

# The Environmental Audit of Lycoming College



*Ninth Edition: April 2018*

By Andrew Shelly '18 and Mikayla Schappert '20

*Eighth Edition: April 2017*

By Andrew Shelly '18

*Seventh Edition: April 2016*

By Tiffany Faulk '16

*Sixth Edition: April 2015*

By Amber Seibel '15

*Fifth Edition: April 2014*

By Jocelyn Owens '15, Dacin Kemmerer '14, Emily Vebrosky '14, Samantha Hewitt '14, Lynette Dooley '15, and  
Miranda Giraldo '15

*Fourth Edition: April 2012*

By Zebidiah Buck '12, Alyssa Tomaskovic '13, Laura Walter '13, Ashlynn Beacker '14, Chelsea Brewer '14, and  
Samantha Hewitt '14

*Third Edition: April 2011*

By Megan Schulze '11, Brooke Gessner '12, and Alyssa Tomaskovic '13

*Second Edition: April 2010*

By Megan Schulze '11 and Nick Lansberry '11

*First Edition: December 2009*

By Tyler Hutson '10, Dan Cassidy '11, Bethany Herring '11, Emily Hopko '11, and Megan Runyon '10.

Supervisors: Dr. Mel Zimmerman and Dr. Bob Smith

2017  
Environmental Audit



Mikayla Schappert 20', Andrew Shelly 18'

## **Introduction**

Developing more environmentally sustainable ways of living has become a global concern. Universities and colleges around the world are creating alternative, more sustainable methods to continue to meet their campus's needs, as well as decrease their own environmental footprints. As a progressive step towards these aforementioned ideas, Lycoming College conducts an annual environmental audit.

This audit incorporates data comparing utility costs, water consumption, natural gas consumption, electricity consumption, solid waste production, as well as information regarding any recycling and sustainability efforts. It also outlines a list of classes and clubs that incorporate environmental aspects into their curriculum and activities. Since students, faculty, and staff have been cataloguing data since 2009, this document also provides a comparative analysis of past forms of energy consumption among the various buildings on Lycoming College's campus. The Lycoming College Environmental Audit provides a baseline from which improvements can be documented and measured. The audit is intended to evolve through time, as future students incorporate annual updates. But above all, this document is a place that records Lycoming College's progress and growth towards enhanced sustainability.

# Electrical

Lycoming College currently purchases its electricity from PPL Electric Utilities Corporation. A billing analysis has been created to produce an electricity use profile for the entire college. Appendices 1 and 2 provide the individual electricity consumption of each building and the usage of kWh/square feet. The following graph (*Figure 1*) shows total electrical energy consumption for all properties owned by Lycoming College from 2005 to 2017.



*Figure 1. Totals can appear lower due to missing data.*

## Trends

2017 at Lycoming College saw a slight decrease in overall campus kWh usage from the previous year. The data for 2016 is part of a steady incline in the graph, were the college has used more electricity from 2014 to 2016. This increase could be accounted for with a variety of factors, but three major ones were the addition of Lynn, purchasing of new apartments, and increase in usage of the recreation center and Lamade Gym. For 2017, the top consumers of total Kwh were Heim Hall, Academic Center, and the Recreation Center. The most inefficient buildings on campus, based off total Kwh usage per square feet include, Clark Chapel, Heim Hall, Recreation Center, Wertz Hall, Lamade Gym, and the Academic Center. This is a new trend, for the Academic center was the largest consumer of electricity from 2009 when the audit was first started to 2016.

## Improvements

The year 2009 experienced a decrease in electricity consumption caused by updating a previously wasteful sprinkler system in the Heim Building used to cool compressors. Before this update, the compressors operated on full power at all times of the day. After the more efficient installation replaced the old one, these compressors operated at significantly lower power throughout the day, conserving a considerable amount of energy. In addition, the third and fourth floors of the Snowden Library experienced changes to reduce electricity consumption. A decision was made to use only every other light on the top two floors of the library, as opposed to full lighting. The alterations made to the compressors and the change in the library's lighting accounts for the steep decrease in electrical usage from 2008 to 2009. Prior to this change the library used 3, 200 tubes. After Buildings and Grounds removed 800 tubes, the library used only 2,400 tubes. This sustainable action allowed the library to run at 25 watts instead of 50 watts.

To further aid sustainable efforts in saving electricity, the Sustainability Committee initiated the "Flip It Off" campaign in 2011. As a part of their campaign, the committee encouraged students to turn off lights, appliances, electronics, and faucets when not in use. Currently, LEAF (Lycoming Environmental Awareness Foundation) assumes responsibility for continuing this campaign by hanging posters in dorms, academic buildings, and bathrooms reminding people to turn the tap completely off or shut off the lights.

## **Renewable Energy**

### **Solar**

Lycoming College's involvement in the solar program began after Dr. Mel Zimmerman and Clean Water Institute interns, Megan Schulze '11 and Tracie Curtis '09, attended the Solar Scholars Conference at Dickinson College to learn more about the advantages of solar energy. Attendance at this conference, hosted by the Sustainable Energy Fund, led to a competitive grant process involving institutions that were interested in receiving a grant for a 3.1 kW Photovoltaic (PV) system. After applying for the \$15,000 opportunity amidst competition from thirty-six other colleges and universities, Lycoming was one of twelve institutions to be awarded the grant. On November 12, 2009, a 15-panel Photovoltaic (PV) system was installed on the roof of the Heim building and the electrical output began to be monitored.

According to Eduardo Lorenzo, author of "Solar Electricity: Engineering of Photovoltaic Systems," the method employed uses semi-conductors, usually consisting of silicon, to capture solar rays. The rays captured consist of photons, whose bonds are broken, which allows the photons to move around freely to create an electrical current that can be transmitted into an electrical system and subsequently, monitored.

The solar photovoltaic system output in 2010 was compared with the energy demands needed to run equipment, not including lights, in three of the Clean Water Institute laboratories. Room 112 houses a refrigerator and two incubators (1.021 kWh), room 105 contains a 150-gallon saltwater tank with a separate emergency circuit (0.972 kWh), and room 120 has two incubators (0.240 kWh). On average, these labs require 1.909 kW per hour, 45.816 kW per day, and 1393.57 kW per month. As of March 5, 2012, the total output of the solar photovoltaic system since its November 12, 2009 installation is 8369.9 kWh, and it is estimated that the PV system offsets the equipment energy demand by approximately 40%.

## **Renovated Residence Halls**

Over the past few years, three residence halls have been renovated to make the electrical, water, and natural gas usage more efficient. To monitor the effects of the renovations, data collected for the Environmental Audit can provide precise numbers for the amount of electricity, water, and natural gas used before and after the renovations. Provided below are tables and graphs that illustrate what was found.

Rich Hall was the first dorm to be renovated in 2013. During the renovations, new windows, shower heads, light fixtures, and plumbing were installed. Insulation was put in, and new heating and hot water systems were installed. Electrical usage seems to have increased since the renovations, with 2015 having the highest electricity usage since data has been recorded. Water, however, appears to have significantly decreased after renovations.

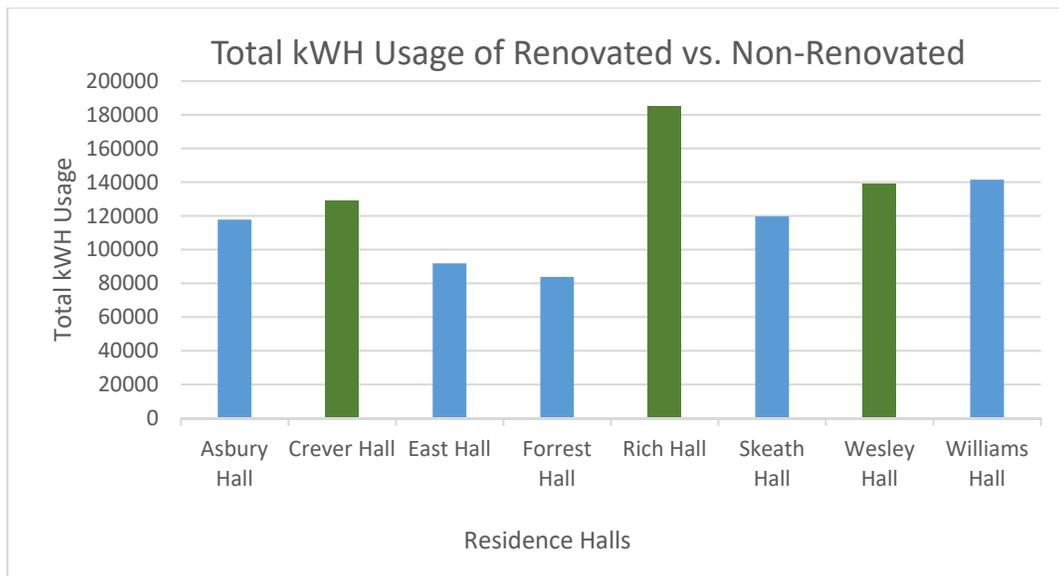
Crever Hall was given similar upgrades to Rich in 2014. New windows, shower heads, light fixtures, and plumbing were installed. Insulation was put in, and new heating and hot water systems were installed. Again, electrical usage appears to have increased since renovations, though it still remains fairly normal compared to past electrical usage. Water, however, did decrease after renovations.

Wesley Hall has been the latest dorm to be renovated, which was done in 2015. It did not receive as many upgrades as the two previous dorms. No insulation was put in to Wesley, except for in the ceiling. New windows were not installed because the windows already in Wesley were fairly new, and there was no cost/benefit for installing newer windows.

Also, in 2015, Crever and Rich were given separate heating systems. Prior to 2015, Crever used to supply heat to Rich Hall and part of Wertz Student Center. Crever and Rich were given separate steam boilers, and Wertz was converted to water. Due to Crever supplying heat to Rich before 2015, there is no past data on the natural gas usage of Rich Hall in the data figures. As can be seen in the table

labeled “Natural Gas Usage...,” Crever’s natural gas usage decreased greatly after renovations separated it and Rich’s heating systems.

While going over the figures, there a couple key points to keep in mind. Though some buildings were recently renovated, some variables cannot be controlled. These variables include weather, number of students, and the price of electricity. Along those lines, numbers will might also decrease during the renovations, as people are not capable of using the building while renovations are occurring. Because of this, is may still take a few more years to get a better idea on how the upgrades have impacted utility usage.



**Figure 2.** Renovated residence halls: Rich 2013, Crever 2014, Wesley 2015, compared to non-renovated residence halls.

## Renewable Energy

### Solar

Lycoming College’s involvement in the solar program began after Dr. Mel Zimmerman and Clean Water Institute interns, Megan Schulze ’11 and Tracie Curtis ’09, attended the Solar Scholars Conference at Dickinson College to learn more about the advantages of solar energy. Attendance at this conference, hosted by the Sustainable Energy Fund, led to a competitive grant process involving institutions that were interested in receiving a grant for a 3.1 kW Photovoltaic (PV) system. After applying for the \$15,000 opportunity amidst competition from thirty-six other colleges and universities, Lycoming was one of twelve institutions to be awarded the grant. On November 12, 2009, a 15-panel Photovoltaic (PV) system was installed on the roof of the Heim building and the electrical output began to be monitored.

According to Eduardo Lorenzo, author of “Solar Electricity: Engineering of Photovoltaic Systems,” the method employed uses semi-conductors, usually consisting of silicon, to capture solar rays. The rays captured consist of photons, whose bonds are broken, which allows the photons to move around freely to create an electrical current that can be transmitted into an electrical system and subsequently, monitored.

The solar photovoltaic system output in 2010 was compared with the energy demands needed to run equipment, not including lights, in three of the Clean Water Institute laboratories. Room 112 houses a refrigerator and two incubators (1.021 kWh), room 105 contains a 150-gallon saltwater tank with a separate emergency circuit (0.972 kWh), and room 120 has two incubators (0.240 kWh). On average, these labs require 1.909 kW per hour, 45.816 kW per day, and 1393.57 kW per month. As of March 5, 2012, the total output of the solar photovoltaic system since its November 12, 2009 installation is 8369.9 kWh, and it is estimated that the PV system offsets the equipment energy demand by approximately 40%.

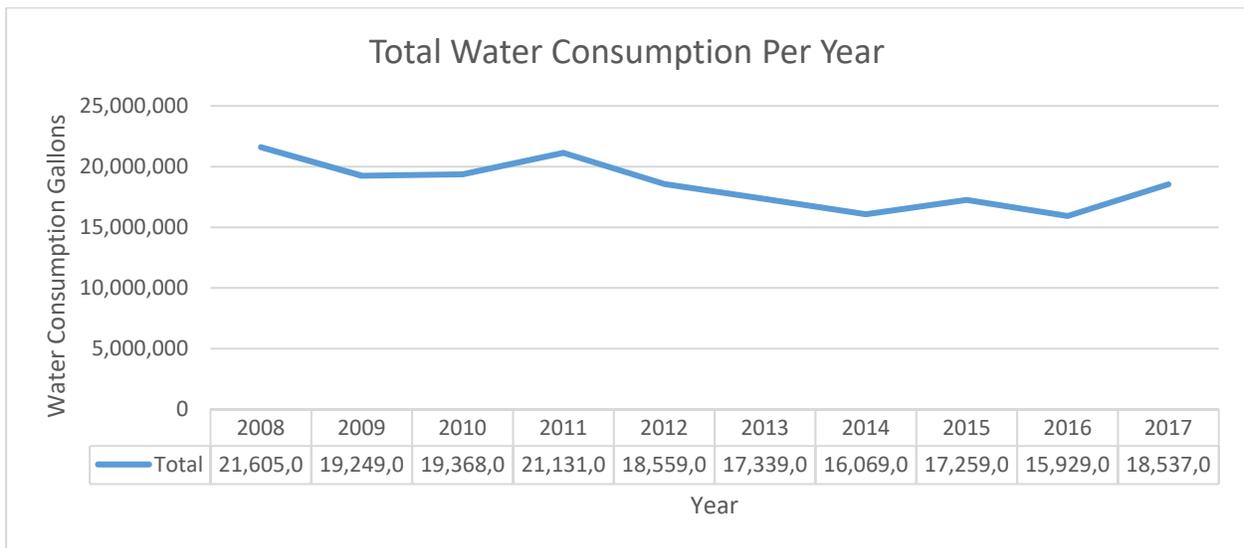
## **Overall Recommendations**

By using 2017s data, there are three categories of recommendations to help improve energy usage on campus. Firstly, by re implementing the bio diesel program, it would reduce fuel costs for on campus vehicles. An estimation from a contracting company should assess the cost needed to fix the system. This price will have a short-term payback period, making it not only cost effective but also sustainable for Lycoming’s campus. Another recommendation, is to look at other possible companies to purchase electricity. Currently, 0% of the energy that is provided by Constellation uses renewable energy as a source. Instead, a company like Triegle produces 10% of its energy with renewable technology. This helps to reduce the carbon footprint and allows for the large-scale use of renewable energy systems. Though the price may not be the lowest, it allows customers to vote with their dollar and support renewables.

