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DUQUESNE UNIVERSITY

ONE STEP AT A TIME:

Duquesne University's Sixth Biennial

Greenhouse Gas Emissions Inventory

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I. Acknowledgements

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II. Executive Summary

This report, assembled by graduate students Abigail Ellert and Nathan Ribar of the Center for Environmental Research and Education (CERE), under the direction of Dr. John Stolz, presents the results of an inventory of Duquesne University's greenhouse gas (GHG) emissions in fiscal year 2016. This period begins July 1, 2015 and ends June 30, 2016. As the sixth biennial report CERE has issued, its findings are compared with those derived from fiscal years 2014, 2012, 2010, 2008, and 2006 data and assesses trends in Duquesne's GHG emissions. Additionally, this report discusses options for reducing Duquesne's carbon footprint in the future.

Duquesne University's total GHG emissions for fiscal year 2016 were 54,893.89 metric tonnes eCO_2, equaling 5.77 metric tonnes eCO_2 per student. This is slight drop in gross eCO_2 emissions from 59,049.56 metric tonnes in 2014, as well as a decrease in metric tonnes eCO_2 per student. Despite the mere 7% decrease in gross emissions since 2014, fiscal year 2016 saw much lower net emissions at 43,440.40 metric tonnes eCO_2. Net emissions are at a four-year low due to a change in sourcing for Renewable Energy Credits (RECs), which allowed Duquesne to obtain a much larger quantity than previous years. Duquesne's carbon footprint ranks in the top three of Atlantic 10 universities in net emissions and fourth in emissions per student. Figure 1 displays the percentages of various sources of GHG emissions on campus:

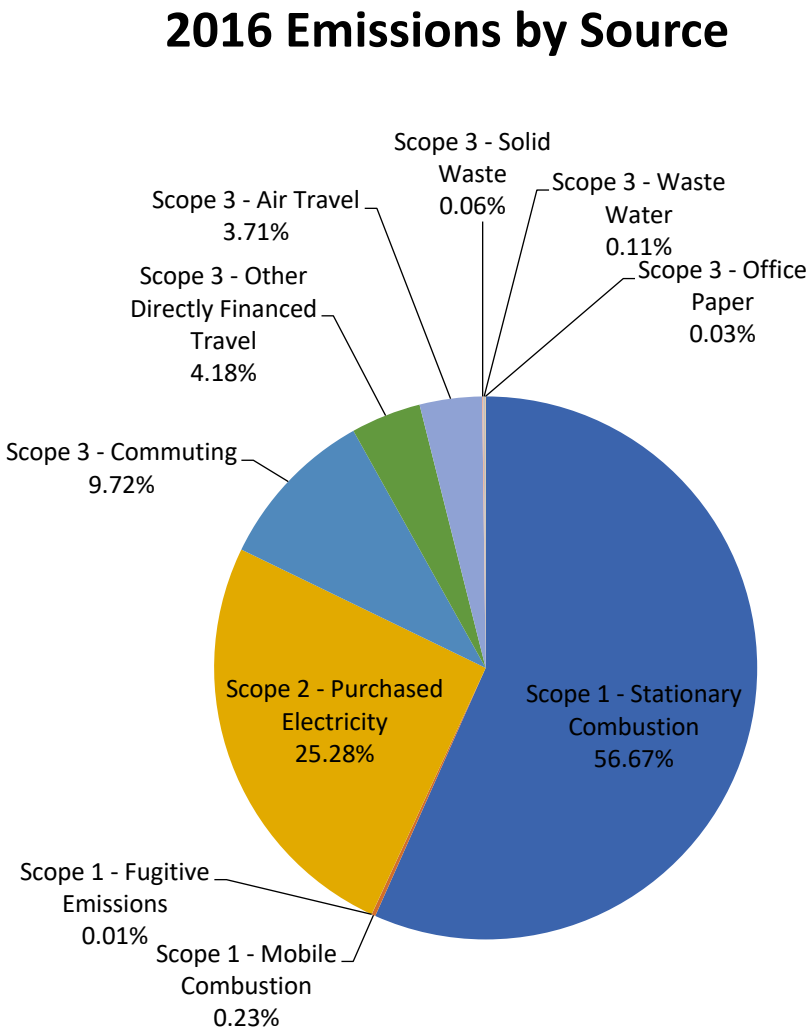


Figure 1: 2016 Emissions by Source

The largest contributor to Duquesne's GHG emissions was on-campus stationary combustion, which contributed 57% 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 25%, and commuting at 10%. Directly financed travel and air travel, both at about 4% each, contributed much less than in 2014. All other sources had minimal effect on the overall totals. While solid waste, waste water, office paper, and fugitive emissions are all registered, but only at a fraction of a percent - they do exist at miniscule levels that are negligable when compared to the main sources.

Relative to fiscal year 2014, emissions from purchased electricity increased, while that from directly financed travel, air travel, and stationary combustion all decreased:

Category	2014 Emissions	2016 Emissions	Percent Change
Stationary Combustion	30,548.98	29,930.99	-2.02%
Purchased Electricity	11,841.54	13,351.84	+ 11.3%
Other Directly Financed Travel	5,375.59	2,207.43	-58.9%
Air Travel	4,259.08	1,959.93	-54.0%

The largest factor contributing to the drop in net emissions from 2014 were the eCO_2 offsets from RECs. In fiscal year (FY) 2016, Duquesne purchased 18,305,532.5 kWh in RECs from Direct Energy Business LLC, a liscensed credit-trading enterprise.[1] This is a large increase from the 11,387,368 kWh purchased in FY14. The increase in purchased RECs comes from the sourcing type of the RECs. In previous years, RECs were purchased as Pennsylvania produced wind energy. In 2015, Duquesne began purchasing RECs in the form of National any Green-e, which encompasses any renewable resource supplied electricity generation in the United States. The advantage to this type of REC is that it comes at much lower price per REC, allowing Duquesne to purchase the same amout or more renwable energy at a lower price.

