions originated from the cogeneration plant. The cogeneration plant consumed 529,848 MMBTU of natural gas to produce 33,625,863 kWh of electricity and 205,804,000,000 lbs of steam in fiscal year 2012. In addition to the consumption of natural gas by the cogeneration plant, the University purchased natural gas for heating and cooking for some buildings, which totaled 23,073 MMBTU. Additional electricity was also purchased to supplement the electricity provided by the cogeneration plant and totaled 12,662,807 kWh. This purchased electricity did not contribute greatly to the campus greenhouse gas emissions however, because 95% (12,020,000 kWh) was purchased using RECs. This data is represented by Figure 3: Scope 1, stationary combustion, includes electricity and heating from the cogeneration plant; *Scope 2, includes purchased electricity overall. It is represented with offsets (light green) and Scope 2 emissions after offsets (darker green).

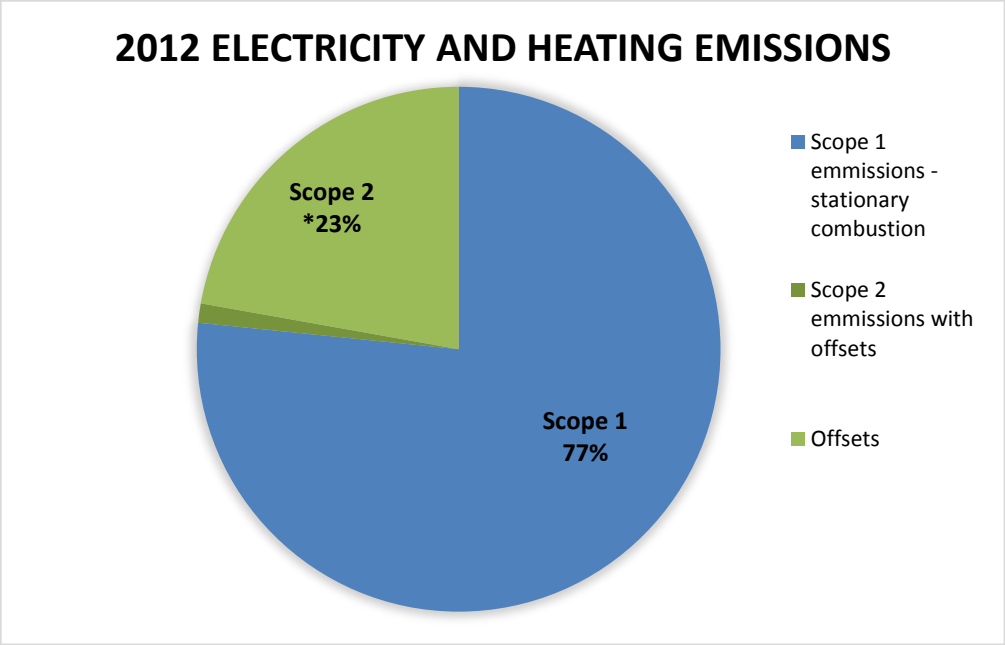


Figure 3: 2012 Electricity and Heating Emissions

Transportation

The University's transportation emissions included commuting, directly financed outsourced travel, and study abroad air travel. These sources accounted for 21%, or 9,882.2 metric tonnes eCO_2, of the University's carbon footprint. The majority of transportation emissions were attributed to commuting, which made up 15% of Duquesne's total emissions. In addition, study abroad air travel contributed 3% of the University's emissions, and directly financed travel contributed another 3%. The total emissions for each category are presented in Figure 4.

