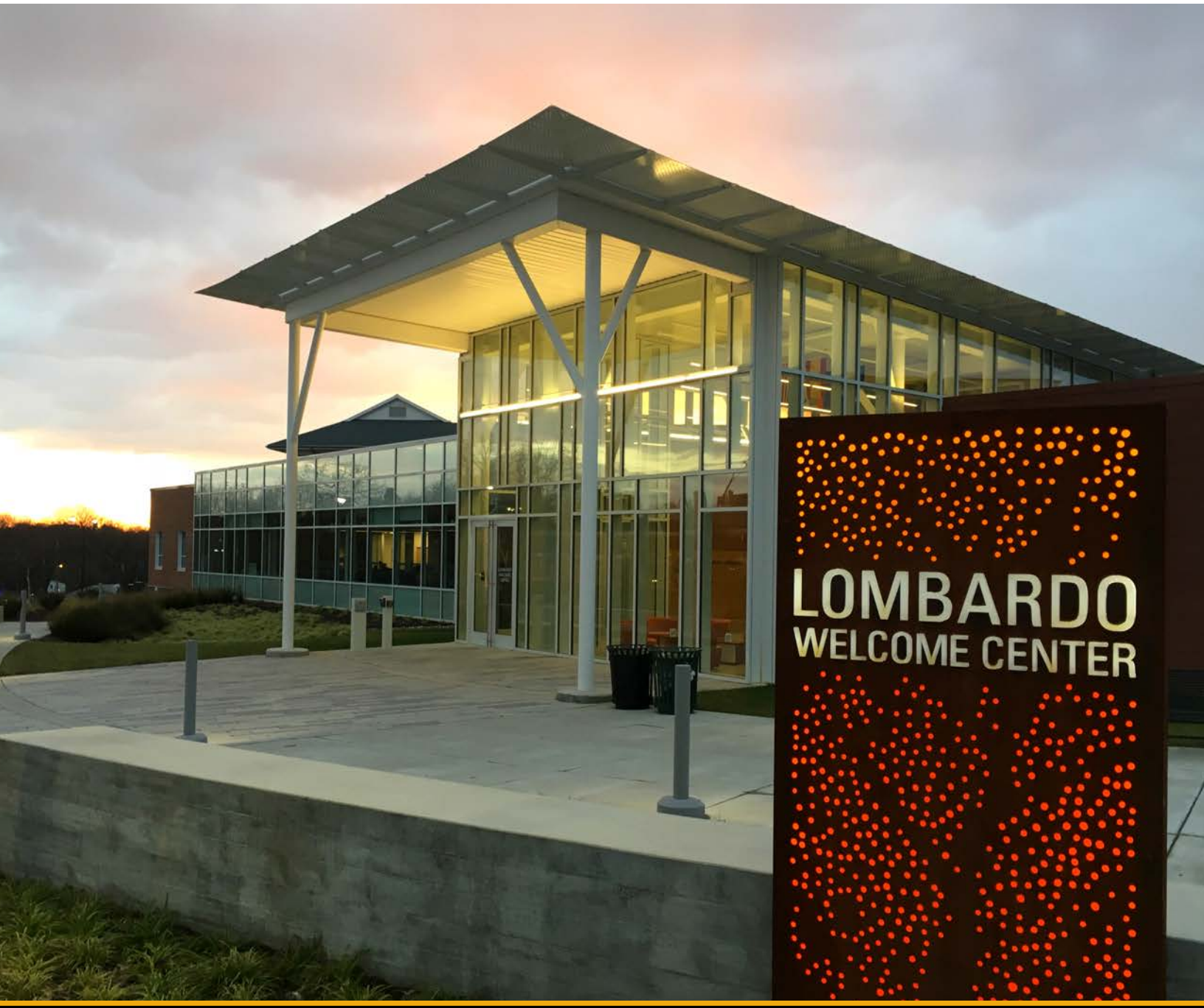
CLIMATE ACTION PLAN



Millersville University

May 2019

MESSAGE FROM THE PRESIDENT

To paraphrase the famous naturalist, John Muir, "when one tugs at a single thing in nature, we find it hitched to everything else in the universe." As a microbiologist, I see how small organisms affect larger organisms and how those organisms affect their local environment, and how local environments create ecosystems that comprise the natural world. Through this frame I look at the world from our corner of it and see the changes that our activities impose on the global climate, but also on the positive impacts that our University community creates.

Our place is unique. Millersville University sits within Lancaster County, Pennsylvania—a location known internationally for its rich history of stewardship of the land. We're also located alongside the City of Lancaster —a city that's gaining national recognition for its commitment to sustainable growth born from an intrinsic willingness to put the interest of the community above personal interests and affiliations.