In the future, Lycoming should investigate finding more grants and support for other solar power projects such as water pumps for the campus swimming pool and solar recycling compactors. The solar recycling compactors and possibly even solar composting units would be a perfect addition to campus because its small size inhibits the effects of smaller scale projects. These two projects would be ideal to use as sustainability teaching tools for educating students, faculty, and the community.

# Water

Williamsport Municipal Water Authority (WMWA) provides Lycoming College with water. This facility extends its services to over 50,000 residents living in Williamsport, South Williamsport, Duboistown, Loyalsock Township, and Newberry. The plant filters water from two, 650 million gallon reservoirs, as well as groundwater as needed during periods of drought from a field along the Susquehanna River. The WMWA publishes a yearly update of their drinking water quality, which can be found on their website: [www.wmwa-wsa.org/waterquality.htm](http://www.wmwa-wsa.org/waterquality.htm).



**Figure 3.** *Depicting total water usage for Lycoming College from 2008-2017.*

Lycoming College currently has three active wells set aside for watering and lawn maintenance. One of the wells is located at the practice field located on the southern end of campus, and the second is located by the graduation steps on the quad. The largest of these wells is located at the stadium, and it is used the most frequently to irrigate the practice fields and the softball field. The college also owns a fourth well, however this well is not in current use. This well is located between Heim and Forrest Hall.

In 2008, Don Cook of Don Cook’s Scuba Equipment made a significant repair to the Lamade Gymnasium pool. The pool developed a pervasive leak that lead to thousands of unnecessary gallons of water consumption to keep the pool filled to proper levels. This repair potentially helps explains the 3,244,099-gallon reduction in water use from 2008 to 2009. Consumption has steadily decreased from 2011, which will hopefully continue into the future.

A number of changes aid in the steady decrease of consumption. In an effort to boost sustainability efforts the college continues to install water efficient showerheads and toilets whenever possible. The more efficient showerheads expel 2.5 gallons per minute (gpm) and the toilets range from 1.6 to 3.5 gallons per flush (gpf). As older toilets break, which typically use 3.6 gpf or more, Buildings and Grounds replaces them with the new, more efficient toilets.

The data for water usage can be found in Appendices 2, 3, 6, and 7. In 2014, Buildings and Grounds discovered a leak in the water pipes that lead to the alarming increase of Long Hall's water consumption; the leak has since been attended to. Since the leak, water usage for Long Hall is now recorded by the same meter that records water usage for Asbury.

Renovations made to Rich Hall in the summer of 2013 led to a greatly decreased water consumption in 2014. These renovations included new showerheads and more efficient toilets. Lycoming College projected that the 2015 water data for Crever Hall would reflect a similar reduction close to that of Rich Hall in 2014. During the summer of 2014, Lycoming College remodeled Crever, installing boilers that require less water, efficient showerheads, and efficient toilets, along with installing another meter to measure the building's water consumption. However, the data compiled for 2015 does not corroborate with those projections. While Crever Hall water consumption for 2015 has decreased compared to 2014 values, it has not seen a reduction anywhere close to the Rich Hall 2014 reduction. Also, Rich Hall did have a significant decrease in 2014, but that has not carried over into 2015. The 2015 Rich Hall water consumption is nearly 3 times the amount of water consumed in 2014.

In 2017 water consumption continues to increase in Rich (now up to 1,410,000 gallons) and is now slightly over the 2014 levels. Although, since Rich is a female only dorm the total water consumption could theoretically be higher because of the number of showers girls take. Even though the overall water consumption has now increased since in remodel in 2013, the amount of water used from 2008-2012 averaged 2 million gallons. The increase then to 1,410,000 gallons can then be put into perspective and observed as a large overall decrease. Crever illustrates a similar pattern of decrease in 2016, where 907,000 gallons dropped to 840,000 gallons. In 2017, the decrease in Crever's water usage continued from 2016 dropping from 840,000 to 832,000. The decreased continued since 2015 and the measurements in the remodel to reduce water usage and increase efficiency are working.

In 2015 Wesley was remodeled with efficient showerheads and toilets like Crever. The building also now houses about 40 less residents than before its remodel in 2015. 2016 was going to be the first year with water data after the remodel, but there was a problem with the water line. The Wesley line itself only

recorded 15,000 gallons in the whole year for the building. Therefore, in the upcoming years future audits must determine if Wesley has a shared line with another building or if there was just an issue with the water line in 2016. The water line has been fixed in 2017 and the water line for Westley recorded 718,000 gallons in 2017. Before the building was remodeled Wesley water usage was 1,056,000 gallons and after the remodel it is down to 718,000 gallons of water usage.

Figure 3 depicting the total water consumption data shows a return to a continuation of the previous trend from 2011-2014, where the Lycoming Campus used lessening amounts of water each year. In 2015, there was a slight increase from the previous year but 2016 continues the trend of using less water on campus. In 2016, the decreasing trend returned and water usage is at its lowest level since the audit began. 2017 there was an increase in water usage.

## **Sewage**

The Williamsport Sanitary Authority (WSA) treats all of Lycoming College's sewage. The WSA maintains two secondary wastewater treatment plants, the Central Plant and the West Plant. The Central Plant serves residents living in the Williamsport area lying east of Lycoming Creek, eastern Loyalsock Township, South Williamsport, and Armstrong Township. The West Plant on the other hand, serves customers residing in the Williamsport area lying west of Lycoming Creek, portions of Old Lycoming Township, Loyalsock Township, Lycoming Township, and Duboistown. It is estimated that approximately 10.5 million gallons of water per day (mgal/day) passes through the Central Plant and 5.5 mgal/day of water passes through the West Plant. Lycoming College's sewage goes directly to the Central Plant near Basin Street.

A \$125 million upgrade of both the West Plant and the Central Plant was mandated by the Environmental Protection Agency and the Department of Environmental Protection in an effort to reduce nitrogen and phosphorus discharge levels to the Chesapeake Bay and to also reduce the frequency and severity of combined sewer overflow systems (CSOs). Modifications to the West Plant began in 2000 and were recently completed sometime between 2011 and 2012. The West Plant upgrade was meant primarily to reduce the discharge severity of combined sewer overflows, but nitrogen removal capabilities were also incorporated into construction. The Central Plant however, is still in the process of being upgraded and construction is focused primarily on reducing the nutrients, namely nitrogen and phosphorus, which are discharged to the Chesapeake Bay. However, there is also hope that the upgrades being made to the Central Plant will help to reduce combined sewage overflow events that occur during heavy rains. Combined sewage overflow has detrimental effects to the health of the Chesapeake Bay because storm water that comes into contact with roadways and sidewalks can transfer raw

sewage directly into the West Branch of the Susquehanna River. The upgrade of the Central Plant in particular, is a proactive move that reduces nitrogen concentrations in the West Branch as a part of the Chesapeake Bay initiative and has had success in lessening a factor that has had so much of an effect on the bay.

On March 27, 2013, the Williamsport Sanitary Authority signed a sales and service agreement to acquire and maintain the sanitary collection system that was previously owned by Loyalsock Township. The purpose of the agreement is to direct finances onto purchases and investments that are more important to sanitary treatment by reducing administrative costs and unnecessary operational costs and equipment purchases.

Ultimately, the upgrade of both the West Plant and the Central Plant may lead to a reduction in the rate customers pay for sewage treatment. Over the past five years, in particular, rates imposed to customers have been high in order to fund the construction of the two upgrades. According to John Baker, the authorities' director of finance at the Williamsport Water Authority, "On average, a household using 52,000 gallons a year pays \$808 annually" (Maroney, 2013). Until all nutrients credits are purchased and other costs involving the operation, administration, and construction of the upgrade are handled, budget costs are expected to remain high. According to Doug Kuntz from Buildings and Grounds, the campus is currently paying 1.5 cents per gallon for domestic sewage and water for the years 2013 and 2014.

The Lycoming College Clean Water Institute (CWI) has participated in an educational effort in the city of Williamsport to encourage the public to not dump materials down storm water drains. Storm water that contains materials like trash, grease, grass, and motor oil is not treated like sanitary waste water and many residents are not aware that the harmful chemicals contained in these substances are carried to the Susquehanna River, and eventually to the Chesapeake Bay. In Williamsport, there are 13,000 storm water drains, with one hundred and ten of these located in and around the campus of Lycoming College. In the past, CWI interns were engaged in a storm water stencil project to warn the public to not dump down storm drains and to promote awareness about how harmful chemicals from wastes find their way back to the Chesapeake Bay.

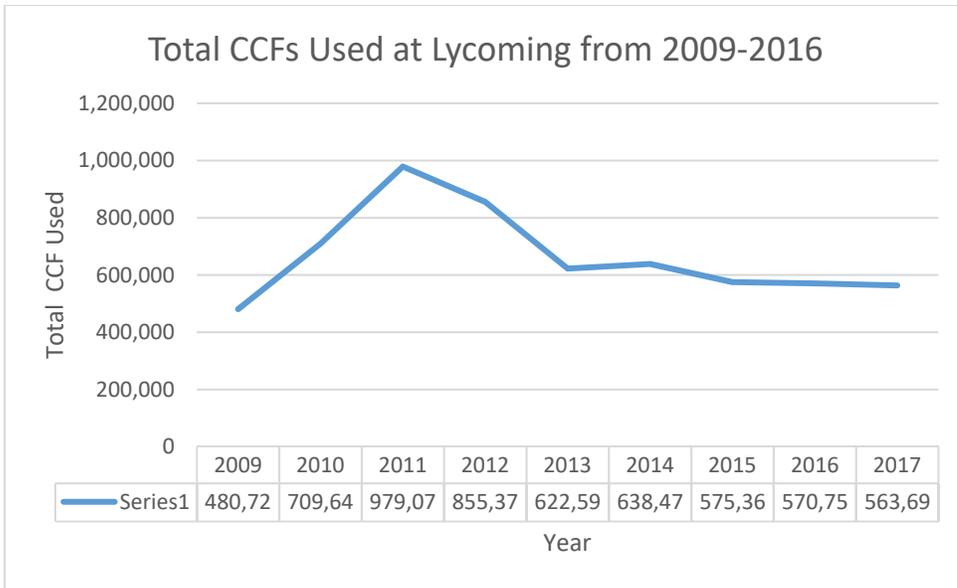
## Natural Gas

In 2008 Lycoming College used a considerably higher amount of gas than in 2009. During this year, the temperatures dropped by an average of 4-6°Fahrenheit between January and March across the northeastern United States. Due to this drop-in temperature, the school required more gas to heat campus buildings. To

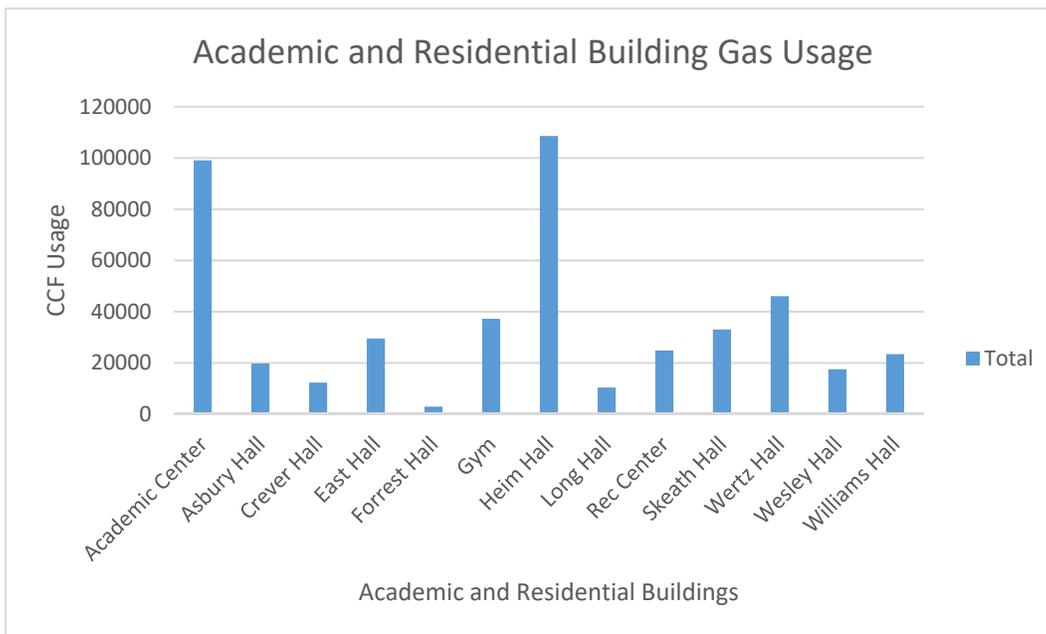
compensate for the increased gas usage, the college reduced the temperatures in the dormitories (East, Wesley, Williams, Forrest, and Asbury) 11 during winter break to 58° Fahrenheit. Typically, dormitories are kept at 68° Fahrenheit, but in 2008 temperatures decreased by an additional 10°.

In 2010 Lycoming College switched its natural gas provider from UGI Utilities, Inc., a subsidiary of UGI Corporation, to Hess Corporation because the latter provided more economic benefit. Hess Corporation provided the school with the ability to consolidate its gas usage totals from all the campus buildings. This meant that the school could now purchase MCFs (1000 cubic feet) rather than CCF's (100 cubic feet). However, this switch only lasted one year and even when Lycoming switched the College still used UGI's gas for a plethora of buildings. In 2016 Lycoming College continues to use UGI as its provider of natural gas and the CCF measurement. All the calculations performed in this audit regarding natural gas are measured and referred to as CCF, instead of MCF.

Figure 4 illustrates a decreasing usage of natural gas since 2011. From its peak usage in 2011, the total CCF's have been almost cut in half. This decrease could be influenced by weather and warmer winters. Then with warmer weather, less natural gas is needed to heat the buildings on campus. Yet, the decrease could also be attributed to the end of the large gas boom in the Northcentral Pennsylvania area. From 2010-2012 especially, there was a large increase in drilling for natural gas near the college. An increase in drilling meant more gas was available for use at a lower cost, therefore being a preferable energy of choice for the college. Figure 2 shows the four largest consumers of natural gas for academic and residential buildings in 2017 were: Academic Center, Heim, Skeath, and East. With 2017, the Academic Center took over Heim as the largest consumer of natural gas. Heim used to be the largest consumer of natural gas three years in a row. Figure 3 shows that months where school is in session, the natural gas is used more than the out of school months of May, June, July, and August.