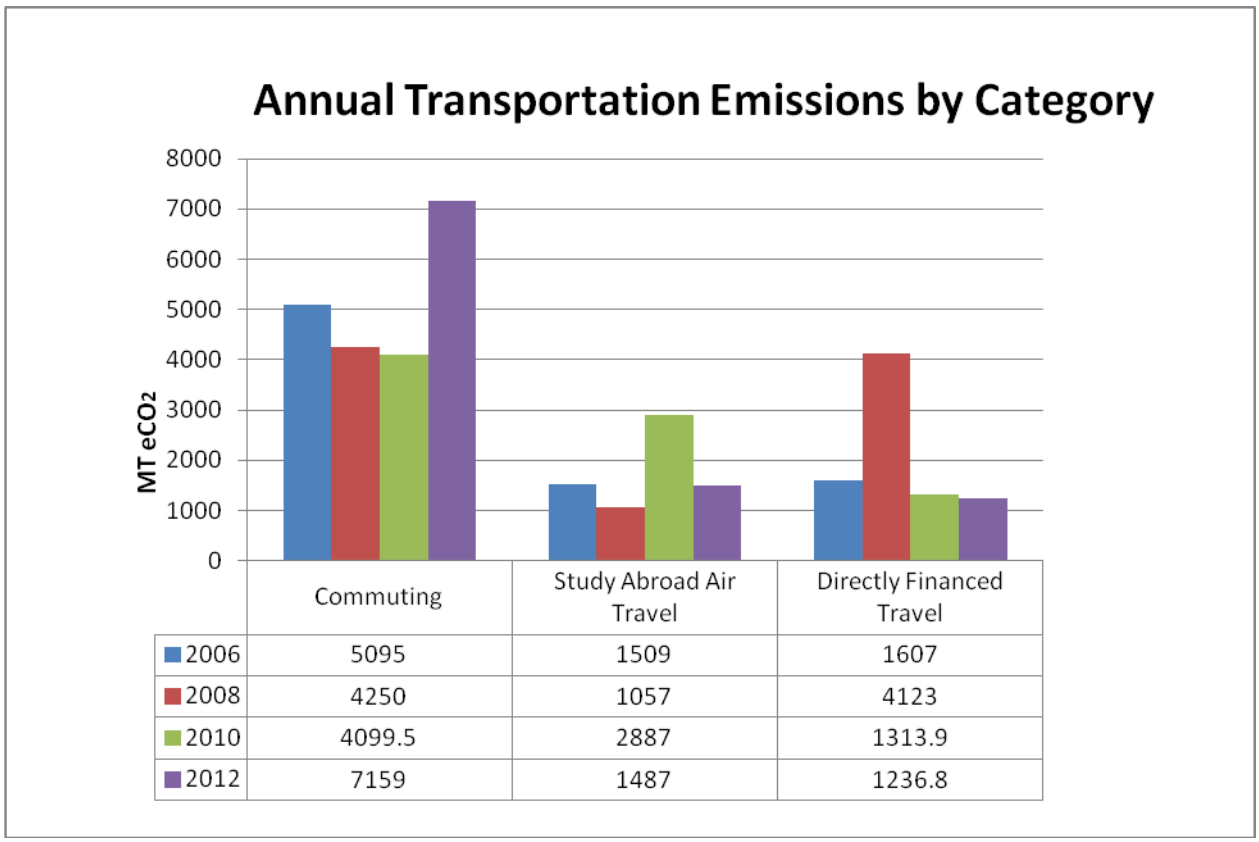


Figure 4 : Annual Transportation Emissions by Category

Miscellaneous

Minor GHG sources collectively contributed 1%, or 244.24 metric tonnes eCO_2, to Duquesne's total emissions. These included the following:

- Fleet vehicle use, 207.65 metric tonnes eCO_2.
- Fertilizer application, 2.82 metric tonnes eCO_2.
- Solid waste landfilling, -36 metric tonnes eCO_2. *
- Wastewater disposal, 30.09 metric tonnes eCO_2
- Paper usage, 39.68 metric tonnes eCO_2

* Solid waste landfilling was reduced to -36 metric tonnes eCO_2 as a result of methane recovery and electricity generation.

VI. Comparison of 2006, 2008, 2010, and 2012 Results

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 2008, all 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, and as such was adjusted for this in 2008 adjustment. This correction increased the emissions from purchased electricity by 4,500 metric tonnes eCO_2.