Our programs are world class. The learning opportunities they create are both comprehensive and deep—providing students with experiences that shape a lifetime while creating citizens with the power to shape local and global communities.

Our people are inspired and inspiring. From our faculty to our staff to our students, my conversations with them reveal insights and ideas that enrich, enliven and empower. They have the knowledge and ability to develop local solutions that can be scaled to solve global challenges. Perhaps more importantly they have a sense of purpose and authenticity that compels us to imagine the possible.

Our purpose is clear. Climate change is perhaps the greatest challenge of our time with the power to exacerbate other pressing global challenges, such as hunger, poverty and inequality. It is also a solvable challenge. The strategies in this Climate Action Plan provide answers to the global climate crisis, and when paired with the work of other universities, governments, and businesses create an ecosystem of solutions capable of changing the world.

Daniel A. Wubah

Dr. Daniel A. Wubah
President

Thank you

The authors of this plan would like to thank the following individuals for their contributions:

Climate Action Plan Committee Members
Dr. Kathleen Schreiber, Geography, Committee Chair

Dr. Ethan Frost, Geography

Dr. Ajoy Kumar, Earth Sciences

Mr. Thomas Richardson, Associate Vice President/Dean of Students

Mr. Chris Steuer, Sustainability Director

Mr. Thomas Waltz, Assistant Vice President for Facilities

President and Cabinet
Dr. Daniel Wubah, President

Dr. Victor DeSantis, Interim Chief of Staff

Dr. Vilas Prabhu, Provost and Vice President of Academic Affairs

Mr. Guilbert Brown, Interim Vice President of Finance and Administration

Mr. Brian Hazlett, Vice President for Student Affairs and Enrollment Management

Ms. Alice McMurry, Interim Vice President for Advancement

Mr. Geoffrey Beers, CEO Student Services Inc.

Student Climate Planning Support
Zachary Dodson

Sebastian De Rosa

Human Environment Resilience Planning Team
Dr. Kathleen Schreiber, Geography

Dr. Alan Peterson, MD; Lancaster General.

Dr. Duane Hagelgans, Earth Sciences

Mr. Patrick Weidinger, Health and Safety Director

Mr. Larry Earnesty, Associate Director Athletics

Ms. Sharmon Brant

Steven Copertino

Robert Helmerick

Sarah Holland

Drew Hughes

Jason Malkowski

William Matthews

Brandon Mitchell

Katie Prichard

Jessica Stokes

Applied Climate Planning Faculty & Students
Dr. Ethan Frost, Geography

Sabrina Rowe

Nathan Bauer

Derek Boone

Tucker Cavallo

Arynn Cooper

Christian Ott

Angel Yamil Perez-Irizarry

William Todd

Edward Schick

Cameron Strosser

Built Environment Resilience Planning Team
Mr. Thomas Waltz, Assistant Vice President for Facilities

Mr. Greg Black, Director of Maintenance and Operations

Mr. John Halton, HVAC Manager

Mr. Matt Sellers, HVAC Systems Specialist

Mr. Chris Steuer, Sustainability Director

Climate & Society Faculty and Students
Dr. Kathleen Schreiber, Geography

Derek Boone

Audrey Esser

Cole Fitch

Christian Ott

Yamil Perez

Morgan Phillips

Edward Schick

Jessica Soullaird

Cameron Strosser

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EXECUTIVE SUMMARY

Recognizing and valuing its role as a local leader called to address the global challenge of climate change, Millersville University established a goal to achieve carbon neutrality and prepared its first Climate Action Plan in 2016. Since then, faculty members have incorporated climate change into coursework, facilities staff have implemented energy conservation and fuel-switching measures, and the University constructed one of the first zero energy buildings in the country—the Lombardo Welcome Center. Collectively, these efforts have reduced Millersville University's greenhouse gas (GHG) emissions by 16 percent since the base year of 2005 and 5 percent since the 2016 Climate Action Plan.