**Figure 4.** Depicting total natural gas usage for Lycoming College from 2009-2017.



**Figure 5.** Shows the overall gas usage in both academic and residential buildings in 2017.

# Infrared Thermography Report

## Asbury Hall

### Inspection Date and Time:

March 21, 2018 13:40

### Prepared for:

Dr. Melvin Zimmerman

### Prepared by:

Anthony Mancuso

### Inspectors:

Anthony Mancuso

Samuel Lamport

### Lycoming College:

700 College Place

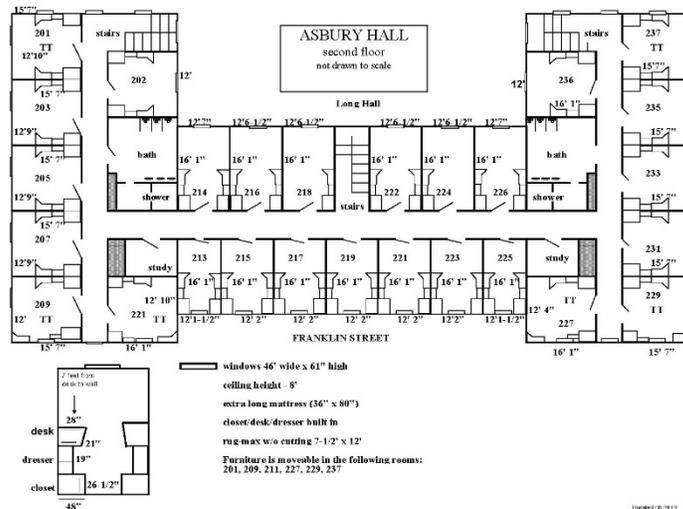
Williamsport PA 17701

(570) 321-4000

1 (800) 345-3920

### Report Number:

000001



## **Introduction**

Infrared thermal imaging is utilized to create a heat map of a wall, door, window, ceiling, or a floor to see heat spots in order to visualize where heat may be escaping or infiltrating the building. For every shot the camera was set to take both a normal visible light photo as well as an infrared photo showing a heat gradient for the shooting frame. All photos were taken with the camera units set to degrees Celsius.

## **Inspection**

This inspection was conducted on Asbury Hall, a freshman Residence hall on the Lycoming College campus. This dorm has not been recently renovated and so still has single pane windows, and under window radiators. The reason for this inspection was to catalog the shortcomings of the dated windows and heating system. Before beginning the inspection, the number of windows and doors were counted on the exterior of the building, the total number of windows was then multiplied by 0.1 to determine a ten percent sample size. Asbury Hall has 126 windows and the ten percent sample for the hall is 12.6 windows. The sample was randomized by knocking on every door on a floor until three or four people answered and granted access for the survey.

## **Weather**

This inspection was conducted on March 21 2018. The exterior air temperature was 7.8 degrees Celsius. Williamsport PA did also receive approximately two tenths of an inch of snow on the 21 of March. winds were mild and not much to speak of. even though it snowed the cloud cover was also minimal.

## **Observations**

Many of the windows shot on this day showed to be much cooler than the inside air temperature. Around 14 degrees C on average. Many of the windows also had heat leaks around the perimeters most likely due to the older inefficient design of the windows, or leaky/broken gaskets within the window mechanism.



*This photo shows room 101: looking at the circled area you can clearly see that there is 8.6 degree C air coming in through the poorly sealed joint in the window. This could be due to a broken or missing gasket*



*This photo also shows room 101: and in this photo you can see by the indicated area that there is 8.9 degree C air coming in along the right hand side of the window.*



*This photo shows room 229: the indicated area of this photo shows an air leak of 6.3 degrees C. as well as the whole base of the window allowing 7 degree C air to infiltrate the room.*



*This photo was taken in the stairwell on the second floor and shows an 8.8 degree C air leak around the perimeter.*



*3<sup>rd</sup> floor hallway: I noticed that this hallway was very chilly, upon shooting I found that there was a major heat discrepancy at the window in this hallway.*



*Room 311: this image shows that the warmest part of the window is a chilly 16.4 degrees C and the cool spot is only 8 degrees C*

# Infrared Thermography Report

## Crever Hall

### Inspection Date and Time:

March 21, 2018 14:45

### Prepared for:

Dr. Melvin Zimmerman

Dr. Robert Smith

### Prepared by:

Anthony Mancuso

### Inspectors:

Anthony Mancuso

Samuel Lamport

### Lycoming College:

700 College Place

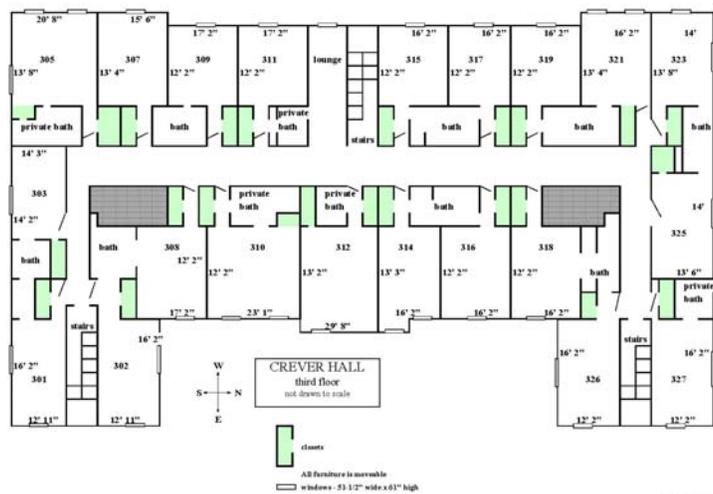
Williamsport PA 17701

(570) 321-4000

1 (800) 345-3920

### Report Number:

000002



## **Introduction**

Infrared thermal imaging is utilized to create a heat map of a wall, door, window, ceiling, or a floor to see heat spots in order to visualize where heat may be escaping or infiltrating the building. The camera used for this survey is a flir C2 thermal imaging camera. For every shot the camera was set to take both a normal visible light photo as well as an infrared photo showing a heat gradient for the shooting frame. All photos were taken with the camera units set to degrees Celsius.

## **Inspection**

This inspection was conducted on Crever Hall, an Upperclassmen Residence hall on the Lycoming College campus. This dorm was recently during the summer of 2014 and so has new multi pane windows and central HVAC which should serve to be fairly energy efficient. The reason for this inspection was to catalog the shortcomings of the dated windows and heating system. Before beginning the inspection, the number of windows and doors were counted on the exterior of the building, the total number of windows were then multiplied by 0.1 to determine a ten percent sample size. Asbury Hall has 126 windows and the ten percent sample for the hall is 12.6 windows. The sample was randomized by knocking on every door on a floor until three or four people answered and granted access for the survey.

## **Weather**

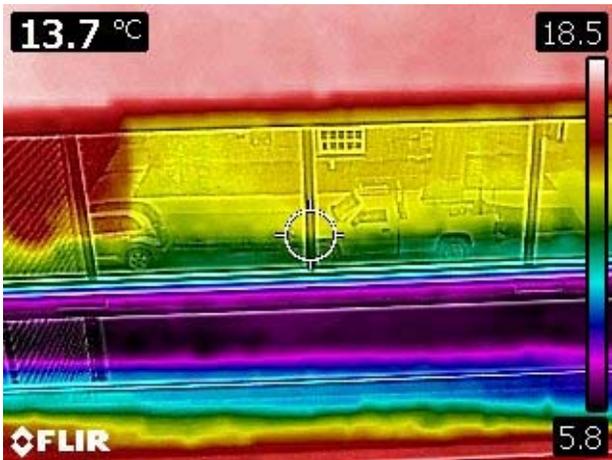
This inspection was conducted on March 21, 2018. The exterior air temperature was 7.8 degrees Celsius. Williamsport PA did also receive approximately two tenths of an inch of snow on the 21 of March. Winds were mild and not much to speak of. Even though it snowed the cloud cover was also minimal.

## **Observations**

Overall this building seems to have pretty efficient windows. Of the rooms sampled with their windows closed the windows were a reasonable temperature compared to the room temperature. I believe that the inefficiencies in Crever hall are due to the thermostat temperatures being too high for the student's comfort, causing them to crack their windows open.



*This photo is of room 326: the center of the glass pane is only around 20 degrees C. The cold spot on the bottom is also only 15.6 degrees C*



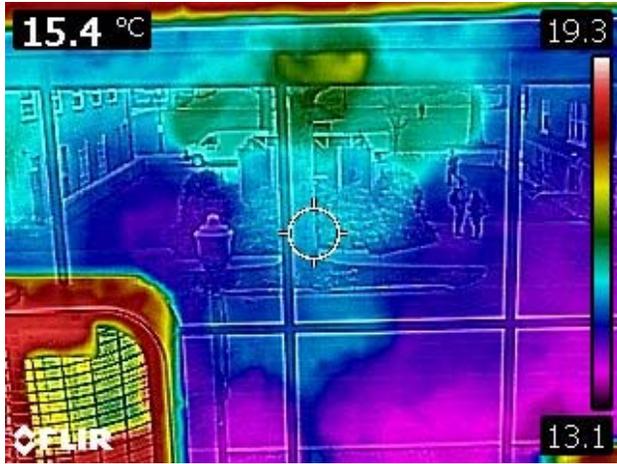
*Room 318: these students are forced to have their window cracked due to lack of control over their thermostat and being uncomfortable in the temperature of their room.*



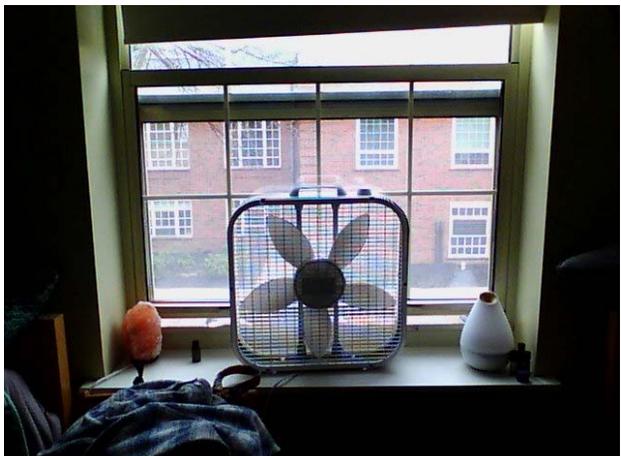
*Room 318: the other window in room 318 is also cracked , suggesting an inefficiency in the heat being sent to the rooms.*



*Room 210: these students were also uncomfortable with the temperature of their room and so had to crack the window to regulate.*



*Room 210: this closed window shows in the same room the efficiency of the windows when closed to retain heat within the room, the cool spot is only around 6 degrees C cooler than the room temperature.*



*Room 226: this room also has the window cracked because the students weren't comfortable with the temperature.*

## Dining Services

There is a focus on the food sector of the College in this audit to determine where our food comes from and how much of it is organically and locally grown. Buying from local farmers strengthens the economy of the local community by cutting down the travel time it takes food to arrive to dinner tables.

Lycoming College outsources its food services to Parkhurst Dining, a company whose commitment to sustainability is a leader in the industry. While most of Lycoming's food comes from USFood's distribution center in Altoona PA, Parkhurst also purchases food nationwide, much of which is bought locally and in various other areas of Pennsylvania. According to Leslie Ekstrand, the General Manager of Dining Services, milk is purchased from Schneider Valley Farms distribution center, located on Third Street in Williamsport, PA. Schneider Valley Farms, in turn, purchases its milk from farmers in Pennsylvania and New York. Bread and buns are purchased from the Bimbo Bakery branch in Northumberland, PA, sub rolls are purchased from New Lycoming Bakery in South Williamsport, PA, and bagels are purchased from Georgie's Bagels in Berwick, PA. In season local vegetables are purchased from Pocono Produce in East Stroudsburg, PA and in season apples, peaches, and pears are purchased from Dries Orchard in Sunbury, PA. Canola oil is purchased from Susquehanna Mills Co. in Montoursville, PA. The oil provided by this company is converted to biodiesel in a processing shed located on Willow Street in Williamsport, PA, and later returns to the Susquehanna Mills Co. to be used as fuel on the Susquehanna Mills Co. farm. Pork products are purchased from Clemens Food Group in Hatfield, PA and ground beef is purchased from Milky Way Farms in Troy, PA. In addition, the purchase of farm shares from Walnut Run Farm located in the Nippenose Valley in Lycoming County, PA has been considered. Walnut Run Farm is a local farm specializing in the producing of vegetables like artichokes, cucumbers, onions, beans, beets, carrots, tomatoes, lettuce, squash, and more. Efforts are made to purchase from local sustainable farms whenever possible, and Lycoming College Dining Services currently purchases around 20% of their overall purchases from vendors that are considered local, or are within 125 miles of the college.

Sustainability efforts have also reached Lycoming College's other dining locations like Jack's Corner and Café 1812. Jack's Corner is making an effort to transition from using aluminum foil to waxed paper to wrap food that is taken out by students, but hasn't fully made the switch. In the future, the establishment hopes to eradicate its use of aluminum foil all together. According to Jay Breeding, the Assistant Director of Dining Services, plates that are now used are tree-free and to-go containers are made from corn and are biodegradable. Management has now replaced Styrofoam cups with cups made from more cardboard material. However, Jack's is required by the company that makes the Freshens smoothies to keep the Styrofoam cups for its smoothies. Café 1812, which is a small establishment that

serves coffee and food products to students and faculty, uses cardboard for its drinks. Additionally, Café 1812 participated in the Fair Trade Agreement with coffee bean farmers who will only buy coffee beans from sustainable farms, or farms that are working towards becoming sustainable. Starting in 2017,

Café 1812 will be moving to Alabaster coffee products (still Warrior One Bean). The business is actively involved in sustainability by serving organic coffee, and recycling paper products like soup bowls, bakery bags, coffee bags, and plastic products like milk cartons. To encourage sustainability on campus, the establishment offers a discount on regular coffee if students bring their own reusable cup. Package products are also reduced to two per meal swipe. Café 1812 now charges for plastic cups for water, but if an individual brings a reusable the water is free. To improve sustainability in Café 1812 employees have suggested recycling receipts used in taking orders because they generate around three trashcans worth of waste each day.