Looking at previous years, the amount of eCO_2 emissions per student has decreased, with FY16 seeing lower emissions per student compared to 2014. Net emissions have been also been reduced to levels that were seen prior to the FY14 report:

- **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
- **2014**: 51,187.7 tonnes eCO_2 = 5.13 tonnes eCO_2 per student
- **2016**: 43,440.4 tonnes eCO_2 = 4.57 tonnes eCO_2 per student

Another contribution to the decrease in the emissions from the 2014 was a reduction in overall travel. The 2014 report focused on the improved reporting on university travel and commuting, and how as a result these Scope 3 contributions greatly increased the overall emissions from previous years.[2] Using the same improved methods, the results of the 2016 report indicate that there was a decrease in travel related emissions, particularly in directly financed travel and study abroad, due to less overall travel.

This report both gives reason for optimism and leaves room for continued improvement for reducing greenhouse gas emissions at Duquesne. On the side of optimism, Duquesne has found a way to greatly increase its support for

[1] Direct Energy Business LLC. <https://www.directenergy.com/>.

[2] *One Step at a Time: Duquesne University's Fourth Biennial Greenhouse Gas Emissions Inventory.* 2014.

the use of renewable energy by purchasing a greater quantity of RECs. This has the two-fold benefit of reducing carbon emissions at Duquesne and contributing to the development of renewable energy generation in the U.S. Further optimism comes from continued "green" commitments at Duquesne such as installing PV solar panels on Des Places Hall, purchasing efficient ENERGY STAR* appliances, constructing LEED-certified buildings, installing motion-activated, higher-efficiency lighting in rooms around the campus, and educating students about the importance of energy conservation[3]. On the other hand, electricity purchased from the grid and emissions from commuting continued to be large contributors of emissions in FY16.

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 any 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 emissions. Following the success of the 2006 inventory, CERE decided to update this snapshot biennially to supply current information and uncover long-term trends. While other institutions were conducting their first report, 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, the fourth inventory in December 2014 using data from fiscal year 2012, and the fifth inventory from fiscal year 2014. Data from these five inventories were compared to the findings of this inventory to determine the status of Duquesne's efforts to reduce its emissions.

IV. Methods

At the end of 2017, the developers of Clean Air-Cool Planet (CACP), a nonprofit organization specializing in community and campus sustainability, announced the launch of a new platform for managing carbon footprint data. The new platform, Sustainability Indicator Management & Analysis Platform (SIMAP), was used for the first time to complete the inventory for FY16.[4] Like CACP, which was traditionally used by CERE for this report, SIMAP uses specialized formulas and algorithms to convert readily available institutional data into emissions figures.

SIMAP categorizes data into 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. Efficiency percentages for steam and electricity were obtained by from Facilities Management. Total natural gas purchased was obtained by using the online utility management tool *Energy* Watchdog.[5] Natural gas usage for on-campus boilers not associated with the Energy Center summary was determined by subtracting the amount of natural gas used in the Energy Center from total natural gas purchases on campus.

Calculations of fleet emissions focused on vehicle usage by Facilities Management and Public Safety. All other vehicle usage is included in Directly Financed Outsourced Travel in Scope 3. Facilities Management usage was

[3] Des Places Hall, Committed to Sustainability. <http://www.duq.edu/life-at-duquesne/residence-life/living-learning-centers/des-places/green-initiatives>.

[4] SIMAP. <https://unhsimap.org>

estimated by dividing the total amount spent on gasoline by Facilities Management over FY16 by the average price of Regular, Conventional-area gasoline in 2016, as determined by the U.S. Energy Information Agency.[5] Public Safety usage was estimated in consultation with the Public Safety Department, which estimates that their patrol cars drive approximately 82,000 miles per year. To arrive at a figure for fuel use, the mileage was divided by the average fuel economy of the Ford Explorer Police Interceptor package.[6]

GHG emissions associated with fertilizer use were estimated by contacting Facilities Management to determine how many bags of fertilizer they purchased in FY16. Based on information from Penn State, the assumptions were made that each bag is 50 lbs, and that the nitrogen content was 32%, a commonly available percentage that is within the normal range for fertilizers used on turf.[7]

Scope 2 Sources

Scope 2 requires data on purchased electricity, steam, and hot water. Duquesne produces all steam and hot water on campus, so there are no purchases in those categories. Duquesne's utility management tool, *Energy Watchdog*, supplied data on the energy budget, including kilowatt-hours (kWh) of purchased electricity for FY16. The impact was limited because Duquesne purchased Renewable Energy Certificates from Direct Energy Business, LLC. These RECs were National any Green-e, which are entered under Scope 3.

Scope 3 Sources

Estimating emissions for Scope 3 as usual required more effort than the other two scopes due to complexities associated with gathering appropriate data and converting it into units from which eCO_2 quantities can be derived. 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 solid waste was provided by inquiring with Facilities Management. 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 of in waste short tons sent to the Monroeville landfill. Solid waste generation is recorded on a calendar year rather than a fiscal year basis. We were provided with the waste production numbers for calendar years 2015 and 2016. The 2016 calendar year was used for the report. Wastewater generation for FY16 was available on Energy Watchdog. Duquesne's wastewater contributions to GHG emissions are governed by the treatment method(s) used at the facility the wastewater is sent to. For the Allegheny County Sanitary Authority (Alcosan), where the treatment process that by far has the most impact GHG emissions is anaerobic digestion.

Paper Purchasing

Paper usage was determined by inquiring with Duquesne's in-house Print Shop and Receiving, which accepts most other paper purchases made on campus. These offices provided the total paper purchases in

[5] Energy Information Administration. "Weekly Retail Gasoline and Diesel Prices." <https://www.eia.gov/dnav/pet/pet_pri_gnd_dcus_nus_a.htm>.

[6] Ford Police Interceptor Gets Official EPA Fuel Economy Numbers. http://www.government-<fleet.com/channel/fuel-management/news/story/2012/03/ford-police-interceptor-gets-official-epa-fuel-economy-numbers.aspx>.