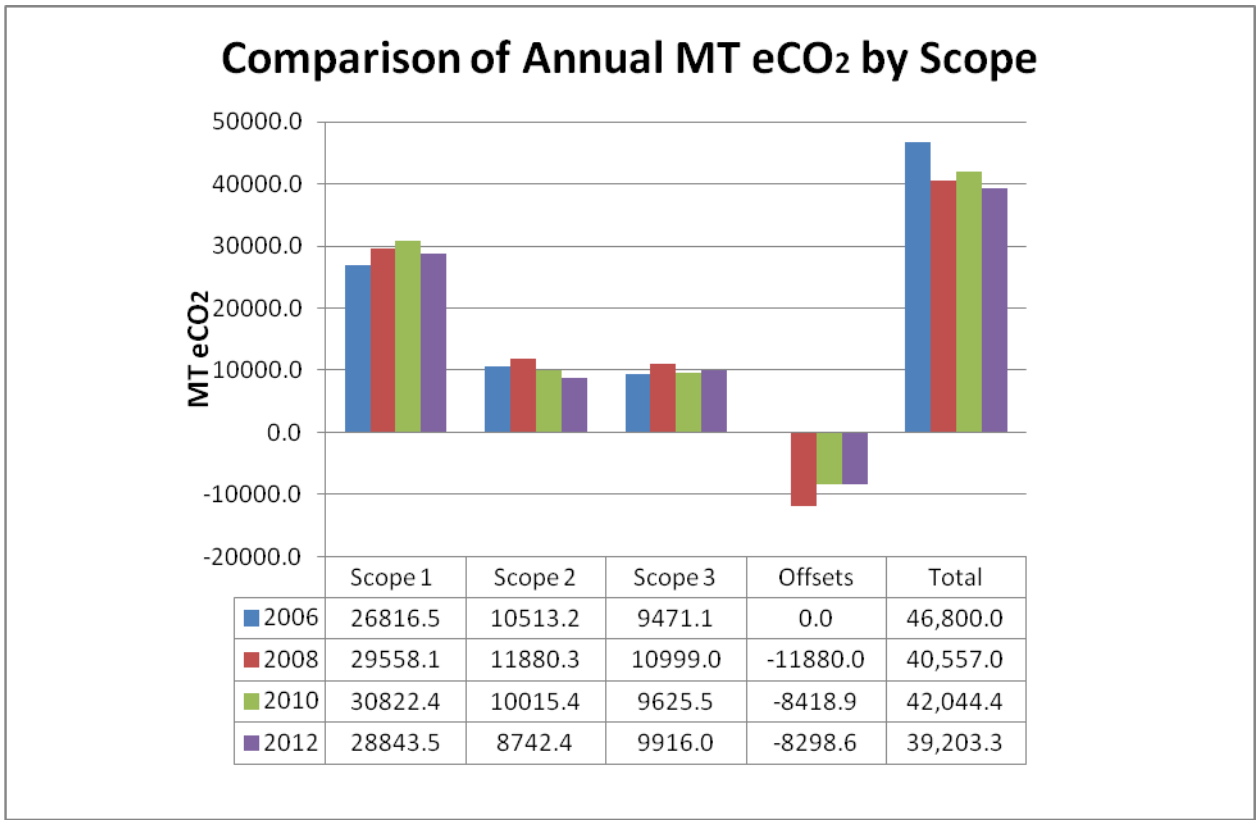
Another adjustment made was the analysis of the percentage of drivers. The 2008 report entered a percentage of the total campus population, which was corrected from the 2006 report (which used a percentage of the drivers found on campus and the campus' population). This correction led to a decrease in emissions.

After correcting the electricity grid region and the commuting data transcription, the emissions increased by 2,750 metric tonnes. This brings the 2006 total to 46,670 metric tonnes eCO_2. Updating to a new version of the CACP calculator, with its adjusted formulas, accounts for the remaining 130 metric tonnes 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 eCO_2) were maintained in the 2010 report. The 2010 team also adjusted the Transportation Survey to more accurately assess faculty and staff commuting habits.

Comparison of 2006, 2008, 2010, and 2012

By comparing the results of 2006, 2008, 2010, and 2012 campus greenhouse gas emissions inventories, Duquesne can now effectively assess its carbon dioxide emissions trends and patterns. Duquesne's total emissions decreased by 6,200 metric tonnes from 2006 to 2008, then increased by 1,487.4 metric tonnes from 2008 to 2010, and decreased 2,841.1 metric tonnes from 2010 to 2012. Figure 5 illustrates this pattern.