Dining Services has been striving to become environmentally sustainable through its catering practices and efforts are being made to replace plastic ware with chinaware and to suspend the use of plastic utensils. There have even been considerations to buy recyclable utensils and/or “spudware,” utensils made from potatoes! For instance, the sustainability sector at the University of Wisconsin-Green Bay has utilized biodegradable dishware that is made of corn, potatoes, and limestone (Patrick et al. 2008). However, plastic utensils are still used occasionally and these goals have not yet been reached.

At the beginning of the spring 2014 semester, dining services introduced the Reusable To-Go Container Program as a way to reduce waste and promote campus sustainability. The program replaced unsustainable plastic containers with containers that are washable. Prior to the implementation of this program, it is estimated that Lycoming disposed of approximately 1,500 to 1,700 plastic containers weekly and 24,000 containers throughout the semester. Currently, there are six hundred “green” boxes that are being distributed in the cafeteria, all of which that are washable, reusable, and responsible for reducing the waste existing prior to the spring semester. The program, despite being received with mixed feelings, is a convenient and easy system for students, especially if they are on a meal plan. Students using a meal plan can simply ask for a to-go box, use it, bring it back to Wertz to be washed, and receive a “green box ticket” that enables them to obtain another box. Commuter students or visitors who are not using a meal plan must pay \$4.50 for their first box and must return the box to the cafeteria to be washed. According to Leslie Ekstrand, the General Manager of Dining Services, approximately 100 to 125 students ordered take-out prior to the implementation of the Reusable To-Go Container Program and currently, around 110 to 140 students ask for take-out with the “green” boxes. Based on these statistics, Ms. Ekstrand does not believe that the boxes are having any effect on student to-go practices yet, perhaps due to students’ difficulties with handling change.

In February of 2014, dining services entered a partnership with Northern Tier Sustainable Meats, a consortium of local beef organizers brought together by Kim Seeley of Milky Way Farms in Troy, PA. Kim Seeley established Northern Tier Sustainable Meats in 2005, and since its establishment, it has offered customers a local, sustainable, and convenient way to purchase a variety of meats including pork, ham, and beef. Founded in 1962 by Lewis Seeley, Milky Way Farms is currently operated by the 4th generation of the Seeley family to produce beef from grass-fed cattle. In addition to producing beef from livestock that are grass-fed rather than corn-fed, the Seeley family also practices pesticide-free farming, pasteurizes and bottles milk at the farm rather than at a plant, and sustainably produces other dairy products like butter, heavy cream, ice cream, and cheese. By being local, Milky Way Farms reduces packaging and travel costs normally associated with factory processing by selling its products directly through its Milky Way Store, as well as through Penn College of Technology, Bullfrog Brewery, and the Peter Herdic House in Williamsport. The partnership between Dining Services and Northern Tier Sustainable Meats is an environmentally friendly decision that reduces travel costs, saves oil, and gives students meat that is more likely to be higher in nutrients.

2016 saw the introduction of the renewable cup program in Wertz. The to-go cups were removed and each student was given a Lycoming cup valued at 7 dollars. Cups can be used to take drinks from Wertz, but must be cleaned by the student. The cup will be given at the beginning of a student's freshman year and if lost students can purchase a new one from the book store at \$7. Reusable cups are also available at Café 1812 for thirteen dollars. Removing the to-go cups has an estimated savings of \$40,000 for dining services each year. This money could then go into serving higher quality food during the school year or supplement the purchase of new equipment. The waste that was generated by the to-go cups was approximately 6,000 to 8,000 cups weekly, which added up to around 96,000 cups throughout the semester; a staggering amount of waste surmounting the waste produced by the plastic to-go containers. Mount Holyoke College's "sustainable mug" program has saved them approximately 31,000 gallons of water and 5 tons of paper, a staggering amount of material that was used in the manufacture of the 322,700 paper cups used by the college annually.

### **Warrior Coffee** (<http://www.lycoming.edu/coffee/> )

In October 2014, Lycoming College joined the Cultivation to Cup (C2C) network, partnering with Golden Valley Farm Coffee Roasters (GVF) and Parkhurst Dining, to offer Warrior Run. Warrior Run is Lycoming College's own brand of organic, shade-grown coffee from the Las Lajas farm in Costa Rica.

### **Food Waste**

Dining Services has been changing its own policies in the last few years in an effort to become more sustainable. The tray-less initiative, which dining services introduced in the 2008-2009 school year, was one a notable change that helped to reduce food waste and water usage. First, trays were not used on Tuesdays and then, an additional tray-less day was added each week until trays were no longer available. The purpose of the tray-less dining hall is to:

- 1) Reduce the amount of food waste produced
- 2) Decrease the amount of water going into and out of the Wertz Student Center
- 3) Reduce the amount of electricity used in running the dishwashers
- 4) Decrease the amount of dish washing chemicals that are purchased and wasted

As a result of this initiative, dining services was able to reduce the amount of food waste that is comparable to that which is produced by eight, fifty-gallon trash cans, and water usage by about 360,000 gallons per semester.

All campus wastes are disposed of at the Lycoming County Landfill. Prior to 2014, all food waste was mixed in with other solid wastes from around campus and was measured in tonnage. Because of limited space, there were no dumpsters outside of the Wertz building and each day, food waste was refrigerated in order to reduce odor and insect problems. The waste was then transported to the county landfill for disposal.

However, in January of 2014, the Sustainability Committee launched the Food Recovery Network, an organization that assists colleges in collecting food from dining halls and other campus dining facilities to donate to local food banks and soup kitchens. This new initiative was made possible by the Bill Emerson Good Samaritan Act, which helped to cover any liabilities, and a grant that covered the cost of the containers that were used to transfer food. Collections are made by volunteers and members of the Sustainability Committee Monday through Friday and are delivered each week to the American Rescue Workers. The Food Recovery Network is a new organization that seems to have much promise for lowering food waste from campus and for helping the local community.

## **Food Waste & Hunger Summit**

The weekend of April 5 and 6 at Northwestern University in Evanston, IL marked the first annual Food Waste & Hunger Summit, which was co-hosted by the Campus Kitchens Project and the Food Recovery Network. The conference served to gather student leaders who have worked to reduce food waste in their own communities in an effort to educate and introduce them to new ideas relating to the reduction of food waste and problems concerning food insecurity. Students attending the conference listed to a variety of experts from fields relating to social

justice, social enterprise, public health, and non-profit management in order to learn more about how they could work more efficiently with their local communities.

The Campus Kitchens Project (CKP), a co-host of the event, provides community service for students that focuses on hunger relief through the development of models that are used to combat hunger in the students' local communities. In other words, the project aims to build strong leaders out of high school and college students alike, by encouraging them to develop solutions to problems they encounter in their schools and their towns and cities. The Campus Kitchens Project works to help communities help themselves by building leaders who are capable of developing solutions to poverty and food waste. The overall mission of the Campus Kitchens Project is to strengthen bodies by using existing resources to satisfy the hunger and nutritional needs of the community, empower minds by providing leadership opportunities for students and educational benefits for adults, and to build communities by building a network of partnerships among students, schools, and businesses. Currently, fifty-two schools, including Lycoming College, are involved in the Campus Kitchens Project and are actively involved in a food reduction program like the Food Recovery Network at their institution.

In the spring of 2014, three Lycoming students, Emily Vebrosky '14, Lynette Dooley '15, and Julian Jones '16, attended the Food Waste & Hunger Summit conference in Evanston, IL. Throughout the entire semester, the Sustainability Committee has been working alongside LEAF and student volunteers to recover leftover food from the cafeteria every Monday through Friday after lunch and dinner. The food that is recovered is then donated to the American Rescue Workers in Williamsport, PA. As of April 2018, the Sustainability Committee at Lycoming College has recovered 35,000 lbs of food from the cafeteria to be donated!! The impact this has on the community is unquestionable, especially with American Rescue Workers as the college is their primary food provider. The college will undoubtedly continue participating in the Food Recovery Network in the future and help the community as the years go on.

## **Appliances**

In an effort to make the campus more sustainable, employees have been urged to turn off their appliances after they are finished using them. This request to Lycoming's workers to "Flip it Off" has been of particular importance because the majority of the appliances on campus are at least thirty years old. However, outdated appliances are gradually being replaced with newer, more energy efficient appliances as they wear out. In 2009, Dining Services made the switch to a more sustainable, electric gas oven. Electric gas ovens contain no pilot light, spark and light on demand, and are better insulated; qualities that all work to reduce cooking time. Many light fixtures have begun using Compact Fluorescent Light (CFL) bulbs with special care being taken to not use CFL bulbs on lights that are used to warm

food. Dining services management also tracks the costs of equipment repairs in comparison to the original cost of the equipment to determine whether or not it would be more cost effective to replace that piece of equipment with a more sustainable model. The most energy consuming appliances in the kitchen are the dish washer, bakery oven, and the coolers and freezers. The dish washer generates a high amount of energy because it runs constantly is fueled by steam-generated water pumps. The bakery oven generates a large amount of energy because it is continuously rotating, and the coolers and freezers owe their high energy to the fact that they are continuously running for twenty-four hours throughout the entire week.

### **Other Initiatives**

Parkhurst Dining Services, in addition to purchasing its food from local farmers, working to reduce food waste by participating in the Food Recovery Network, and helping to reduce energy by turning off appliances when not in use, is helping with environmental sustainability in other ways. Parkhurst is working with the school to convert used fryer oil into biodiesel fuel for use by the Susquehanna Mills Co. farm. Cardboard products are currently being recycled, and efforts are being made to find available space to recycle more plastics. During the 2008-2009 school year, dining services replaced individual ketchup bottles on each table with a condiment station containing fast food-style pump dispensers. In addition to this, bleached napkins were replaced with napkins made from post-consumer recyclable materials.

Parkhurst and Lycoming College's Building and Grounds staff are looking into more ways to recycle the large volume of cans and plastic bottles that are generated every week by the college. Currently, the cans and plastic bottles are picked up each day and sent to recycling by the building and grounds crew.

### **Recycling**

Climate change, groundwater contamination, and greenhouse gas emissions are becoming of greater concern to environmentalists and individuals with an average or below average interest in the environment, alike. The EPA estimates that increasing the rate of recycling from 30% to 35% is enough to reduce greenhouse gas emissions by ten million metric tons of carbon equivalent (Patrick et al. 2008), suggesting that steps taken by small campuses like Lycoming are enough to make a difference. Every building on campus is equipped with recycling bins on each floor that are able to collect recyclables such as glass, plastic, aluminum, and paper. In addition, bins have been installed in each computer lab specifically for the collection of paper and other recycling bins have been placed in the professors' offices. However, recycling is more extensive in the dormitory buildings because the

trash rooms house glass, plastic, aluminum, newspaper, white paper, magazine, and cardboard recycling, as well as general trash cans. It is our hope in the future to install permanent glass, aluminum, and plastic recycling units beside each trash can in every building.

In March of 2012, Lycoming College received nearly 1,600, six-gallon blue recycling bins that appeared in every residence hall upon students' return from Spring Break. The receptacles were provided by the ALCOA Foundation's grant to encourage students to enhance their recycling efforts. Any excess bins were placed by the Building and Grounds staff in classrooms, faculty offices, and other common areas.

The ALCOA Foundation grant was discovered as a result of Lycoming College's participation in RecycleMania, an eight-week competition between colleges and universities that is meant to reduce waste, increase campus recycling efforts, generate attention towards recycling programs, and encourage students and faculty to pay attention to how much of their waste is actually being recycled and how much is being wasted so their campus can become more sustainable. With the help of Dr. Sue Gaylor, who drafted the proposal to help enable the school to acquire the bins, Lycoming College was one of thirty-two schools that were awarded the grant. Part of the stipulations of receiving the containers however, includes monitoring the impact that the bins have on student recycling efforts, which is a task that is assisted by the weight measurements and data collection that is required by RecycleMania.

As of 2015, Lycoming College is now a single-stream recycling university. Being single-stream means that any recycle material can go into the bins, making it easier than ever to recycle. Recyclables are then weighed by the recycling trucks once they arrive at the landfill. Once at the landfill, recyclables are separated into their own designated sections at the plant. In the future, having more outdoor recycling bins could increase the rate of recycling on campus. Currently, there is only one outdoor recycling bin located at the Snowden Library and Academic Center entrance.

## **RecycleMania**

Lycoming College is an annual participant in RecycleMania, a recycling competition active in the United States, Canada, and a few other countries that challenges colleges and universities to promote waste reduction over a 10-week period. This year, RecycleMania ran from January 24 to April 2; the first of the two weeks' act as a preliminary trial period.

Increased awareness for recycling through the efforts of the LEAF organization and the Sustainability Committee has helped to promote student

interest in recycling and waste reduction. Currently, efforts are being made to re-label the trash rooms to help make sorting recyclable materials easier to understand for both students and members of the Sustainability committee and volunteers who assist in recycling collections. Grants, like the ALCOA Foundation grant received in 2012, has helped to improve sustainability on campus by helping to ensure that recycling can be monitored through the use of small bins issued to each and every student.

In 2007, the first year Lycoming participated in the RecycleMania competition, Lycoming was ranked number one out of the ten Pennsylvania colleges and universities in the category of pounds and cans per person weekly. Lycoming won by recycling more recyclables both per person and overall than Dickinson College, Bucknell University, Millersville University, and Shippensburg University, among others competing that year. Overall, Lycoming ranked 12th out of 15 Pennsylvania schools in regards to collections of paper, corrugated cardboard, and food service organics. It is a hope that through awareness, both by the Sustainability Committee and the LEAF organization, that Lycoming students can be encouraged to recycle to this magnitude again in the future.

Now that Lycoming is single-stream we can no longer do individual categories of recycled items. The two available categories we can participate in are, total recycled goods and per capita recycling. The 2016 Recyclemania competition showed that Lycoming College has plenty of work to do to improve recycling amounts. Overall in total amount recycled, Lycoming College placed 198 out of 217 with 13,828 lbs. recycled. In the per capita competition, Lycoming College placed 137 out of 245 with 8.096 lbs. recycled per person. Increasing initiatives in recycling across campus will then improve these numbers and demonstrate that Lycoming is a leader in 21st century recycling and sustainability.

In the 2017-2018 school year, Lycoming College was able to record 14,646 pounds of recycled goods. This number compared to last year shows an increase in the amount of recycled goods collected from our campus by almost over 1,000 pounds.