[7] Center for Turfgrass Science, Penn State University. "Turfgrass Fertilization: A Basic Guide for Turfgrass Managers." <https://extension.psu.edu/turfgrass-fertilization-a-basic-guide-for-professional-turfgrass-managers>.

number of reams accepted in FY16. Based on specifications from Office Depot, we assume each ream to weigh 2lbs.[8] We assume most paper purchases contain 30% recycled content.

Study Abroad

The Study Abroad Office provided information on study abroad participation (*i.e.* locations visited and number of students who traveled to each). Mileages to each destination were calculated using Google Maps, and the distances to each destination were multiplied by the number of students who visited that site.

Directly Financed Outsourced Travel

Duquesne's directly financed outsourced travel includes sports team travel and air travel by faculty and staff. Air travel for athletics was determined by assessing sports teams' schedules. When men's and women's schedules overlapped, we assumed the teams traveled concurrently, and when two or more away events were spaced by 1-2 days, we assumed teams traveled from one away event to the next without returning to Duquesne in between. For ground travel, roster size was used to determine whether bus or van was used for travel. Per consultation with the Athletics Department, we assumed any event greater than 7 hours away by ground to be reached via air. All air travel was logged as passenger miles except for football air travel, which we assumed to be a chartered flight. Google Maps was used to determine mileage.

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 $0.1785 per mile. This number was obtained from the Standard Industry Fare Level (SIFL) for July 2015- December 2015.[9] The average miles flown by faculty were estimated to fall in the 501-1500 mile category. We recognize the weakness of gauging air miles and travelled based on ticket prices.

Faculty and Staff Commuting

In the 2010 inventory, faculty and staff commuting habits were calculated on the basis of a transportation survey (See Appendix B). The 2016 team assumed transportation habits remained the same from the 2010 inventory, and adjusted for the number of faculty and staff according to the numbers provided by the Office of Institutional Research for fiscal year 2016. 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.

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 number of miles traveled per day, mode of transportation, and number of trips per week (See Appendix B). For the 2016 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 SIMAP calculator to determine total student commuting emissions.

[8] Office Depot. "Office Depot Brand Copy & Print Paper, Letter Size Paper, 20 Lb, 500 Sheets Per Ream, Case of 10 Reams." <https://www.officedepot.com/a/products/348037/Office-Depot-Brand-Copy-Print-Paper/>.

[9] SIFL Rates Issued for the second half of 2015. http://news.wolterskluwerlb.com/news/sifl-rates-issued-for-the-second-half-of-2015/

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. These credits serve to offset the use of coal-fired power by supporting renewable energy sources. The quantity of RECs purchased by Duquesne is given in kWh, but the SIMAP reporting platform requires RECs to be entered as MTCDE. This conversion was made using an emissions factor for electricity generation provided by the EPA[10]. The emissions factor, 1,379.48 lbs. CO_2/ MWh, was converted to $MTCO_2$/ kWh then multiplied by the quantity of RECs in kWh. The result was the $MTCO_2$ that would be emitted if that quantity of RECs had been purchased from the grid. Note that this conversion gave only $MTCO_2$, not MTCDE. Therefore, the quantity of RECs in MTCDE used for the report is a conservative number.

Methods Challenges

When measuring Duquesne's carbon footprint, ease and precision are essential. One of the primary challenges we face is converting institution-provided data into units accepted by SIMAP without making any unjustifiable assumptions. For example, data from Facilities Management on steam generation is supplied in Mlbs, whereas SIMAP only accepts MMBTUs. This conversion was calculated using the provided document.[11] Data on travel and fuel consumption required numerous assumptions. For example: records for faculty air travel are kept in monetary values, which SIMAP does not accept, rather than in mileage, which SIMAP does accept. To convert monetary totals into mileage, we used the Standard Industry Fare Level,[12] which may result in inaccuracies in actual mileage flown. A university recordkeeping system for faculty air travel that records destinations traveled to would eliminate the uncertainty introduced by using the Standard Industry Fare Level. Similarly, a record-keeping system that periodically records mileage of Duquesne's fleet vehicles would provide a more accurate assessment of fleet usage than the current approach of relying solely on fuel expenditures. A tracking system for university purchases that records goods/services purchased in addition to the amount spent would also provide better accuracy for fields such as paper usage and fertilizer. Regarding information on faculty and staff commuting, the team was again unable to obtain this information, so we extrapolated from the survey conducted as part of 2010 inventory to remain consistent with previous reports.

Additional challenges were faced in the 2016 report due to the switch to SIMAP from CACP. This presented difficulties because of the new format of the program. Also, since the CACP site was subsequently shut down upon the launch of SIMAP, data had to be transferred from CACP. This was handled by CACP administration in the form of an *Excel* file, which was then imported in SIMAP. For unknown reasons, institutional data, offsets, and electric and steam outputs were not retained in the data transferred from previous years. Fortunately, some of this data is written in hard copy, and will be entered into SIMAP for future reports. To avoid further confusion and difficulties in the future, fastidious notes and written records should be kept.

[10] Emissions factors for Greenhouse Gas Inventories. https://www.epa.gov/sites/production/files/2015-12/documents/emission-factors_nov_2015.pdf

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

[12] SIFL Rates Issued for the second half of 2015. http://news.wolterskluwerlb.com/news/sifl-rates-issued-for-the-second-half-of-2015/

V. Results

Duquesne University's total greenhouse gas emissions for fiscal year 2016 were 54,893.89 metric tonnes of eCO_2 and 43,440.40 metric tonnes of eCO_2 after factoring in the university's offsets. With a student population (full and part time students) of 9,506, the carbon footprint per student is 4.57 metric tonnes of eCO_2. Fifty-eight percent of the university's total GHG emissions, totaling 31,498.93 metric tonnes of eCO_2, came from Scope 1 sources. Twenty-four percent of the university's emissions, totaling 13,351.84 metric tonnes of eCO_2, came from Scope 2 sources, and eighteen percent of the university's emissions, totaling 10,043.12 metric tonnes of eCO_2, came from Scope 3 sources. These figures are presented in Figure 2. Offsets from RECs totaled 11,453.5 metric tonnes of eCO_2. This covered a total of 86 percent of scope 2 emissions.