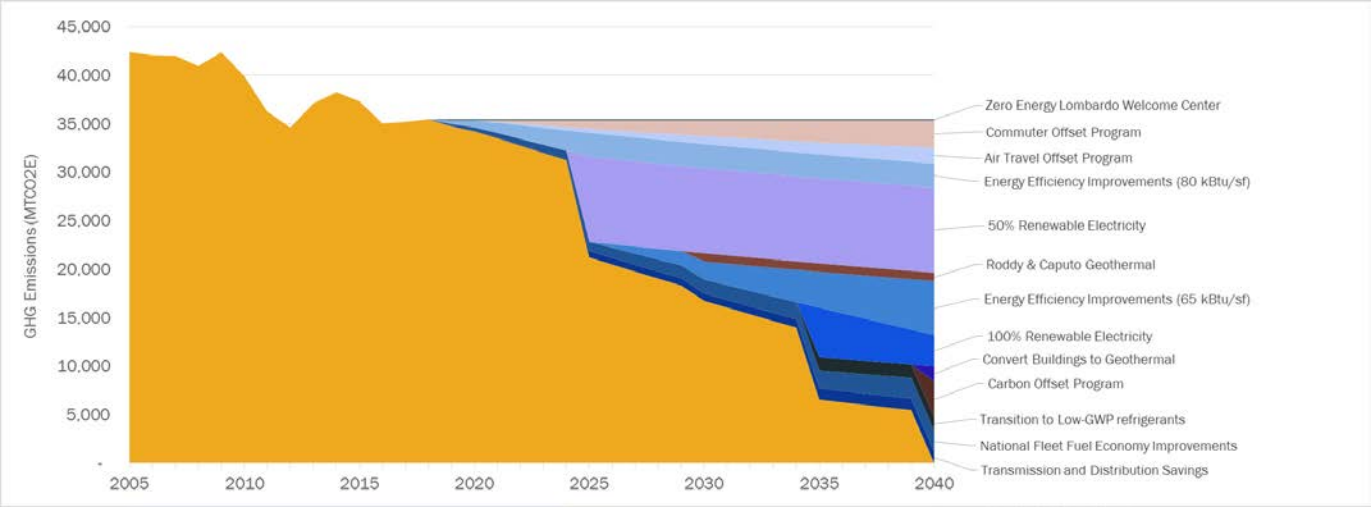
While Millersville University has made progress addressing the climate change challenge, there is much to be done, both as a University and as a global community. This updated Climate Action Plan articulates Millersville University's expanding efforts to respond to climate change. The updated Plan maintains the goal to achieve carbon neutrality by 2040, but adds new near- and long-term performance targets for key GHG mitigation activities, such as improving energy efficiency and purchasing renewable energy. The chart below presents Millersville University's path to carbon neutrality, including planned mitigation actions.

Additionally, the updated Plan expands the University's climate change response efforts to include collaborating with the City of Lancaster on climate change response planning and build campus climate resiliency while incorporating climate change into the curriculum, campus planning and engagement.

MILLERSVILLE UNIVERSITY'S CLIMATE CHANGE RESPONSE GOALS

1. Be Carbon Neutral by 2040
2. Build Resilience to Climate Change on Campus
3. Collaborate on Community Climate Change Response Planning
4. Incorporate Climate Change and Sustainability into the Curriculum
5. Integrate Climate Change Considerations into Campus Planning and Engagement

MILLERSVILLE UNIVERSITY'S PATH TO CARBON NEUTRALITY



INTRODUCTION

Millersville University's mission is to inspire learners to grow both intellectually and personally so that they may contribute positively to local and global communities. Inherent in this mission is a willingness and responsibility to be part of the solution to the challenges that society faces. Today's challenges are many, but few necessitate a communal response at the scale required by climate change.

Recognizing and valuing its role as a local leader called to address the global challenge of climate change, Millersville University established a goal to achieve carbon neutrality and prepared its first Climate Action Plan in 2016. Since then, Millersville has made significant progress to respond to climate change. Faculty members have incorporated climate change discussions into coursework, faculty and staff have become more involved in community climate change response planning, and the Facilities Department greatly improved energy management efforts while implementing energy conservation and fuel-switching measures. Perhaps most significantly, the University finished construction of the new zero energy Lombardo Welcome Center, which stands as a clear testament to the University's climate change and sustainability goals. These and other actions have contributed to Millersville reducing GHG emissions by 5 percent since the 2016 Climate Action Plan was released and 16 percent since 2005.

Despite progress, there is much more work to do and the global climate change challenge has only grown. Human activities are already believed to have caused a 1.0°C increase in atmospheric temperatures over pre-industrial levels.[1] Coincident with this change, U.S. growing seasons have lengthened, wildfire incidents and extent have increased, heat wave season length has increased in many U.S. cities, and the frequency and intensity of heavy precipitation events have increased across the U.S., with particular increases in the Northeast U.S.[2] Recent reports indicate that atmospheric temperatures will continue to rise, hitting 1.5°C increase above pre-industrial levels by mid-century or earlier depending on what global actions are taken to reduce emissions.[3]

While the challenge of climate change is significant, the challenge also provides opportunity to energize and empower a generation of individuals that will manage businesses that create new and better ways of living, raise families that use resources responsibly and transform communities into places that elevate the quality of life. As such, Millersville will use its climate change response to accentuate its core mission of educating the next generation of leaders, thinkers and doers. The projects and programs Millersville implements to address climate change will take place on campus grounds and in classrooms and will be led by faculty, staff and students who are committed to creating a sustainable future.