	Scope 1	Scope 2	Scope 3	Offsets	Total
2006	26816.5	10513.2	9471.1	0.0	46,800.0
2008	29558.1	11880.3	10999.0	-11880.0	40,557.0
2010	30822.4	10015.4	9625.5	-8418.9	42,044.4
2012	28843.5	8742.4	9916.0	-8298.6	39,203.3

Figure 5: Comparison of Annual Emissions by Scope

Changes Reflecting Variation in Data

The decrease in emissions from 2010 to 2012 is attributable to several things. First, there was a decrease in total electricity usage for the campus. Due to this, the RECs purchased for the 2012 fiscal year covered a higher portion of the purchased electricity (the amount of RECs purchased in fiscal year 2010 and 2012 were the same, but due to the lower total usage in 2012, the RECs covered a higher percentage of the total).

Changes Reflecting Inventory Methodology

In the 2010 inventory, the faculty/staff air travel mileage was not included in Directly Financed Outsourced Travel. However, the 2012 team obtained the monetary value for faculty/staff air travel and was able to calculate the mileage based on the Standard Industry Fare Level for January 2012 (See Section IV: *Directly Financed Outsourced Travel*).

The 2010 team calculated the commuting habits of students using two surveys completed through *Blackboard*. One survey included student commuters, while the other one included campus residents. The residents' survey looked at trips traveled home for breaks. The 2010 team combined this data to arrive at commuting habits for the whole student population. However, the 2012 team concluded that combining these two was not an accurate representation, because mileage could not be determined using the residential portion of the survey. Because of this, the residential portion of the survey was excluded. This exclusion may result in an inaccuracy in the campuses' actual carbon footprint, as those students traveling home for breaks are not included.

The 2012 inventory was completed using a web-based calculator from Clean Air-Cool-Planet (CA-CP). Previous inventories were completed using an older, Excel-based calculator, created by the same organization. While the majority of the calculations proved to be similar, there were instances where differences were noted. For example, the actual RECs purchased in the 2010 fiscal year were the same as in the 2012 fiscal year. However, metric tonnes

eCO_2 calculated for these offsets were slightly different. Also, the new web-based calculator no longer separates some of the emissions by source. For example, "cogeneration electricity and steam output," and "other on-campus stationary combustion" are represented as Stationary Combustion only. Furthermore, "faculty/staff commuting" and "student commuting" are combined into a general Commuting category, and "directly financed air travel" and "other directly financed travel" have been combined into Directly Financed Travel.

VII. Conclusions

Comparison with Other Universities

Duquesne's total carbon footprint of 3.92 metric tonnes eCO_2 per student compares favorably with those universities that have published GHG inventories. In order to accurately compare footprints, it is important to be aware that many 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* with similar attributes such as climate zone, student population, urban or rural setting, physical size, and building use.

Comparison To Atlantic 10 Schools[8]				
School	Year Completed	Total Footprint	Per Student Footprint	Location
Duquesne University	2012	39,203.31	3.92	Pittsburgh, PA
Temple University	2012	189,983	5.9	Philadelphia, PA
Xavier University	2010	32,964	6.3	Cincinnati, OH
University of Massachusetts-Amherst	2012	138,146	4.9	Amherst, MA
George Washington University	2010	124,116	6.1	Washington D.C.

[8] American College & University Presidents' Climate Commitment. "Public GHG Reports." <http://rs.acupcc.org/stats/complete-ghg/>

Existing Environmental Assets

Physical Facilities

Duquesne's purchase of Renewable Energy Certificates, as well as its cogeneration and ice-cooling plants, puts it in a position to maintain its low per-student carbon footprint. The cogeneration plant plays a dual role in reducing emissions. It supplied 73% of campus electricity using 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 48,090.86 metric tonnes eCO_2. Figure 7 illustrates this hypothetical increase in emissions. This would raise the total carbon footprint from 3.92 to 4.80 metric tonnes eCO_2 for each student.