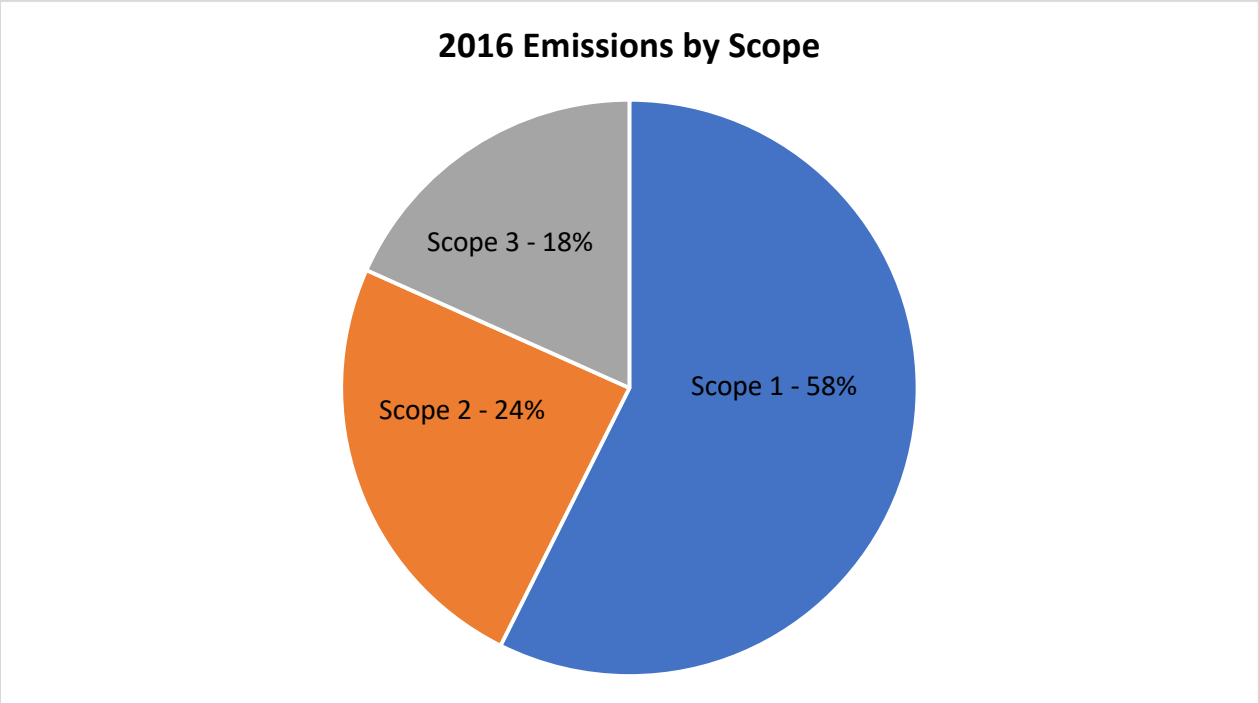


Figure 2 : 2016 GHG emissions by Scope

Electricity and Heating

Electricity and heating contributed 69% of Duquesne's gross GHG emissions for 2016. The cogeneration plant was responsible for most of the emissions. The cogeneration plant consumed 562,789.10 MMBTU of natural gas to produce 27,593,900.00 kWh of electricity and 225,861,959.30 lbs. of steam in fiscal year 2016. In addition to the consumption of natural gas by the cogeneration plant, Duquesne purchased 27,143.53 MMBTU of natural gas for cooking and for heating for some buildings. Electricity was purchased to supplement the electricity provided by the cogeneration plant and totaled 21,248,744.00 kWh. This purchased electricity did not contribute as significantly to the campus greenhouse gas emissions however, because 86% (18,305,532.50 kWh) was offset 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 as purchased electricity offset by RECs (gray) and purchased electricity not offset by RECs (orange).