Climate Change Response Goals

This Plan builds upon the carbon neutrality goal established in Millersville's first climate action plan by adding goals to build resilience to climate change and to collaborate with the community on climate

[1] IPCC Special Report. Global Warming of 1.5°C. https://www.ipcc.ch/sr15/chapter/summary-for-policy-makers/
[2] Fourth National Climate Assessment. Chapter 1 & 7.1.3 https://nca2018.globalchange.gov/
[3] IPCC Special Report. Global Warming of 1.5°C. https://www.ipcc.ch/sr15/chapter/summary-for-policy-makers/

change response planning. Additionally, the Plan elevates existing efforts to incorporate climate change and sustainability into the curriculum and integrate climate change considerations into campus planning and engagement. Millersville University's climate change response centers on the following five goals:

1. Be Carbon Neutral by 2040
2. Build Resilience to Climate Change on Campus
3. Collaborate on Community Climate Change Response Planning
4. Incorporate Climate Change and Sustainability into the Curriculum
5. Integrate Climate Change Considerations into Campus Planning and Engagement

Climate Change: Millersville University Perspective

From lighting the night to powering global travel, burning fossil fuels has provided countless societal and technological advancements since the advent of the Industrial Revolution. The energy provided by this resource has improved the quality of life for hundreds of millions of individuals and contributed to an increase in global life expectancy.[4] Global productivity and personal income have increased substantially and conveniences that were revolutionary a century ago have become commonplace. Across any number of indicators the world is a demonstrably better place in which to live due to the energy that has been provided by burning fossil fuels.[5]

However, burning fossil fuels has also dramatically increased atmospheric concentrations of GHGs—primarily carbon dioxide (CO_2). In the early 1800s (prior to the Industrial Revolution), global atmospheric CO_2 concentrations were about 280 ppm (parts per million). Persistent use of fossil fuels has driven concentration levels above 400 ppm. At current rates, concentration levels are expected to exceed 450 ppm by the mid 2030s—well above the 350 ppm level that many scientists consider safe. Reaching 450 ppm will lead to a global temperature rise that is 2 degrees Celsius (°C) above pre-industrial levels. The Intergovernmental Panel on Climate Change (IPCC) advises that pushing beyond a 2°C threshold commits the globe to changes in climate that will have severe impacts on human health, ecosystem strength and diversity, and resource availability.[6]

The effects of climate change are already being felt, globally and locally in Pennsylvania. Over the past 110 years, Pennsylvania has become warmer and wetter. Specifically, Pennsylvania has experienced a 1°C (1.8°F) increase in temperature as well as a general trend toward increasing levels of precipitation.[7] Locally, according to the Millersville University weather station records, 1998 was the hottest year on record (since local records began in 1914) and 9 of the 10 hottest years on record have occurred since 1990 (Figure 1). Local annual precipitation totals have varied considerably year-to-year with a record low of 22.7 inches in 2001 and a record high of 61.3 inches in 2018.[8]

[4] Our World in Data, Life Expectancy http://ourworldindata.org/data/population-growth-vital-statistics/life-expectancy/
[5] Our World in Data, GDP Growth http://ourworldindata.org/data/growth-and-distribution-of-prosperity/gdp-growth-over-the-last-centuries/
[6] IPCC Fifth Assessment Report, https://www.ipcc.ch/report/ar5/
[7] Pennsylvania Climate Impacts Assessment Update, http://www.elibrary.dep.state.pa.us/dsweb/Get/Document-108470/2700-BK-DEP4494.pdf
[8] Datasets provided by the MU Weather Information Center (http://www.atmos.millersville.edu/~wic/climatology.html), Local Data Archives: Monthly Temp. Departures and Monthly Precip. Departures. Charts prepared by MU Student, Zachary Dodson.

Figure 1 – Annual Temperature Anomalies (1914-2018), Millersville University Weather Station