## **TerraCycle**

Natural resources like water, timber, air, and even raw materials used for processing seem inexhaustible at times, but in reality, are diminishing in quality and amount as unsustainable waste practices persist. Waste, if not recycled, is typically disposed of in a landfill where it poses a risk of leaching chemicals into the soil and contaminating groundwater. If the waste is incinerated however, a more serious danger could arise in the form of dioxin, a persistent chemical that has been seen to cause cancer and other health effects. Recycling is practiced on campus

regularly, and requires that material be extracted from an item in order to transform it into a new product. Recycling is an effective way to reduce waste and is undoubtedly a better option than disposal in a landfill or incinerator. However, upcycling is a revolutionary technique that reduces even more waste by using every aspect of the item in order to make a new product. Two factors that are central to TerraCycle processing are the material the item is made from and the shape of the item. The program will then use the material and shape of the item in processing to create a product that can be used for a longer time without melting or changing recyclable in processing, reduces waste, eliminates the need for raw materials and processing, saves money that would be needed for manufacture, minimizes environmental impact, alleviates the effects of resource depletion and water withdrawal, and reduces the carbon footprint by lowering carbon emissions.

TerraCycle was established by the Sustainability Committee at Lycoming College during the spring semester of 2014 and is slowly growing into an organization that could become a popular way of reducing solid waste on campus. All bins that are used are located in the trash rooms and are made from 100% recycled plastic. The Sustainability Committee and any volunteers who are doing collections record the number and weight of the items present. An accurate record of the weight of the items is critical because the TerraCycle program is based on a point system of \$0.01 per item. The money earned from the TerraCycle point system accumulates quickly and Lycoming College currently donates all of its earnings to Charity: Water, an organization that works to bring clean drinking water to people in as much as twenty-two developing countries, specifically in areas like Sub-Saharan Africa, Central and South America, and South Asia. Charity: Water uses donations to find sustainable solutions for people in rural, impoverished areas through partnerships with local organizations in project areas.



Tetracycling bins introduced in 2015

The Sustainability Committee at Lycoming College is participating in 13 different TerraCycle Brigade Programs: Tom's of Maine Natural Care brigade, Personal Care and Beauty brigade, Brita® brigade, Solo® Cup brigade, Scotch® Tape brigade, Cleaner Packaging brigade, Drink Pouch brigade, Energy Bar Wrapper brigade, MOM Brands® Cereal Bag brigade, GoGo squeeZ® brigade, Bear

Naked® brigade, Entenmann's Little Bites brigade, and Writing Instruments brigade.

The Solo Cup Brigade collects plastic #6 Solo® cups and upcycles them into items like recycled dog bowls. The college is awarded two TerraCycle points for each unit of waste, which is any shipment over six pounds. The Personal Care and Beauty Brigade collects a variety of personal care items including shampoo, conditioner, hair gel, and hair spray bottles, caps, and triggers, lip balm and chap stick tubes, lipstick containers, powder and eyeliner cases, eyeliner and lip liner pencils, and much more. The Personal Care and Beauty Brigade will upcycle these items into products like tote bags, spiral notebooks, and pencil cases and the college receives two points per unit of waste as long as the shipment is over ten pounds. The Energy Bar Wrapper Brigade by Clif Bar is a focused collection of Clif Bar and Co. product packaging and any foil-lined energy bar, granola bar, and protein bar wrapper. The wrapper that is collected is upcycled into items like duffel bags, notepads, and clipboards, and the college gains a point per unit of waste as long as the shipment is over a pound. The Toms of Maine Natural Care Brigade focuses its collection on mouthwash bottles and caps, deodorant containers and caps, toothpaste tubes and toothbrushes, soap packaging, and floss containers. TerraCycle upcycles these personal care items into home décor products like paving stones and patio chairs, and the college receives a point per unit of waste as long as the shipment is at least two pounds. 2016 saw the Sustainability Committee ship out 15,070 Terracycle items and raised about \$150 for charity.

## **E-Waste**

E-waste is any form of consumer and business electronic equipment that is near to, or at the end of its useful life, and makes up about 5% of all municipal solid waste worldwide. Despite its small proportion in comparison to other forms of waste, it is much more hazardous, in that it contains compounds like cadmium, lead, mercury, and polychlorinated biphenyls (PCBs) that can damage human health and the environment.

An interview with Dave Heffner, head of the Information Technology Services (ITS) department, has helped to explain how Lycoming College handles its e-waste. Heffner said that the college is on a five-year cycle of computers with many of the newer ones entering the general computer labs and power users about every two or three years. The older computers are removed, and experience "tumble down," or reuse, in the professors' offices or labs. Computers that are out of commission are either sold to campus employees or traded into the manufacturer. An interview with Heffner revealed that IT Services does not strip large devices like hard drives and spam servers for parts and also does not strongly rely on eBay to sell unused

electronics. The computers that are not purchased are sent to Computer Parts and Electronics in South Williamsport, and are stripped of parts, sold, and recycled if they are unable to be sold. Upon removing all hazardous materials and scrap metal from the electronics, Computer Parts and Electronics ships all devices to Staiman's Recycling Corporation in Williamsport, PA. Computer Parts and Electronics will come to the campus to do a pick-up when outdated e-waste fills the ITS hallway to a level of about 224 cubic feet.

Lycoming College is fairly conservative in its five-year e-waste cycle considering that most other institutions operate on a two to three-year cycle, which generates more waste annually. Additionally, the servers or network equipment that are ready to be replaced are either traded into the manufacturer or sold on eBay and their destination is undetermined.

IT services has been actively pursuing other sustainable measures that many people may not have been aware of. In 2012, they started a five to six-year project where they began phasing out bulky, less-efficient equipment for newer, less energy consuming devices. In addition, they started implementing SANs (Storage Area Network devices) that house the faculty F-drive, student H-drive, and e-mail accounts. SANs are large specialized storage equipment that can be logically divided into smaller storage spaces instead of having separate storage in many

individual servers. The switch has reduced the cost of electricity to run, heat, and cool the SANs because one large server is more energy efficient than many small servers.

VMware is another innovative idea that has been utilized by IT Services. VMware, which refers to virtual machines, is an efficient idea that made it possible for IT Services to go from forty-seven servers to only ten. VMware makes it possible for IT Services to have fewer computers and instead, use a larger computer to increase utilization, consolidation, and efficiency while simultaneously decreasing heat, cooling, and electricity costs.

Other sustainable measures that IT services encourage include having student lab monitors shut down all computers every night and having faculty members do the same. This energy saving step is similar to the initiative that has been undertaken by the University of Ohio, in which Computer Management Software is used to shut down computers every night when not in use. This initiative saved the university approximately 15,150,000 kWh in energy and 15,000 tons of CO<sub>2</sub>, and its similarity to the step taken by IT services may give insight to how much energy is really being saved on campus (Patrick et al. 2008). In another initiative to control waste, a printing curve was calculated in 2000 to project the adequate print balance that should be allotted to all students. This allotment was determined to be six hundred pages and minimal charges were added onto the accounts of those who went over the printing limit during the semester. The limit on

printing was implemented because it was noticed that the paper waste in every computer lab was astronomical without a penalty for over-printing set in place. In addition, IT services recycles their toner cartridges after every use, and also recycles their cardboard boxes for shipping purposes when selling old servers on eBay.

Recently, the campus has converted the phone system to voice over IP (VOIP), which is a much more efficient way to offer phone services than the older large PBX equipment. In the future, more equipment will be consolidated into fewer, more efficient units.

Routine e-waste collections are made by Computer Parts and Electronics of South Williamsport, and IT collects E-waste once a month in their office. In the future, the college hopes to partner with the Funding Factory, a program that is a branch of Clover Technologies Group. The program is unique in that it provides fundraising to non-profit organizations like K-12 schools, colleges and universities, churches, local charity organizations, sports teams, and clubs and has no charge for participation and shipping for recyclables. The Funding Factory was established in 1997, and it is estimated from the Sustainability Report that is available on their website that approximately 14,118,678.81 lbs. of e-waste has been recycled through the program and that 58% of this waste consists primarily of inkjet cartridges. Since the Funding Factory's founding, it has helped raise over \$35 million dollars for non-profit organizations, making it one of the most popular fundraising-thru-recycling programs in the country. The program accepts a variety of products including laptops, laser printer cartridges, cell phones, and small electronics like digital cameras, mP3 players and iPods, GPS systems, and headsets. The Funding Factory works like TerraCycle because participants can redeem recycling points they accumulate for cash that they can either convert into a check that they can receive through the mail, or can use the cash they earn to buy a variety of classroom supplies and technology like tablets, laptops, printers, projectors, and more in the Rewards Catalog. In addition to fundraising, the program can also help businesses recycle their ink cartridges, which can serve as an indirect form of fundraising for the business' non-profit organization of choice. The Funding Factory would be a great addition to Lycoming's sustainability program because the program is easy, free, and is compatible with a variety of brands. The program even offers a ten cent minimum for all broken items, and the cash refunded for recyclables like some cell phones may reach up to \$108.00, which can be converted into cash that can be used by a non-profit organization. It is a hope that this program can be permanently implemented at Lycoming College in order to reduce e-waste that is landfilled, earn money for the college, and further spread awareness for sustainability on campus.

## **Campus Involvement**

## **Sustainability Committee**

The Sustainability Committee is a body of students and faculty members dedicated to the development, implementation, and promotion of environmental sustainability at Lycoming College. The committee works closely with Sustainability Coordinator, Dr. Mel Zimmerman, to develop initiatives that will promote campus environmental sustainability. The Sustainability Committee often reaches out to members of LEAF and other volunteers for assistance with sustainability projects like RecycleMania, food Recovery, and Earth Week.

## **Clean Water Institute (CWI)**

The Clean Water Institute (CWI) provides services to local watershed and environmental groups by developing and coordinating internships and independent study projects and making them available to Lycoming College students. Watershed projects that are offered to interns through the CWI require that they assist in data collection and analyses of water chemistry. In order to fulfill these requirements, the CWI team carries out any analysis in their water testing laboratory, which provides the groups with technical assistance in the design, collection, and interpretation of water chemistry. In addition, the college's CWI lab assist's interns in their analyses and interpretation of any data they find relating to macroinvertebrates, plankton, and fish. All data that is analyzed in the CWI lab is archived and continuously updated as ongoing projects develop, and results are made available to the public in order to promote awareness relating not only to the environment, but also to the health of watersheds and the Susquehanna River. The CWI, in addition to research, also provides educational and training programs. These programs may include an array of seminars and workshops focusing on a multitude of environmental issues, such as stream restoration, habitat improvement for native wildlife species, and water quality, and these awareness programs are offered to groups such as watershed awareness clubs and local schools.

The CWI is also responsible for the 3.1 kW 15 panel photovoltaic (PV) system that was installed on the Heim Science building on November 12, 2009. The solar power that these panels generate is sent to a power grid in Heim as a source of green energy that can be used throughout the facility. In addition, CWI interns also have an opportunity to study the Eastern Hellbender (*Cryptobranchus alleganiensis*), which is an entirely aquatic salamander that is an important indicator of water pollution that is now only found in drainage areas of the Allegheny, Ohio, and Susquehanna Rivers. Interns working with Dr. Petokas not only have a wonderful opportunity to do unique research with a species that is unknown to many people, but also have a chance to promote awareness as to how human activities can have a profound impact on surrounding ecosystems and the wildlife inhabiting its streams, forests, and other habitats.

## **Lycoming Environmental Awareness Foundation (L.E.A.F.)**

In order for change to occur on campus, it is crucial that students, faculty, and administration are all actively involved with sustainability efforts. Lycoming College is an institution that encourages opportunities meant to better its community through campus organizations. The green initiative began on Lycoming College's campus in 1992 with the founding of the Lycoming Environmental Awareness Foundation (LEAF), which is made up of a group of students who strive to create an environmentally friendly campus. The group's purpose is to raise awareness about sustainability issues and ultimately, act on that awareness to promote change.

The majority of LEAF's activities are outdoors, but community service activities are also a priority, with events focusing on stream, park, and highway cleanups. In addition to this, the club donates and participates in the American Cancer Society's annual Relay for Life. LEAF's other trips and activities include, camping, hiking, kayaking, and rafting. The organization also works closely with the Sustainability Office to coordinate RecycleMania, an eight week recycling competition, and Earth Week, a weeklong celebration of Earth Day, both of which occur in the spring. During Earth Week, students can participate in an array of sustainable activities like potting plants and park clean-ups, awareness programs, and can listen to lectures by interesting guest speakers.

During the spring 2014 semester, LEAF collaborated with the Sustainability Committee to assist with the Food Recovery Network, an organization that is showing potential as a way of reducing campus food waste while helping those in the community.

For 2017, LEAF will again be active in a variety of recreational environmental activities. Trips to Reptileland and Penn's Cave will occur in the fall semester, and a trip to Baltimore's Inner Harbor Aquarium in the spring. These trips will allow students to appreciate a variety of different animals and natural structures (especially in Penn's Cave). LEAF will sponsor their main event of Earth Week in the spring semester, where students can participate in a variety of free activities that grow an appreciation of the outdoors.

## **Conferences**

On November 4th and 5th, two students, Gabriella Quintard and Paisley Simmons, attended the Food Recovery Network conference, held at the University of DC. There, they listened to speakers who addressed food insecurity in the United States, the stopping of food waste, and the institution of programs such as recycling

and food recovery. Attendees also broke into networking groups to discuss food recovery, including advice and problems, at their own colleges.

On February 10th, 2018, four students, Cayla Treaster, Braeden Gonzales, Brittany Lenze and Mikayla Schappert, attended the Green Allies conference at Swarthmore College. At the conference, the attendees discussed food recovery, energy waste, sustainability at Swarthmore College's campus, and how to begin the process of writing a green guide with several members of Green Allies and Swarthmore's Sustainability Committee.



On April 12<sup>th</sup>, students Ruric Bowman and Andrew Shelly, Dr. Melvin Zimmerman, and Dean of Students Dan Miller attended the Pennsylvania Energy Resource Consortium conference in State College, PA. There, Andrew Shelly presented on Lycoming College's sustainability on campus, and the attendees also listened to several speakers who presented on topics related to environmental concerns and sustainability.



- Photograph of Sustainability Committee member Andrew Shelly with Josh Hooper the Executive Director of PERC at the 2017 PERC conference at Penn State.

## Athletics

A number of ideas for future involvement in the campus' sustainability efforts have been proposed by the athletics department, but none of the projects are currently in use. The proposals would be important additions to the college's efforts considering that the athletic department is home to seventeen intercollegiate sports, intramural sports, and multiple facilities that are available to students, faculty, alumni, and even members of the Williamsport community. It is estimated that one out of every four students become involved in an intercollegiate team, and between 475 and 600 students visit the Recreation Center and use its facilities every day. A sustainable project therefore, would prove to be an important addition to the athletics department, especially considering the frequency of its daily visitors.