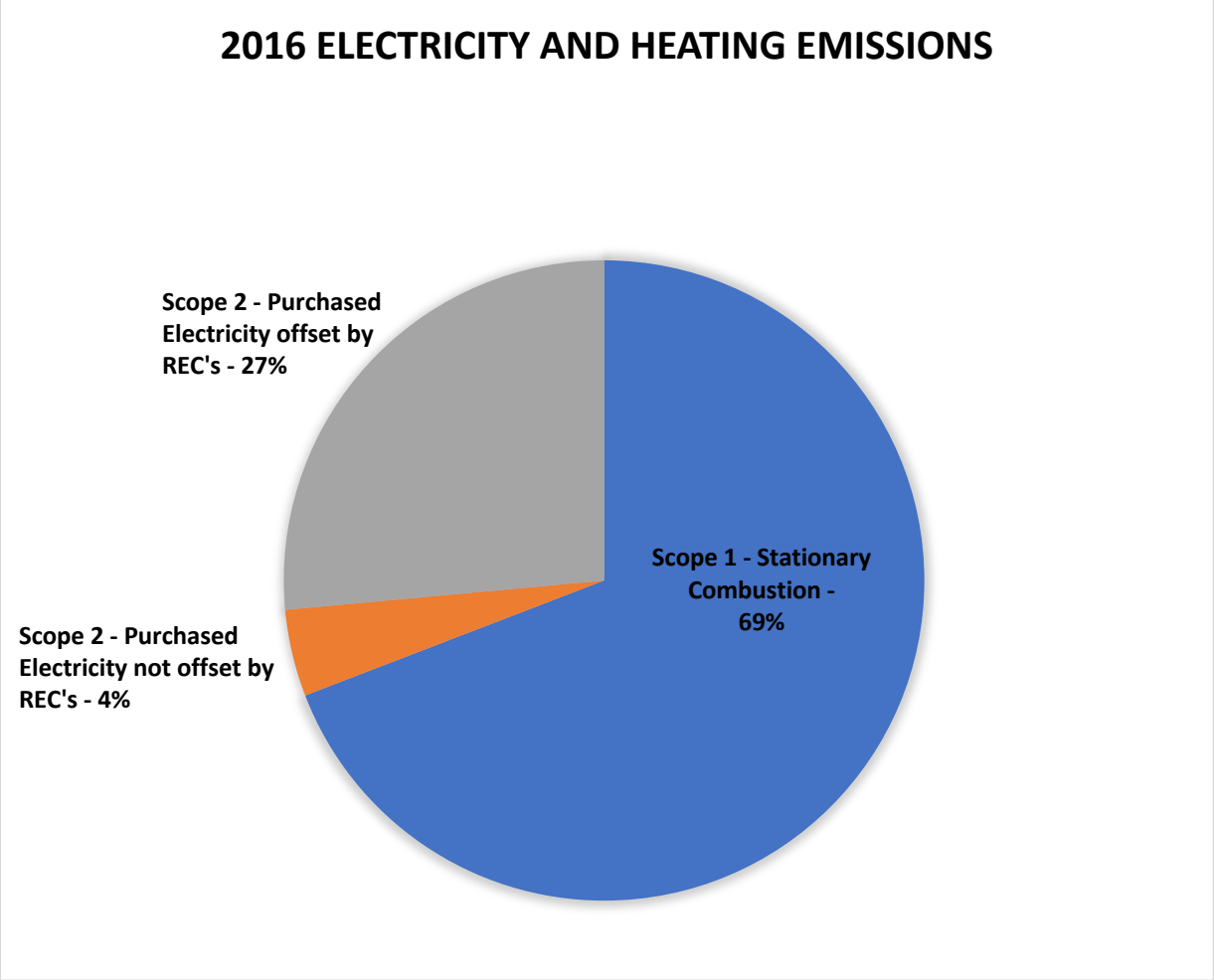
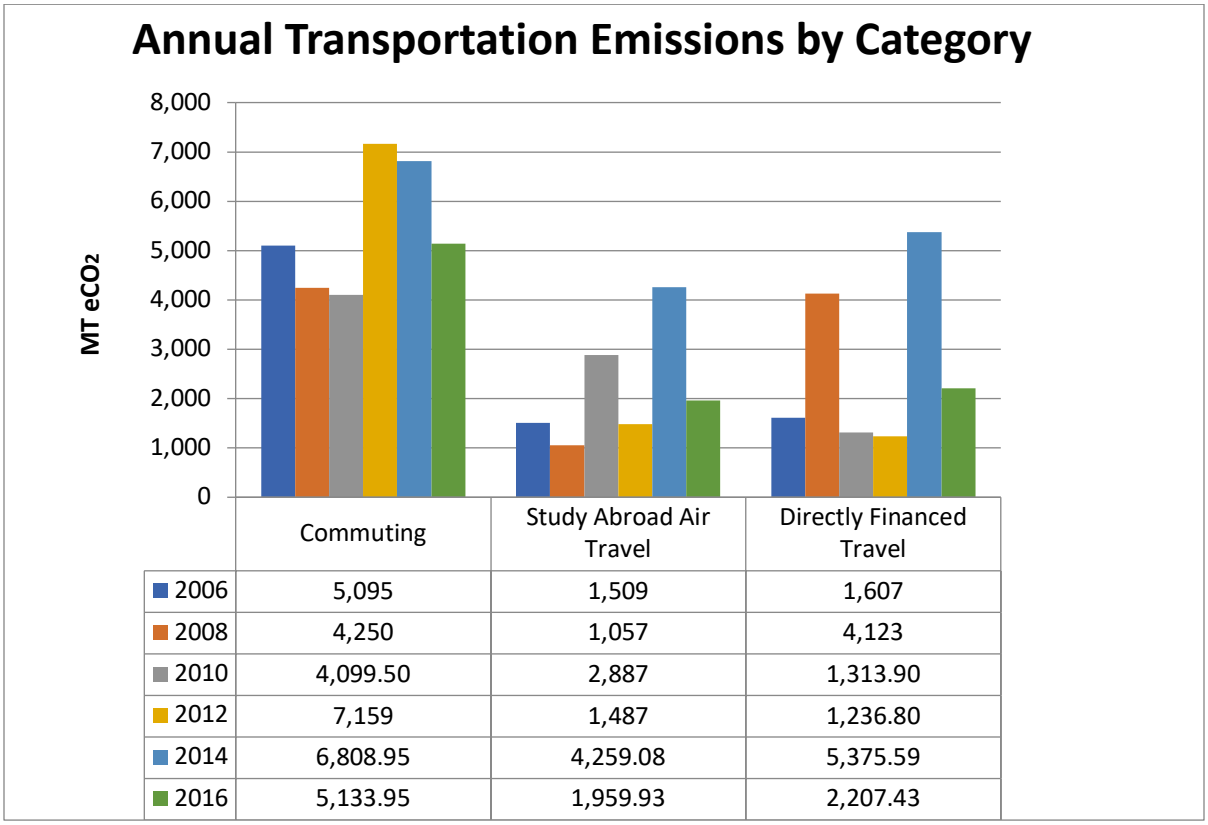


Figure 3: 2016 Electricity and Heating Emissions

Transportation

The University's transportation emissions included commuting, directly financed outsourced travel, and study abroad air travel. These sources accounted for 17%, or 9,301.01 metric tonnes eCO_2, of the University's gross emissions. Commuting accounted for the largest proportion of transportation related emissions, totaling 9.72% of Duquesne's total emissions. In addition, study abroad air travel and directly financed travel contributed 8% of the University's emissions.



	Commuting	Study Abroad Air Travel	Directly Financed Travel
2006	5,095	1,509	1,607
2008	4,250	1,057	4,123
2010	4,099.50	2,887	1,313.90
2012	7,159	1,487	1,236.80
2014	6,808.95	4,259.08	5,375.59
2016	5,133.95	1,959.93	2,207.43

Figure 4 : Annual Transportation Emissions by Category

Miscellaneous

Minor GHG sources collectively contributed 0.003%, or 167.86 metric tonnes eCO_2, to Duquesne's total emissions. These included the following:

- Fleet vehicle use, 121.54 metric tonnes eCO_2.
- Fertilizer application, 2.82 metric tonnes eCO_2.
- Solid waste landfilling, -33.29 metric tonnes eCO_2. *
- Wastewater disposal, 60.03 metric tonnes eCO_2
- Paper usage, 16.76 metric tonnes eCO_2

* Solid waste landfilling was reduced to -33.29 metric tonnes eCO_2 because of methane recovery and electricity generation.