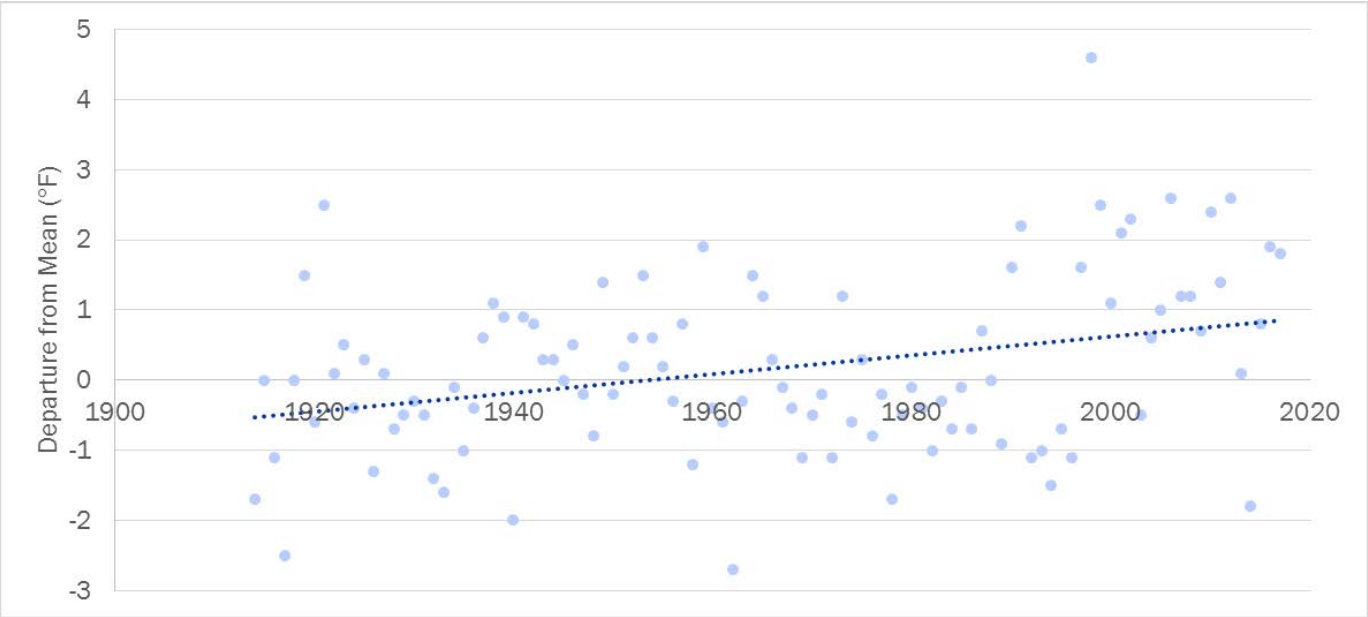
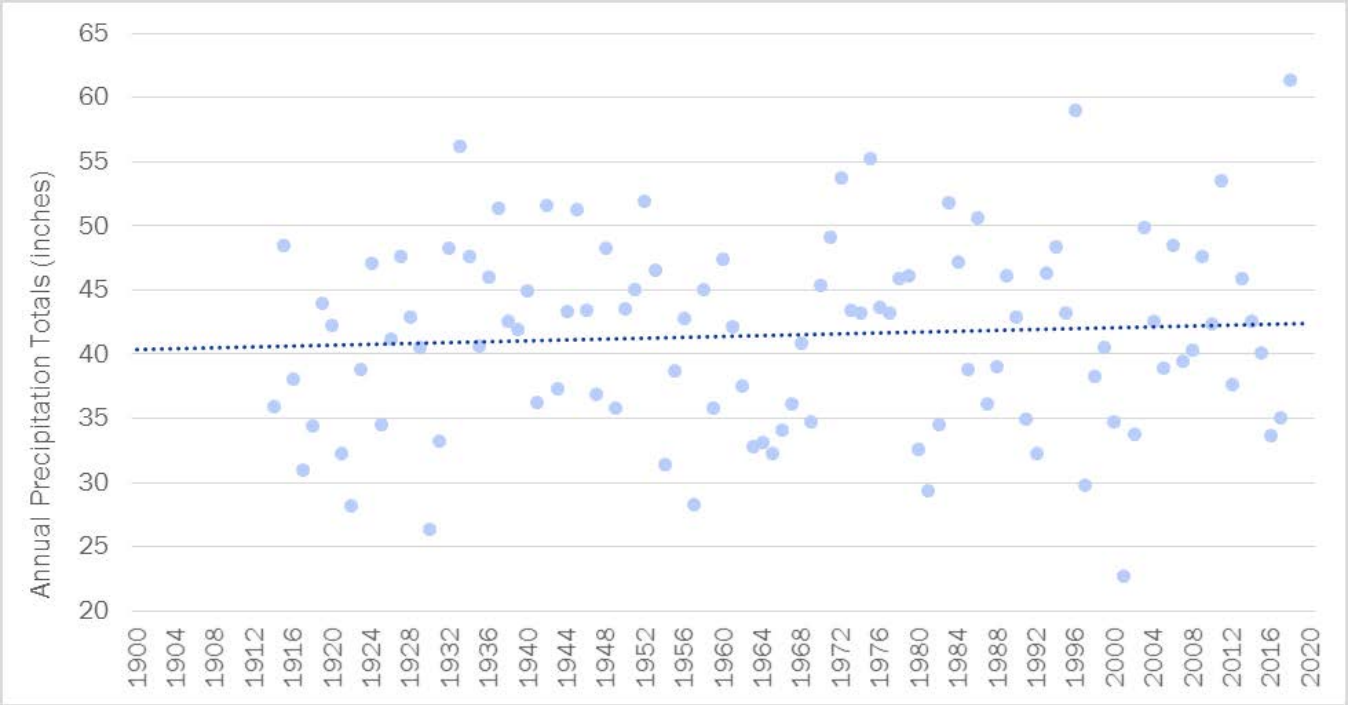