While the projects that have been proposed take time to be implemented, they can be effectual in the campus' efforts to "Go Green." In 2012, the college participated in its first annual Game Day Challenge, a competition in which recyclables were collected from the stands by volunteers from LEAF, Phi Kappa Psi, and various athletic organizations. In addition, bins were installed around the periphery of the field to encourage fans to recycle their waste. The Game Day Challenge, a competition similar to RecycleMania, was sponsored in part by the Environmental Protection Agency, and helped to promote sustainability by educating the community about proper recycling techniques and waste reduction methods. The competition was similar to the University of Arkansas' sustainability program, "Recycling with the Razorbacks." The sustainability sector of the University of Arkansas would place green recycling boxes at all home games to encourage fans to recycle and as a result, collected more than 36.5 tons of recyclables and reduced the amount of trash by 61.5 tons (Patrick et al. 2008). The amount of trash reduced by the University of Arkansas speaks for itself, and shows just how much waste can be reduced if these practices were employed regularly at Lycoming.

Proposals to eliminate or at least lower the waste that is produced in campus athletic facilities have been proposed by other institutions. For instance, the University of Colorado at Boulder has taken steps to eliminate their waste by creating a zero waste football stadium, which has prevented at least 90% of their waste from going to a landfill. The university eliminated their waste by replacing all of their trash containers with recycling bins and relying solely on public food containers and beverage cups that are made of recyclable or compostable materials.

Another idea that has been introduced is that of recycling used sports equipment. This proposal suggests that rather than throwing away gently used equipment, the materials could be sent to local clubs and schools for further use. This initiative would not only keep materials out of landfills, but would save money

for organizations, and would also help to promote physical health by allowing sport participation to be possible for more of the local community.

Although the implementation of these projects could have a huge impact on campus, there are other issues that could be addressed that would improve our sustainability efforts. For instance, if announcers at athletic events could repeat the announcements made of the locations of recycling bins so that fans knew where to drop their recyclables, signs were posted by the garbage cans as a reminder for fans to recycle, and recycling bins were installed at outdoor games, recycling on campus could rise simply by helping the community to become aware that there is an alternative to throwing their waste away.

The athletic department will be a significant help to the college's overall sustainability project; despite the direction they choose to take with their sustainability efforts. Also, by implementing these projects at one of the campus' largest areas of student, faculty, and community involvement, an increase may be seen in all of the campus-wide sustainability efforts in the very near future.

## Campus Grounds

Lycoming College's Building and Grounds (B&G) staff are essential to making campus more sustainable. In addition to having routine maintenance responsibilities, the B&G staff attends to several projects pertaining to sustainability. One of these projects includes a large generator of waste that needs to be dealt with on a daily basis. Currently, the grass and tree clippings and leaves are being sent to the landfill after being collected, but a future project could involve an evaluation of composting grass clippings and leaf litter in conjunction with a local farmer, or in partnership with an institution like Penn College.

Each spring, the lawns are treated once with fertilizer and herbicides supplied by TruGreen ChemLawn in Lamar, PA. The concentrations of the materials used for application are:

Liquid fertilizer 13-0-7 0.75LBAI/M; (3/4 nitrogen per 1,000 Sq.ft.)

Barricade 4FL 0.375 LBAI/A; (pre-emergent herbicide)

TruPower3 0.3.25 Pint/A; (broadleaf weed control)

In addition, B&G has replaced all but three trucks with golf carts and there are now twelve carts that are used for everyday campus chores. Two of these golf carts and one security vehicle are electrically powered, using \$400 batteries that last for five years, while ten of the golf carts are still gas-powered and use four-

stroke engines. The current plan is to replace the gas-powered golf carts with electrically powered golf carts as they wear down. In addition, B&G uses one tractor and three mowers that are all fueled with diesel. The current hope is that the tractors and mowers can be fueled with the biodiesel that is being produced with the help of the new biodiesel project on campus. Also, B&G wants to purchase diesel trucks in the future in order to possibly create a 50/50 mix of gasoline and biodiesel that would help them use energy more sustainably.

## **LEED Certification for Future Exploration**

The push to become more sustainable is quickly spreading throughout American higher education institutions. Lycoming College needs to improve the ways in which it efficiently uses, and maintains energy in the process of constructing and reconstructing its buildings. Green designs are building plans that have environmental, economic, and social elements that benefit all building stakeholders, including owners, occupants, and the general public. With simple building techniques, operating costs can be lessened, building marketability can be enhanced, worker productivity can be increased, and most importantly, harmful greenhouse gas emissions can be reduced.

Leadership in Energy and Environmental Design (LEED) is a performance oriented system in which credits are earned for satisfying criterion designed to address specific environmental impacts inherent in design construction, operations, and maintenance of buildings. Based on the total credits earned, different levels of green building certification are awarded. The system of LEED certification is designed to be comprehensive in scope, yet simple in operation, and can be seen below:

### Points Scale:

Certified: 26-32 points

Silver: 33-38 points

Gold: 39-51 points

Platinum: 52-69 points

LEED addresses the following for new construction: sustainable sites, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality, and innovation in design. In order for a project to become LEED certified for a new construction or renovation plan, it must be registered at the U.S. Green Building Council's website: [www.usgbc.org](http://www.usgbc.org).

As a requirement of the Lycoming College Climate Commitment, any new construction on campus has to meet at least a silver LEED rating. The college could meet this requirement, or a requirement meeting a LEED gold or platinum standard in a variety of ways. For instance, Cape Cod Community College received a gold LEED certification for its use of windows and reflective surfaces to promote natural lighting to illuminate the interior of its buildings during the day. By maximizing the amount of daylight during the day, Cape Cod reduced the amount of energy many other establishments need for electricity (Patrick et al. 2008).

Lycoming College has the potential to improve its environmental sustainability, and with the current economic climate, as well as the 60% increase in the PPL Plug electricity rate, the difficulty posed by rising electric bills is pushing the campus toward making more sustainable choices. With a list of key objectives and solutions, the college could use their LEED certification to promote environmental awareness to current and prospective students as well as a way to receive a tax benefit.

Currently, Lycoming College did not follow its original Climate Commitment as the construction of Lynn was not done in accordance to LEED certification. While guidelines were looked over, Lynn itself is not silver or gold LEED certified. With the edition of the new Welcome Center on campus in the next few years, reconsidering Lycoming College's Climate Commitment and stance on LEED certified buildings would be beneficial for the project.

## **Greenhouse Gas**

In the future, Lycoming College's greenhouse gas emissions should be calculated using the Clean Air-Cool Planet: Campus Carbon Calculator. This calculator is the most thorough way to assess a campus's emission output because it analyzes six greenhouse gases specified by the Kyoto Protocol, carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorinated compounds, and sulfur hexafluoride (CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, HFC, PFC, and SF<sub>6</sub>). The extensive spreadsheet that is provided allows emissions to be calculated for years ranging from 1990-2060 when completed in its entirety. When Lycoming College can gather all of the information necessary for this endeavor, an accurate and almost literal carbon footprint will be achieved.

## **The Lycoming College Climate Commitment**

On April 20, 2011, former college president, James E. Douthat, signed the Lycoming College Climate Commitment during a small ceremony held on the steps of Long Hall. The pledge was brought forward by the sustainability committee,

which was led at that time by both Dr. Neil Boyd and Dr. Mel Zimmerman, and called for a solid action plan to reduce the college's carbon footprint. This action plan includes but is not limited to the following: the requirement of new construction meeting at least a silver LEED rating, an energy-efficient appliance purchasing policy that requires the purchase of ENERGY STAR certified products, a specified set of environmental guidelines for renovations, continued campus involvement in RecycleMania, and access to public transportation for faculty, staff, and students. Lastly, the commitment requires that the action plan initiated by Douthat's signing and any new reports are publically available to students in order to encourage involvement in the sustainability effort. Currently, as Lycoming College has changed president's the goals of the climate commitment have gone unmet. In 2016, a Climate Commitment task force of students, faculty, and staff was assembled and hopefully there will be an updated Lycoming College Climate Commitment for the next audit in 2017.

### **Environmental Sustainability Curriculum Offered by Lycoming College:**

Lycoming College offers two minors, Environmental Sustainability and Environmental Science, and a major, Sustainable Business Management, in order to educate students about environmental issues so that they are better able to promote conservation and awareness. In addition to these courses, the college offers an Ecology track specifically for biology majors that differs only in the lab time and biological focus that is required for the major.

### **Environmental Sustainability**

The Environmental Sustainability minor educates students about the delicate balance that exists between our climate and the earth's other natural processes and the need of society to satisfy its needs. At Lycoming College, students have a unique opportunity to work with experienced faculty to develop effective solutions. The minor requires the following courses:

BIO 220 – Environmental Biology  
ECON 225 – Environmental Economics  
**And three from the following:**  
ANTH 232 – Environmental Anthropology  
ANTH 310 – Food and Culture  
BIO 200 – The 4th and 5th Kingdoms  
BUS 313 – Sustainable Business Management  
BUS 334 – The Business of Energy  
ECON 224 – Urban Problems  
PHIL 228 – Philosophy and the Environment  
PSCI 338 – Environmental Law and Politics

## PSY 221 – Environmental Psychology

Students are encouraged to work outside of the classroom by participating in a practicum or an internship in the field of environmental sustainability. The course the student chooses will often pertain to his or her future career choice and there are several choices for practicum experiences, including:

ANTH 470 – 479 – Anthropology Internship  
BIO 400 – Biology Practicum  
BIO 401 – Environmental Practicum  
BIO 470 – 479 – Biology Internship  
BUS 439 – Business Practicum  
BUS 470 – 479 – Business Internship  
ECON 349 – Management Practicum  
ECON 470 – 479 – Economics Internship  
PHIL 470 – 479 – Philosophy Internship  
PSCI 470 – 479 – Political Science Internship  
PSY 470 – 479 – Psychology Internship  
SOC 448 – Practicum in Sociology – Anthropology

The Environmental Sustainability minor is supervised by coordinators, Dr. Mel Zimmerman and Dr. Ryan Adams.

## **Environmental Science**

The Environmental Science minor was created for students who wish to further their knowledge concerning conservation and issues that are affecting the environment. An interdisciplinary minor in Environmental Science consists of two introductory biology courses, one of which must be Environmental Biology (BIO 220), two additional courses numbered 200 or higher, Environmental Economics (ECON 225) and Principles of Geology (ASTR 102). Biology majors who minor in Environmental Science must complete all requirements of the biology major. In addition to these requirements, they need to complete Environmental Biology (BIO 220), Environmental Practica (BIO 401), Environmental Economics (BIO 225), Principles of Geology (ASTR 112), and one course selected from Economic Geography (ECON 240), Cultural Anthropology (ANTH 229), or an advanced biology course numbered 328 or higher.

## **Energy Studies Minor (New in 2016!)**

The minor in Energy Studies is designed for students majoring in one of the Natural Science disciplines to combine their knowledge of energy systems in the natural sciences with an understanding of the policy, economic, and social issues

surrounding energy production and utilization at the local, national, and global level. Open only to students with majors in the natural sciences, namely Astronomy, Astrophysics, Biology, Chemistry, and Physics. No more than two courses may count toward other majors or minors.

Students who complete the energy studies minor will: Develop an understanding of the political and economic context for energy production and consumption at the local, national and global level. Learn the language and underlying science of energy. Be able to analyze the connections between the science of energy, its production and consumption, and the political and economic contest across energy systems. Be able to communicate effectively to a variety of audiences the complex connections between the science of energy and the politics and economics of energy.

Required Courses:

PSCI 226 The Politics of Energy

ECON 225 Environmental and Resource Economics

Select two of the following courses:

ANTH 232 Environmental Anthropology

BUS 200 The Business of Energy

CCOM 335 Public Communication of Science

HIST 200 Energy, Security, and Global Competition

PHIL 228 Philosophy and the Environment

PSCI 338 Environmental Law and Politics

Select two of the following courses (must come from two prefixes):

ASTR 104 Field Geology

ASTR 112 Fundamentals of Geology

BIO 220 Environmental Biology

BIO 224 Ecology

CHEM 330 Physical Chemistry I

PHYS 337 Thermodynamics

**Energy Sciences Minor (New in 2016!)**

The Energy Science Minor is designed for students with majors outside the natural sciences to combine their understanding of the policy, economic, and social issues surrounding energy production and utilization at the local, national, and global level with science literacy on issues of energy drawn from the disciplines of biology, chemistry, geology, and physics. Open only to students with majors other than the natural sciences, namely Astronomy, Astrophysics, Biology, Chemistry, and Physics. No more than two courses may count toward other majors or minors.

Students who complete the energy science minor will: Develop literacy in the science of energy across its forms. Develop an understanding of the political and economic context for energy production and consumption at the local, national and

global level. Be able to analyze the connections between the science of energy, its production and consumption, and the political and economic contest across energy systems. Be able to communicate effectively to a variety of audiences the complex connections between the science of energy and the politics and economics of energy.

Required Courses:

PSCI 226 The Politics of Energy

CHEM 200 The Science of Energy

Select one of the following courses:

ANTH 232 Environmental Anthropology

BUS 200 The Business of Energy

CCOM 335 Public Communication of Science

ECON 225 Environmental and Resource Economics

HIST 200 Energy, Security, and Global Competition

PHIL 228 Philosophy and the Environment

PSCI 338 Environmental Law and Politics

Select three of the following courses (at least one of which must be numbered 200 or above): Students may request to substitute relevant, upper-level natural science courses to complete the minor's natural science course requirements.