VI. Comparison of 2006, 2008, 2010, 2012, 2014, and 2016 Results

Adjustments to the 2006, 2008, 2010, 2012, 2014, and 2016 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). Additionally, 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 in 2008. 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 used a percentage of the drivers found on campus as a share of the total campus population that corrected the 2006 report. This correction led to a decrease in emissions.

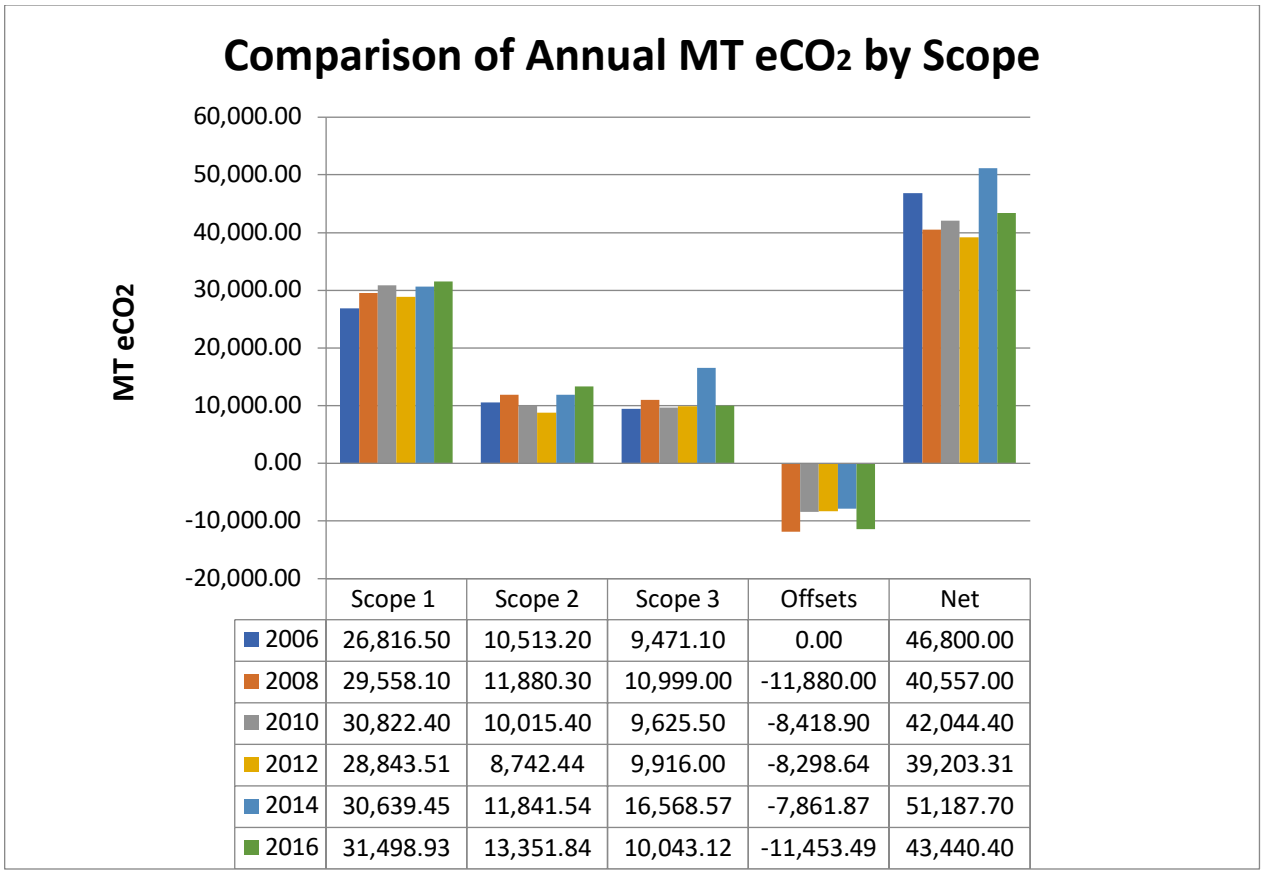
After correcting the electricity grid region and the commuting data transcription, the emissions increased by 2,750 metric tonnes. This brings the 2006 total to 46,670 metric tonnes eCO_2. Updating to a new version of the CACP calculator, with its adjusted formulas, accounts for the remaining 130 metric tonnes increase to 46,800 metric tonnes (51,574 short tons).

The 2010 team retained all 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.

The 2016 team retained all the adjustments made by the 2010 team and made no new adjustments.

Comparison of 2006, 2008, 2010, 2012, 2014, and 2016 Results

The results of the 2016 report showed a slight decrease in gross emissions from 2014, which was still significantly more than emissions between 2006 and 2012. However, due to the large quantity of offsets purchased, net emissions were back to the levels prior to the FY14 report. 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 again by 2,841.1 metric tonnes from 2010 to 2012. Between 2012 and 2014, emissions jumped from 39,203.3 metric tonnes to 51,187.7 metric tonnes. Between 2014 and 2016, emissions fell by 7,743.3 metric tonnes. Figure 5 (see following page) illustrates this pattern.



	Scope 1	Scope 2	Scope 3	Offsets	Net
2006	26,816.50	10,513.20	9,471.10	0.00	46,800.00
2008	29,558.10	11,880.30	10,999.00	-11,880.00	40,557.00
2010	30,822.40	10,015.40	9,625.50	-8,418.90	42,044.40
2012	28,843.51	8,742.44	9,916.00	-8,298.64	39,203.31
2014	30,639.45	11,841.54	16,568.57	-7,861.87	51,187.70
2016	31,498.93	13,351.84	10,043.12	-11,453.49	43,440.40

Figure 5: Comparison of Annual Emissions by Scope

Changes Reflecting Variation in Data

The decrease in gross emissions between 2014 and 2016 is largely attributed to a reduction in Scope 3 emissions, specifically in Study Abroad Air Travel and Directly Financed Travel. In 2014, emissions for Study Abroad Air Travel and Directly Financed Travel were 4,259.08 and 5,375.59 metric tonnes eCO_2 respectively. For fiscal year 2016, Study Abroad Air Travel had emissions of 1,959.93 metric tonnes and 2,207.43 metric tonnes for Directly Financed Travel. The decrease in these transportation categories is due to a decrease in sports travel air miles and a decrease in air travel by university faculty and staff in fiscal year 2016. In addition, the number of students studying abroad and total passenger air miles decreased in 2016.