Figure 2 – Annual Precipitation Totals (1914-2018), Millersville University Weather Station



While temperature and precipitation vary year-to-year and over decades based on different naturally-occurring climate modes (e.g., El Nino/Southern Oscillation, Pacific Decadal Oscillation, etc.), Pennsylvania is expected to get warmer and wetter faster as climate changes in the coming decades. By 2050, Pennsylvania is expected to be 3°C (5.4°F) warmer than it was in the late 1990s. Additionally, average annual precipitation levels are likely to increase and the intensity of precipitation events is likely to increase. [9] Indeed, to date, the broader Northeast Region of the U.S. has experienced a greater increase in extreme precipitation than any other region in the U.S.[10]

These climatic changes will have both beneficial and detrimental effects on Pennsylvanians and Pennsylvania ecosystems, human health and the economy.

As an example, increased average temperatures will likely lengthen the growing season, which may lead to higher crop yields and also make it possible to grow crops that are currently limited to warmer locations. Alternatively, more intense precipitation events, or persistent periods of rain, may damage crops and increase the risk of severe flooding. Changing weather patterns, such as earlier springs, may also require adapting pest, weed, and disease management practices among farmers.

Warmer temperatures may lessen winter heating costs while also increasing demand for electricity for cooling in summer months—the net effect may be an increase in demand for energy, particularly electricity. Increased demand for electricity may coincide with decreased reliability of energy delivery systems created as a result of extreme weather events (e.g., heat wave, ice storm).

Increased frequency of extreme weather events, such as heavy summer thunderstorms, microbursts, and heavy snowfalls, may damage infrastructure such as powerlines, wastewater treatment systems, and roadways leading to costly repairs while placing individuals at risk of death or injury. Such events may also place strain on emergency response teams and municipality budgets.

Increasing temperatures may push tree species that are at the southern extents of their range to higher latitudes—limiting habitat for some species—while prolonging growing seasons, exacerbating challenges with invasive plant species.

Longer periods of high temperatures may result in an increase in heat-related illness, particularly during intense heat waves and among vulnerable populations such as the elderly or individuals with asthma or heart disease. Additionally, warmer temperatures may result in an increase in the prevalence and distribution of vector-borne diseases such as Lyme disease.

Each of the above are examples of how climate change may affect the way of life at Millersville and the communities that surround the University. While there is uncertainty in the specifics, it is clear that climate change is already happening, that Pennsylvania's future will likely be warmer and wetter and that these changes will have small and large effects on the way Pennsylvanian's produce food, generate energy, conduct commerce and interact with their environment. As a community leader, Millersville has the responsibility and intent to contribute meaningfully to the regional climate change response. This begins

[9] Pennsylvania Climate Impacts Assessment Update, http://www.elibrary.dep.state.pa.us/dsweb/Get/Document-108470/2700-BK-DEP4494.pdf
[10] National Climate Assessment, http://nca2014.globalchange.gov/report/regions/northeast#intro-section-2. Citing Groisman, P. Y., R. W. Knight, and O. G. Zolina, 2013: Recent trends in regional and global intense precipitation patterns. Climate Vulnerability, R.A. Pielke, Sr., Ed., Academic Press, 25-55.

with implementing comprehensive measures to lessen our contribution to climate change by reducing, or mitigating, our GHG emissions. Doing so not only improves our own performance, but also demonstrates approaches to the broader community. In addition to mitigating our emissions, Millersville will also begin to identify ways to improve the climate resilience of our University. Millersville will also seek to increase knowledge of climate change among our students and assist with climate change response planning in the surrounding community.

The remainder of this document:

- Presents an assessment of Millersville's GHG emissions followed by a detailed approach for reducing them,
- Characterizes campus strengths and assets as well as vulnerabilities to the impacts of climate change on the natural, built and human environment,
- Overviews climate change response planning efforts within the broader community,
- Discusses efforts to incorporate climate change into the curriculum, and
- Proposes options for integrating climate change considerations into campus planning and engagement.

Dr. Kathleen Schreiber, chair of the Climate Action Plan Committee, incorporates climate change into coursework, such as her Climate and Society class. Through her classes, students have explored various topics ranging from travel-time comparisons between pedestrian and vehicle travel on campus to climate change's impacts on campus human health and wellbeing.