ASTR 104 Field Geology

ASTR 112 Fundamentals of Geology

BIO 220 Environmental Biology

BIO 224 Ecology

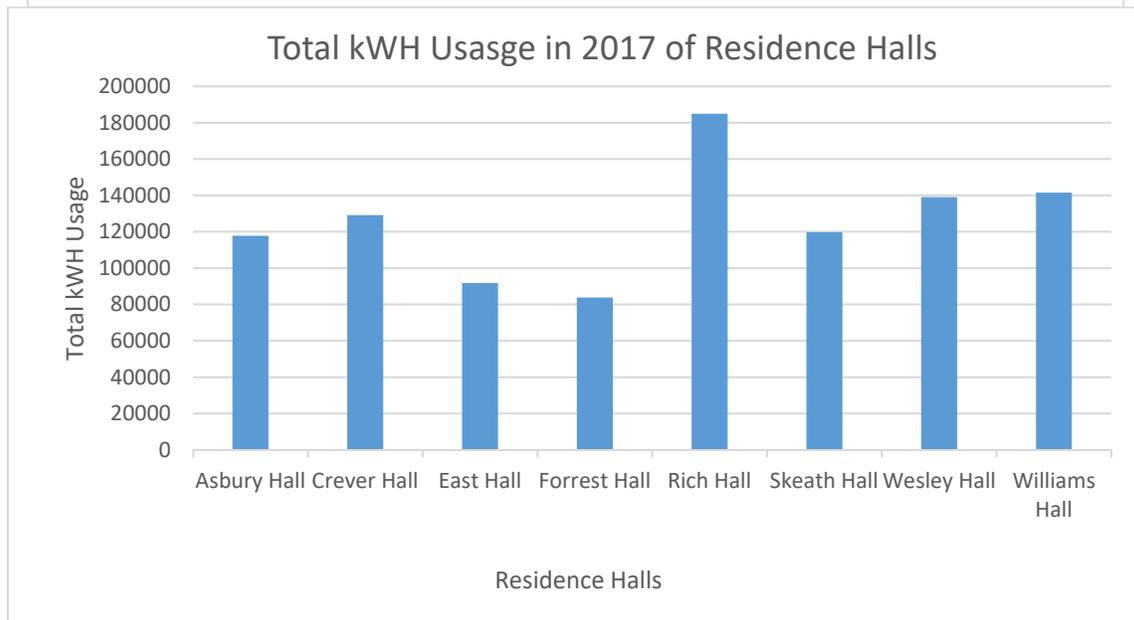
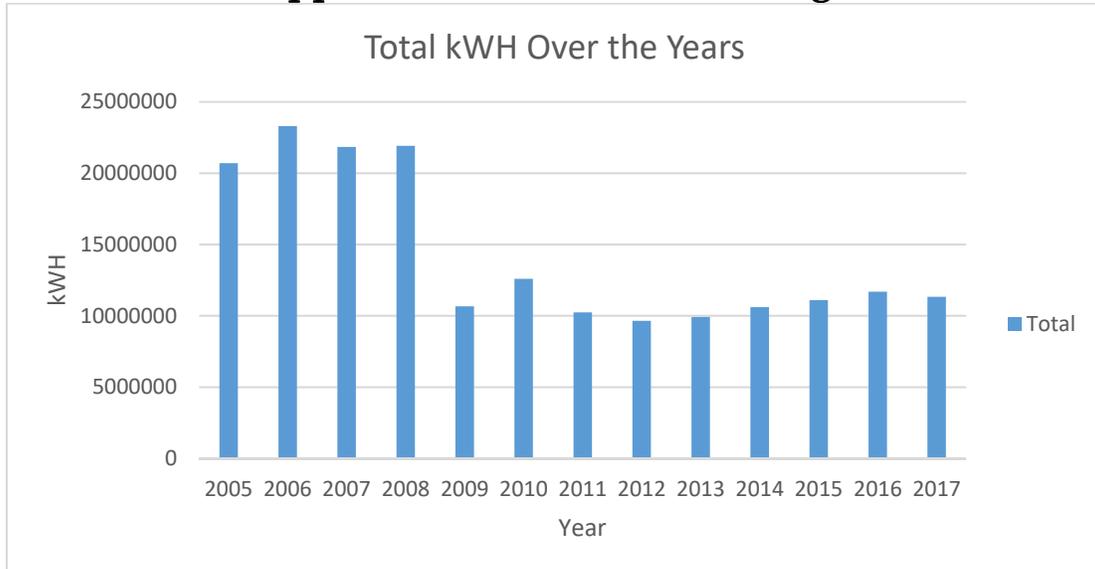
CHEM 110 General Chemistry 1

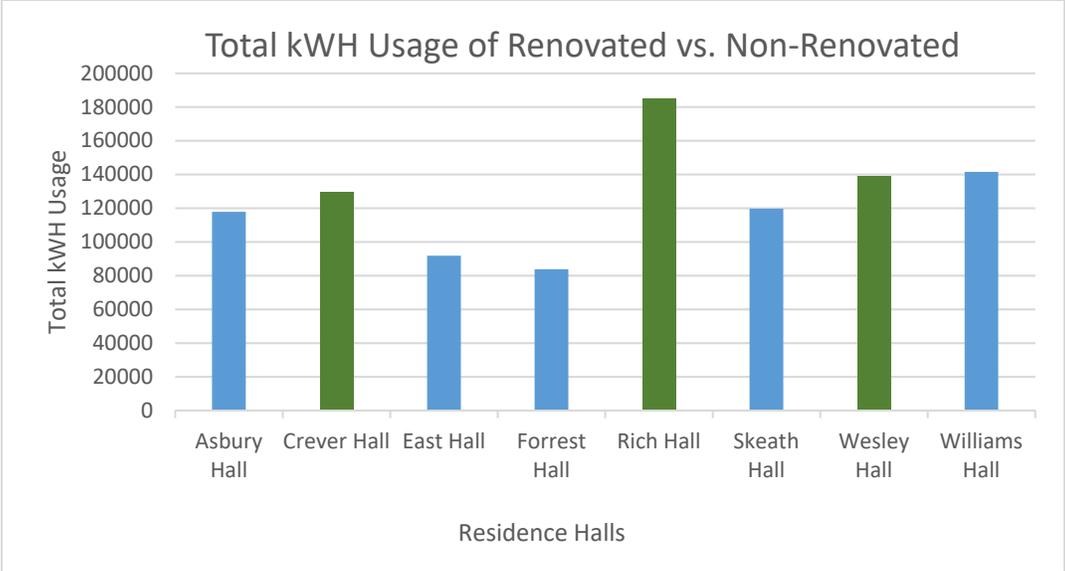
PHYS 106 Energy Alternatives

# Appendices

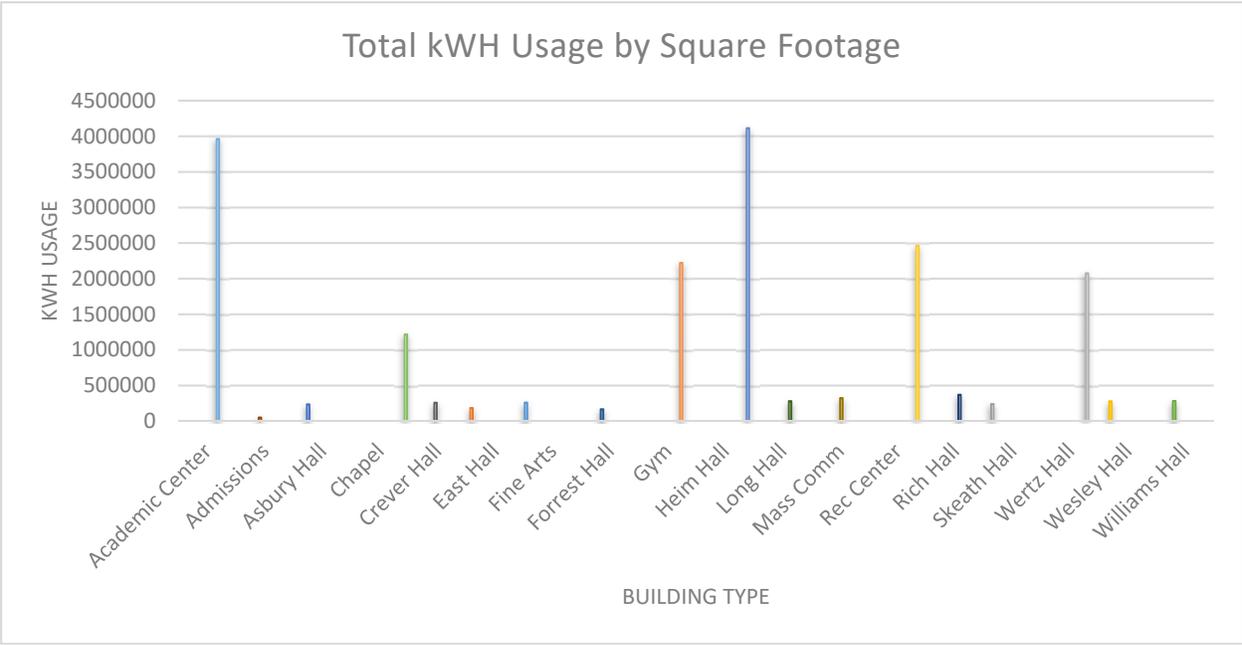
---

## Appendix 1: Total kWh Usage

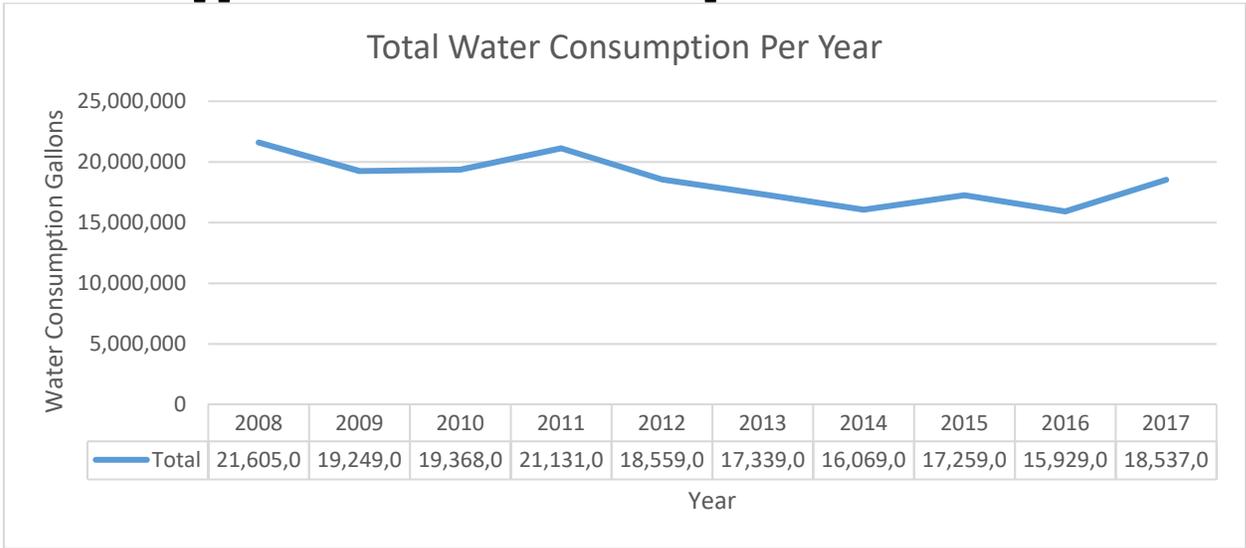




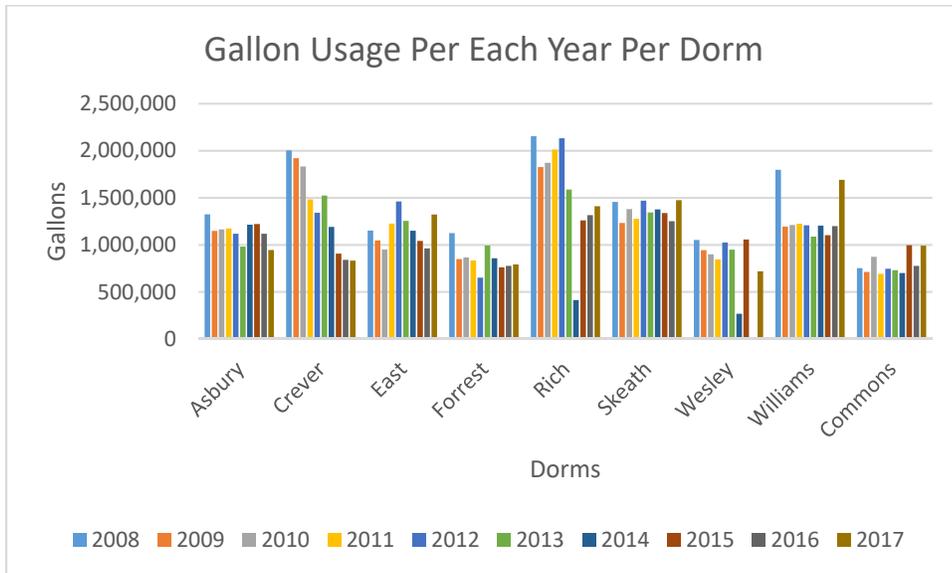
## Appendix 2: Electricity Usage in kWh/Square Feet



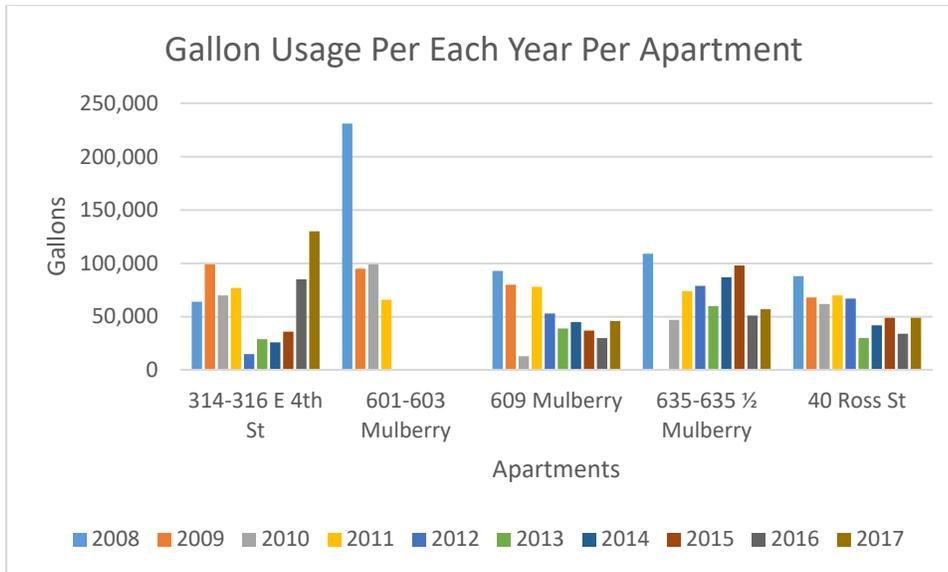
### Appendix 3: Water Consumption Per Year