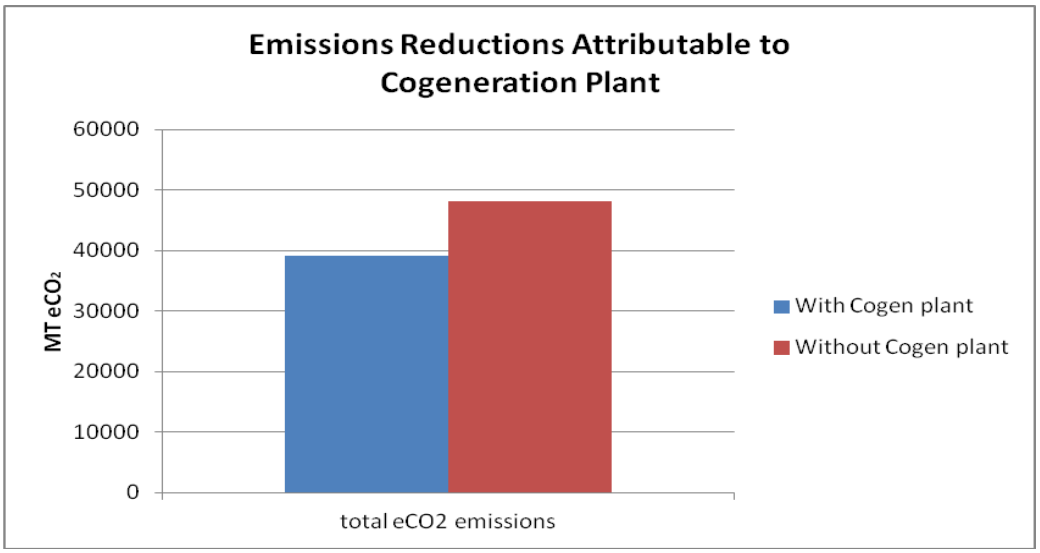


Figure 7: Emissions Reductions Attributable to Cogeneration Plant

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 achieving its 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 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 Palumbo Donahue School of Business 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 further reduce emissions. While this section aims to promote discussion and increase awareness of potential reduction strategies, it does not aim to analyze, create, or implement university policy. This team recommends the following areas for further emission reductions.

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 campus (the Power Center bathrooms currently posses 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, 15%, 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, increasing carpooling, or using alternative transportation methods, such as bicycling, taking public transportation, or using the 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 also sends a shuttle bus to the Southside, due to student call for cheaper forms of transportation to and from Duquesne, as heard in the 2008 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 travel represented 6% of the total carbon footprint for the University. Although there is not much the University can do to reduce emissions from air travel, emissions attributed to bus travel could be reduced. One way to do this would be to use more efficient buses, or buses powered by alternative fuel sources, such as natural gas.

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 CO_2.[9] 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. Moreover, carbon offsets could also be purchased for electricity produced on campus by the cogeneration plant.

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. The 2012 team considers the following to be the most effective:

- Implement a master campus metering program;
- Increased energy efficiency;
- Increased use of alternative energy;
- Continued changes in campus commuting habits;
- Purchasing 100% of its electricity using RECs;
- Purchasing carbon offsets for electricity produced by the cogeneration plant; and,
- 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 because 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.

[9] "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 (eCO_2)

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 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@duq.edu or Talisha Cox coxt@duq.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, 2006-2012 (metric tonnes eCO_2)

Fiscal Year		2006	2008	2010	2012
Scope 1	Stationary Combustion	26,625	29,140	30,477	28,633
	Fleet	190	196	205.4	207.65
	Refrigerants	*	220	139.6	*
	Agriculture	1.2	2.4	0.7	2.82
Scope 2	Purchased Electricity	10,512	11,880	10,015.4	8,742.4
Scope 3	Commuting	5,095	4,250	4,099	7,159
	Directly Financed Travel	1,607	4,123	1,314	1,236
	Study Abroad Air Travel	1,509	1,057	2,887.2	1,487
	Solid Waste	221	211	206	-36
	Wastewater		47	45.4	30.1
	Transmission Losses	1,040	1,175	990.1	**
	Paper Purchasing		136	82.9	39.68
Offsets	RECs		-11880	-8,418.9	-8,298.6
Net Emissions		46,800	40,557	42,044	39,203.3

*** Refrigerant data was not obtained for either the 2006 or 2012 reports and as a result was not included.**

**** Transmission losses were not calculated by the new CACP software for 2012 and updated figures from Duquesne Light (the local power distribution company) indicate a significantly lower transmission loss rate (0-2.9%) than the percent previously used (9.9%). As a result of uncertainty in this calculation it was not included in the overall net emissions. If it were to be included we would not expect to see an increase of more then 253 metric tonnes of eCO2 using the Real Power Distribution Losses percentage for a large service as obtained from Duquesne Light Company.**

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