ACHIEVING CARBON NEUTRALITY

Millersville's 2016 Climate Action Plan first established a goal to be carbon neutral by 2040. To do so, Millersville will reduce GHG emissions to the maximum extent possible and then apply viable and broadly beneficial carbon offsets to balance remaining emissions. Achieving the goal will also require coordination across the University's various departments, and the personal and professional commitment of faculty, staff and students. It will require conservation activities and efficiency improvements, changes in behavior and integration of climate change considerations into University activities—from campus events to classroom discussions. All members of the University community can and should be involved. This section presents the results of Millersville's 2018 GHG emission inventory followed by a discussion of planned actions to reduce GHG emissions in support of the carbon neutrality goal.

Greenhouse Gas Emissions at Millersville University

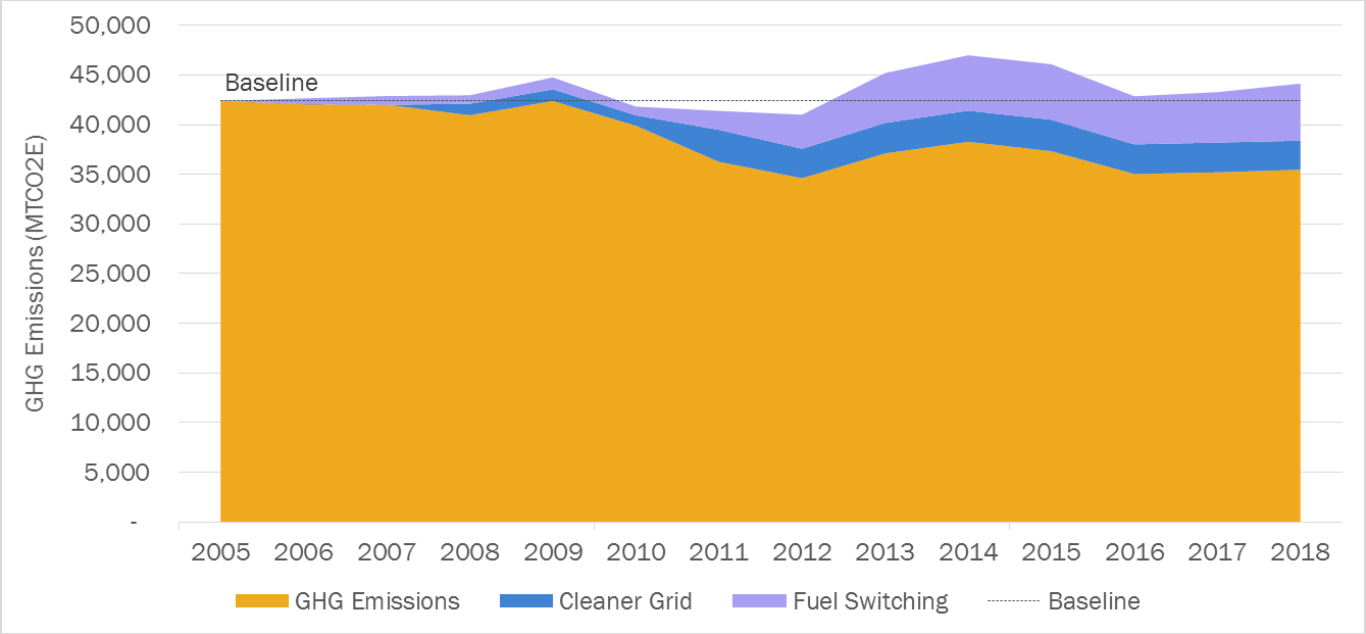
The daily activities needed to run academic and administrative programs at Millersville produce GHG emissions. Some GHG emissions occur directly on-site through the combustion of fossil fuels in campus vehicles and in boilers and generators. They also occur upstream—through the combustion of fossil fuels at power plants that provide electricity to Millersville—and downstream of the University—through the decomposition of organics in wastewater, as examples. Faculty, staff and students use electricity to power computers and classrooms and gasoline to drive commuter vehicles. Each of these activities emit GHGs to the atmosphere. Collectively, the GHG emissions amount to what is commonly referred to as Millersville's carbon footprint. Millersville's GHG emissions along with the GHG emissions of other colleges and universities, corporations, individuals and nations continue to build up in the atmosphere—leading to human-induced changes in climate.

Millersville annually accounts for its GHG emissions by preparing a GHG emission inventory. A GHG emission inventory provides the University with an understanding of where emissions come from to help identify opportunities to reduce, or mitigate, GHG emissions.