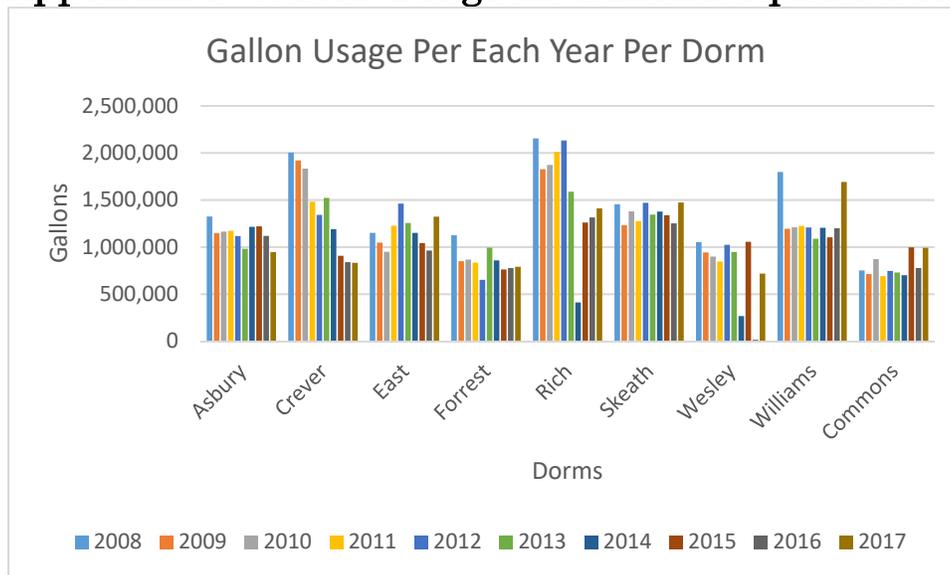
### Appendix 4: Raw Water Usage for 2017





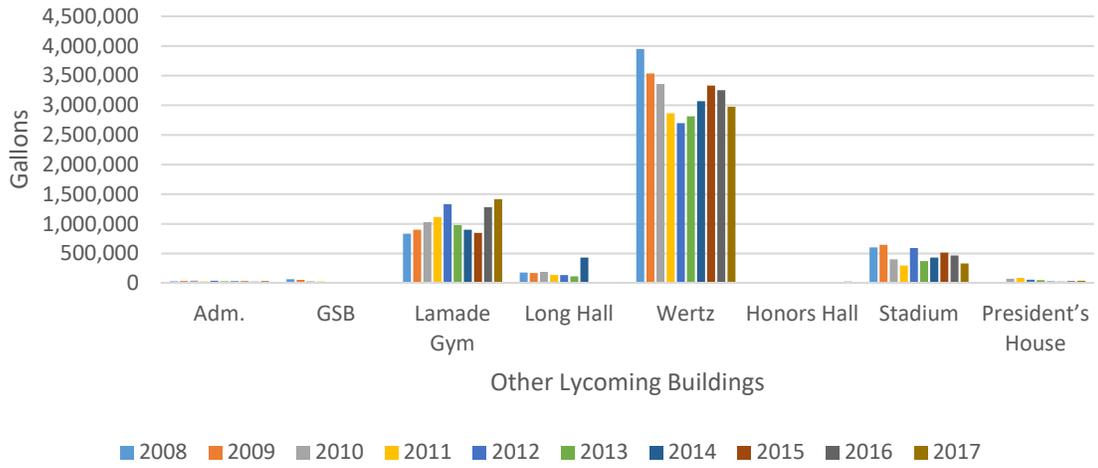


## Appendix 5: Water Usage in Gallons/Square Foot

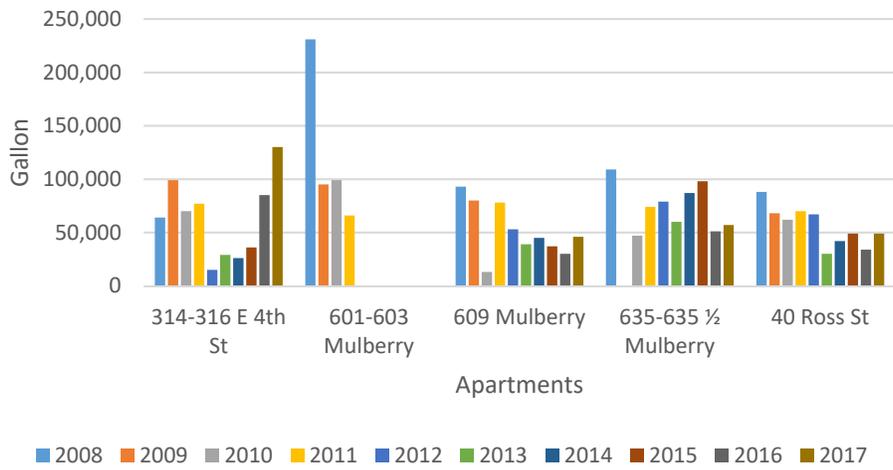




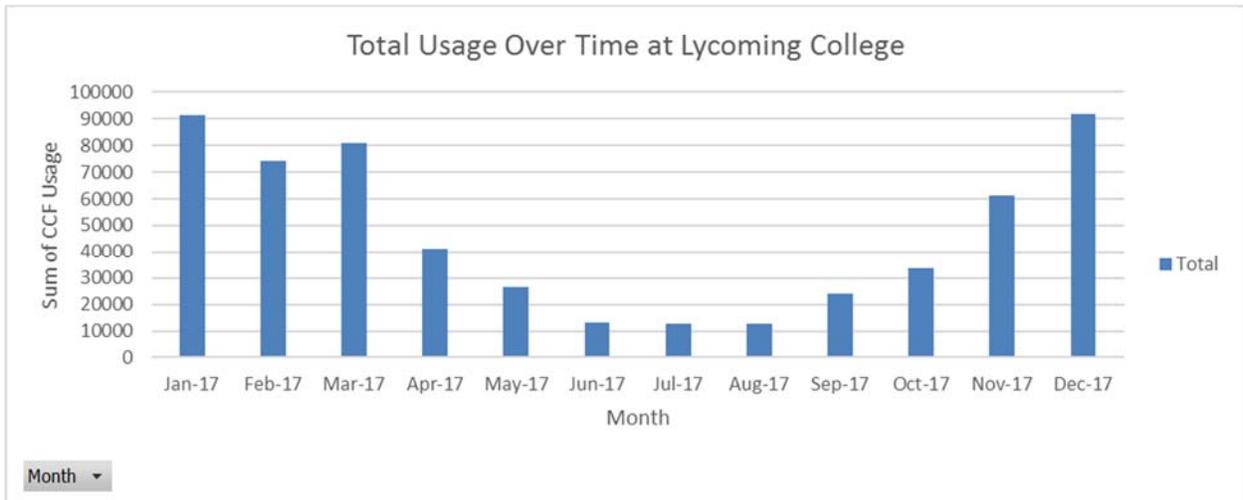
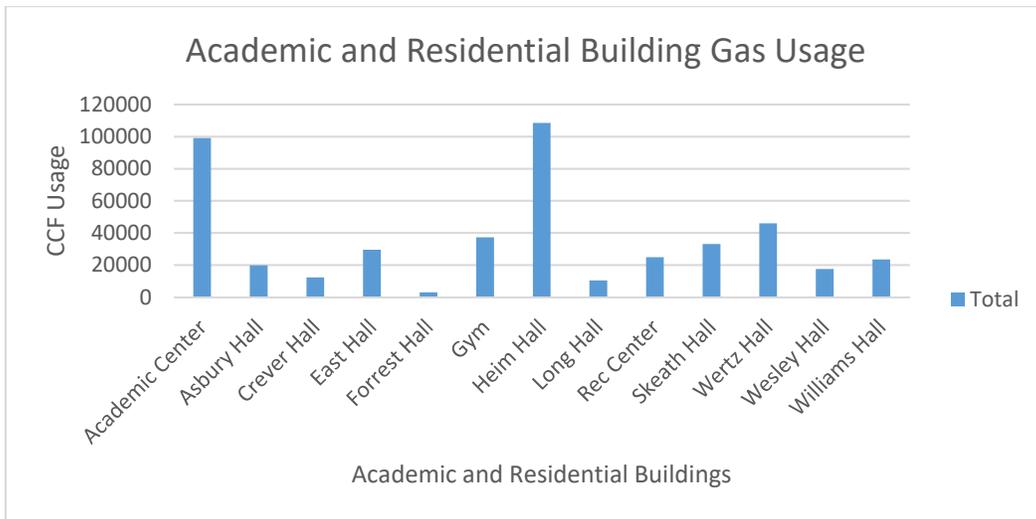
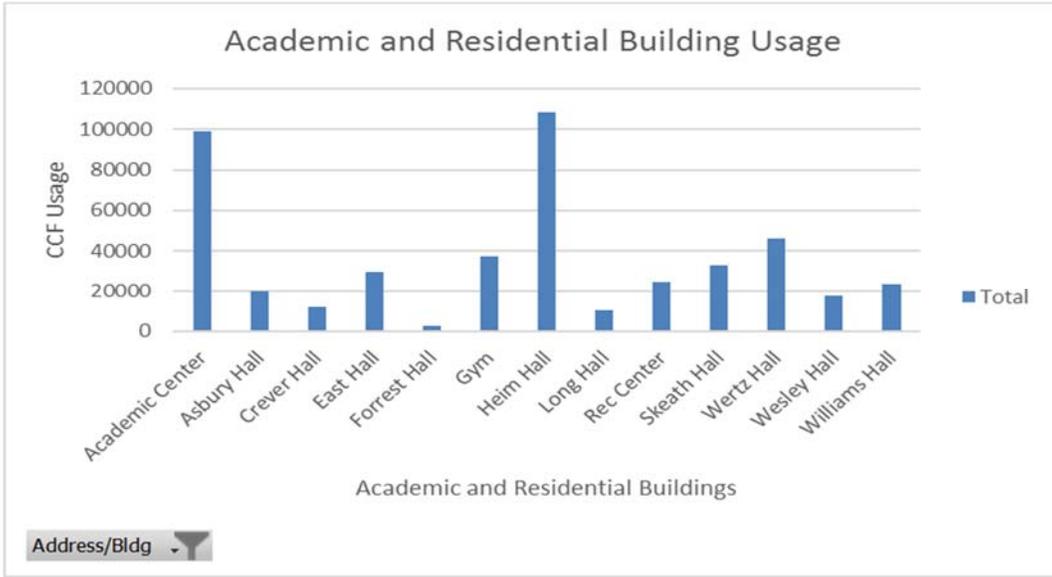
### Gallon Usage Per Each Year Per Other Lycoming Building



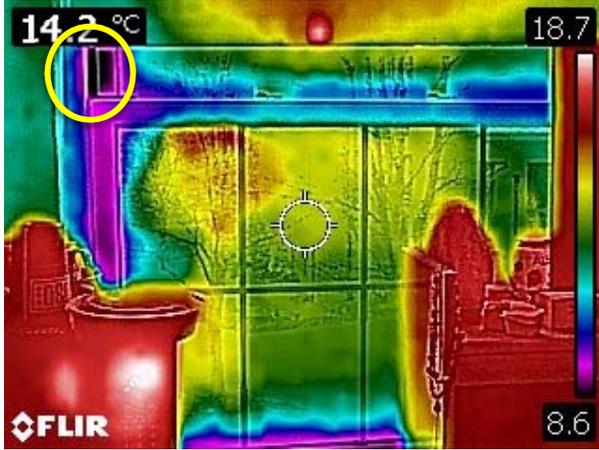
### Gallon Usage Per Each Year Per Apartment



## Appendix 6: Natural Gas Usage



## Appendix 7: Infrared Thermography Report for Asbury Hall



*This photo shows room 101: looking at the circled area you can clearly see that there is 8.6 degree C air coming in through the poorly sealed joint in the window. This could be due to a broken or missing gasket*



*This photo also shows room 101: and in this photo you can see by the indicated area that there is 8.9 degree C air coming in along the right hand side of the window.*



*This photo shows room 229: the indicated area of this photo shows an air leak of 6.3 degrees C. as well as the whole base of the window allowing 7 degree C air to infiltrate the room.*



*This photo was taken in the stairwell on the second floor and shows an 8.8 degree C air leak around the perimeter.*



*3<sup>rd</sup> floor hallway: I noticed that this hallway was very chilly, upon shooting I found that there was a major heat discrepancy at the window in this hallway.*



*Room 311: this image shows that the warmest part of the window is a chilly 16.4 degrees C and the cool spot is only 8 degrees C*

## Appendix 8: Infrared Thermography Report for Crever Hall



*This photo is of room 326: the center of the glass pane is only around 20 degrees C. The cold spot on the bottom is also only 15.6 degrees C*



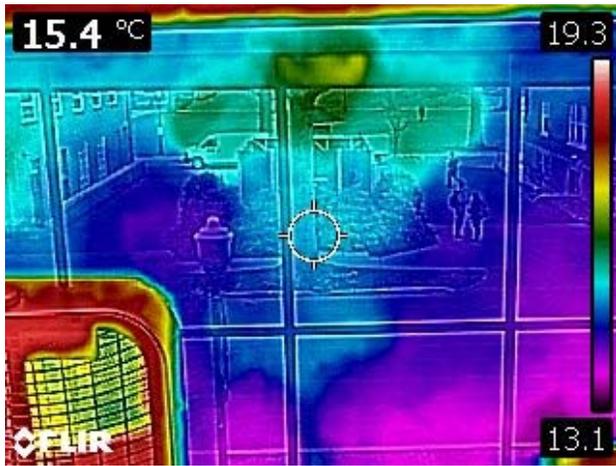
*Room 318: these students are forced to have their window cracked due to lack of control over their thermostat and being uncomfortable in the temperature of their room.*



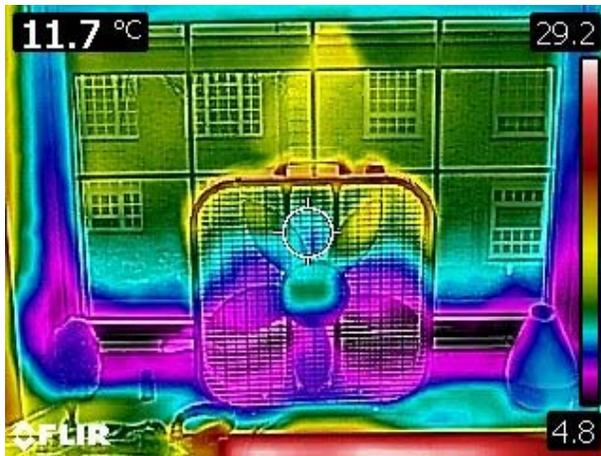
*Room 318: the other window in room 318 is also cracked, suggesting an inefficiency in the heat being sent to the rooms.*



*Room 210: these students were also uncomfortable with the temperature of their room and so had to crack the window to regulate.*



*Room 210: this closed window shows in the same room the efficiency of the windows when closed to retain heat within the room, the cool spot is only around 6 degrees C cooler than the room temperature.*



*Room 226: this room also has the window cracked because the students weren't comfortable with the temperature.*