The decrease in Scope 3 emissions led to an overall decrease in gross emissions, but it is important to note that Scope 1 and Scope 2 emissions continued to increase in 2016. These slight increases are likely due to a change in physical space, which increased by 33,799 sq. ft. between 2014 and 2016. This increase in physical space is likely the source of the increase in purchased electricity and natural gas contributing to the Scope 1 and Scope 2 emissions increases. Fortunately, the quantity of offsets also increased between 2014 and 2016, negating these increases and further reducing the overall net emissions.

Carbon offsets from RECs had the greatest impact on reducing Duquesne's footprint in FY16. The increase in the amount of RECs purchased was possible because the source of the RECs changed from Pennsylvania Wind to National any Green-e. Purchasing National any Green-e RECs greatly reduced the price of the offsets, allowing Duquesne to purchase more and ultimately offset carbon emissions by a greater amount.

Changes Reflecting Inventory Methodology

In the 2014 report, air mileage for study abroad travel and sports travel was calculated using the online flight mileage calculator, webflyer.com. For the 2016, Google Maps was used to calculate these distances. The mileage calculated by Google Maps was nearly identical to mileage from webflyer.com. The change in methodology presented no significant changes to results.

The 2016 report was the first inventory that used the new carbon reporting platform SIMAP. Reporting under SIMAP remained consistent in almost every way when compared to CACP. However, there were some slight changes in the labeling of categories and subcategories for emissions. In CACP reporters had the ability to table categories manually, but SIMAP had predetermined categories, and the most appropriate label was selected. For instance, in CACP air travel could be manually broken into subcategories of "Athletics air travel" and "University funded air travel". In SIMAP, there is no predetermined option for "Athletics air travel" or "University funded air travel", so these emission sources were categorized as "Student air travel" and "Faculty/Staff air travel" respectively. These subcategories were selected because they seemed to be the most appropriate description of the source. Further clarification about the source of the data was typed in the comments section of each entry. One other difference between CACP and SIMAP is the addition of other reporting categories and the ability to report nitrogen emissions as well as carbon emissions. Since the SIMAP platform was not introduced until data was already collected for 2016, the new features were not used for the 2016 report.

As a part of the transition to SIMAP, data from the 2012 and 2014 reports were exported by the CACP team and sent as an *Excel* file to CERE. However, the data exported by the CACP team did not have all the data entered from these years, including: institutional data, cogeneration electricity and steam output and efficiencies, and comments from left by previous teams. Also, inventories prior to 2012 were completed using an older, *Excel*-based calculator, created by the same organization. This data was missing completely from the data exported from CACP. Fortunately, hard copies of data are on file, and can be entered into SIMAP to complete data from previous years. This also presented a challenge during preparation of the "Results" section. Since data was incomplete or missing for previous years, it was not possible to compare results of the 2016 report to past reports directly on SIMAP. The results from the 2016 report were entered into a separate *Excel* file containing data from previous reports so that comparisons could be made.

VII. Conclusions

Comparison with Other Universities

Duquesne ranks third in net emissions and fourth in emissions per student among the Atlantic 10 schools that have completed GHG inventories. In the past, Duquesne has led the Atlantic 10 in having the lowest carbon footprint; however, George Mason University has taken this position in FY14 and FY16. There are many factors affect an institution's footprint. Such factors as climate zone, student population, campus setting (i.e. urban, suburban, or rural), and physical size all play a significant role in what is and isn't achievable for different universities. These factors are important to keep in mind when making comparisons between institutions.

Comparison to Atlantic 10 Schools[13]				
School	**Year Completed**	**Total Footprint (MTCDE)**	**Per Student Footprint (MTCDE)**	**Location**
Duquesne University	2016	43,440.40	4.57	Pittsburgh, PA
University of Massachusetts-Amherst	2016	123,569.00	4.22	Amherst, MA
George Washington University	2016	92,643.00	4.20	Washington D.C.
Davidson College	2017	23,108.00	12.95	Davidson, NC
University of Dayton	2015	82,551.00	7.84	Dayton, OH
George Mason University	2016	98,020.00	3.80	Fairfax, VA
University of Rhode Island	2016	68,289.00	4.87	Kingston, RI
University of Richmond	2016	43,682.00	11.29	Richmond, VA
Virginia Commonwealth University	2016	170,824.00	6.01	Richmond, VA
Temple University*	2016	170,512.00	4.95	Philadelphia, PA
Xavier University*	2016	30,601.00	4.94	Cincinnati, OH

*Denotes former Atlantic 10 universities with whom Duquesne has historically compared GHG emissions.

[13] Second Nature, Inc. "Reporting Platform." <http://reporting.secondnature.org>.

Existing Environmental Assets

Physical Facilities

Duquesne's purchase of RECs, as well as its cogeneration and ice-cooling plants, puts it in a position to maintain a low per-student carbon footprint. The cogeneration plant plays a dual role in reducing emissions: (1) In FY16, it supplied nearly 56% 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. (2) 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 be significantly higher.

Duquesne's ice making plant is an important emissions-reducing asset not captured directly by the SIMAP 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 facility in this way limits the need for electricity purchases from the regional grid to cool 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 a design for the Power Center that led it achieving a LEED Silver certification.

Institutional Approaches

Duquesne has engaged in many 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. The Center for Environmental Research and Education (CERE), as part of the Bayer School of Natural and Environmental Sciences (BSNES), 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 fifth globally and first nationally for its commitment to environmental and social issues by Corporate Knights[14]. 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, and the *Ecology Club*, a student organization within BSNES, assists with local BioBlitzes and other projects focused on promoting better interactions between people and the environment.

[14] Corporate Knights. "2017 Better World MBA Results." <http://www.corporateknights.com/reports/2017-better-world-mba-ranking/2017-better-world-mba-results-15081317/>.

VIII. Recommendations

The results of the 2016 report are encouraging due to a decrease in gross emissions from 2014 as well as a more significant decrease in net emissions after offsets. While carbon emissions have decreased overall, there is always room for continued improvement.

Energy Efficiency

The most sensible and cost-effective means of reducing GHG emissions would be to use more energy efficient systems at the University. This is especially important for older buildings and recently acquired campus structures, which rely on purchased electricity rather than energy supplied by the cogen facility. By lowering energy usage while maintaining all necessary functions, Duquesne can significantly lower its carbon footprint - oftentimes while reducing long-term overhead expenditures in the process. 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 possess this technology), considering the use of LED lights in high-traffic areas on campus, and well as educating students about the importance of energy conservation to engage them in energy-saving behavior.

Renewable Energy on Campus

Renewable energy resources could also lower GHG emissions for Duquesne. Duquesne made strides in this area with the installation of a 5-kilowatt solar panel on Des Places Hall, which will provide a small portion of the buildings energy requirements[15]. Continued research and feasibility studies should be performed to implement more renewable energies on campus. This has become even more feasible in recent years with declining prices for renewable energy systems[16].

Transportation and Commuting

Commuting continues to be a significant source of emissions, with 10% of total emissions stemming from this source. There are several carbon-reducing options available to students, 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 Zipcar. Port Authority Transit buses stop regularly on Forbes and Fifth Avenues and the Boulevard of the Allies on The Bluff. The University also maintains a shuttle bus to the South Side, due to student calls 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.

While directly funded university travel emissions have declined since 2014, they are still responsible for 4% of total emissions. It is important to note that athletics travel as well as faculty and staff traveling is important for the

[15] Des Places Hall, Committed to Sustainability. http://duq.edu/life-at-duquesne/residence-life/living-learning-centers/des-places/green-initiatives

[16] Lazard. “Levelized Cost of Energy Analysis Version 11.0.” <https://www.lazard.com/perspective/levelized-cost-of-energy-2017/>.

success of Duquesne as an institution; however, alternative options should be considered. Examples include conducting meetings over video conference or telephone, and non-conference competitions that are in closer proximity to Duquesne for athletics.

Carbon Offsets

Some travel related emissions could be offset with carbon offsets for air travel by paying 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.[17] 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.

Changing the source of RECs from Pennsylvania Wind to National any Green-e allowed Duquesne to purchase a greater amount of RECs for a much lower cost. The money that was saved from the lower cost of the RECs should be used to purchase more RECs or to further offset carbon emissions by other means (*see recommendations below*).

Green Building

Green building practices can enable Duquesne to reduce its total carbon footprint. 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 and wet weather-induced combined sewer overflow, which is a serious environmental challenge in the Pittsburgh area.[18]

Conclusion

There are many ways for Duquesne to reduce its carbon footprint. The 2016 team considers the following to be the most effective:

- Encourage public transportation use by purchasing Port Authority passes for students;
- Increased use of energy efficient technology;
- Increased use of alternative energy;
- Continued changes in campus commuting habits;
- Purchasing 100% of its electricity using RECs;
- Purchasing RECs to offset other sources of campus emissions (i.e. cogen facility, university-funded travel),
- Changes in residential energy use.

As Duquesne continues to grow as an institution, it is likely that carbon emissions will continue to increase as well. However, if Duquesne continues to put sustainability at the forefront of the university's growth, this trend will change. Reducing greenhouse gas emissions will require an input of financial and intellectual resources. It will also require a continued commitment to Duquesne University's mission of attentiveness to global concerns as well as service to the Church, the community, the nation, and the world[19]. These commitments will not be easy, but they can be accomplished, one step at a time.

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[17] TerraPass. "Buy TerraPass carbon offsets - TerraPass: fight global warming, reduce your carbon footprint." <http://www.terrapass.com/>.

[18] Green Building Alliance. "Green Roofs." <https://www.go-gba.org/resources/green-building-methods/green-roofs/>.

[19] Duquesne University Mission Statement. http://www.duq.edu/about/mission-and-identity/mission-statement

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 webpage on RECs at **https://www.epa.gov/greenpower/renewable-energy-certificates-recs**

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, 2006-2016 (metric tonnes eCO_2)

Fiscal Year	Source	2006	2008	2010	2012	2014	2016
Scope 1	Stationary Combustion	26,625	29,140	30,477	28,633	30,548.98	29,930.99
	Fleet	190	196	205.4	207.65	87.26	121.54
	Refrigerants	*	220	139.6	*	*	*
	Agriculture	1.2	2.4	0.7	2.82	3.22	2.82
Scope 2	Purchased Electricity	10,512	11,880	10,015.40	8,742.40	11,841.54	13,351.84
Scope 3	Commuting	5,095	4,250	4,099	7,159	6,808.95	5,133.95
	Directly Financed Travel	1,607	4,123	1,314	1,236	5,375.59	2,207.43
	Study Abroad Air Travel	1,509	1,057	2,887.20	1,487	4,259.08	1,959.93
	Solid Waste	221	211	206	-36	-40.26	-33.29
	Wastewater		47	45.4	30.1	55.97	60.03
	Transmission Losses	1,040	1,175	990.1	**	**	**
	Paper Purchasing		136	82.9	39.68	109.24	16.76
Offsets	RECs		-11880	-8,418.90	-8,298.60	-7,861.87	-11,453.49
Net Emissions		46,800	40,557	42,044	39,203.30	51,187.70	43,440.4

*** Refrigerant data was not obtained for either the 2006, 2012 and 2014 reports and as a result was not included.**
**** Transmission losses were not calculated by the new CACP software for 2012 and 2014. 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 overall net emissions. If it were to be included we would not expect to see an increase of more than 343 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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