In 2018, Millersville University's gross GHG emissions totaled 35,470 $MTCO_2E$. University GHGs have decreased 16 percent since the base year of 2005 and 5 percent since the 2015 Climate Action Plan. The majority of these emission reductions result from increased use of natural gas (instead of coal) among power suppliers and the University transition to natural gas instead of electricity to heat several large campus buildings (Figure 3).[11]

[11] Beginning with the 2018 GHG emission inventory, Millersville University transitioned to using residual GHG emission factors for purchased electricity. Residual emission factors have been adjusted to remove purchases of renewable energy. This approach removes double counting of the carbon-reduction benefits of renewable energy generation. As a result, Millersville's 2018 GHG emissions from purchased electricity are 65 percent higher than they would be if eGRID GHG emission factors were used. This change means that total GHG emissions throughout the timeseries are higher than those reported in the 2016 Climate Action Plan.

Figure 3 – Millersville University Greenhouse Gas Emissions (2005-2018) with primary mitigation actions

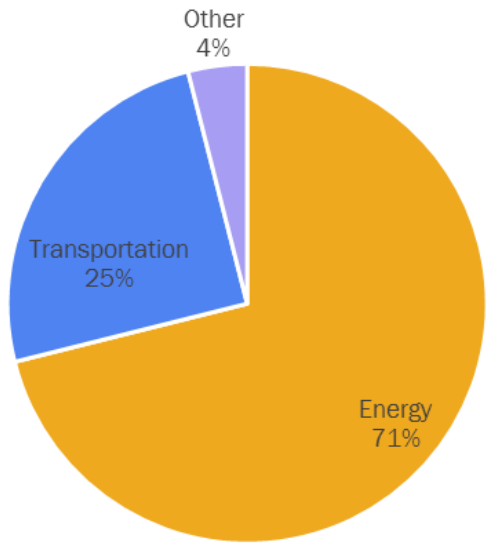


Emissions by Sector

Millersville's current GHG emissions are driven primarily by campus building energy use and, to a lesser degree, through transportation.

- At 71 percent (25,220 $MTCO_2E$), energy use in campus buildings accounted for the majority of emissions.
- At 25 percent (8,838 $MTCO_2E$) transportation—consisting of faculty, staff and student commuting and University-affiliated travel—was the second largest emission sector.
- The remaining 4 percent of emissions (1,411 $MTCO_2E$) came from other emission sources, primarily refrigerant leaks associated with campus building air-conditioning units.

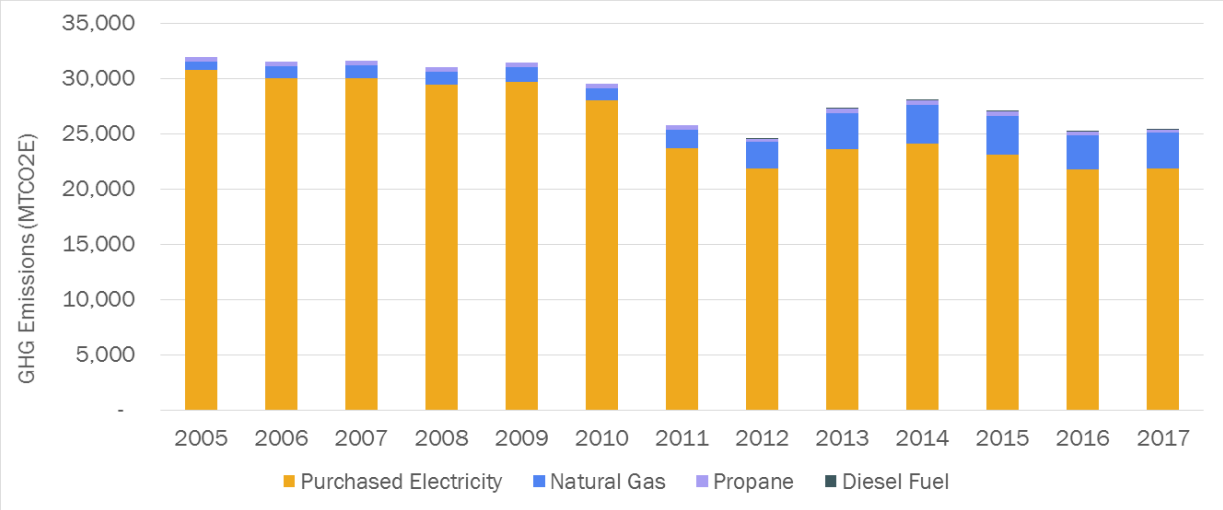
Figure 4 – 2018 Greenhouse Gas Emissions by Sector



Energy-related Greenhouse Gas Emissions

Millersville's energy-related GHG emissions stem primarily from electricity use, followed by natural gas use and to a lesser degree propane and diesel fuel consumption. Electricity is used to provide heating and cooling, lighting and other power needs to campus buildings and to provide power for site and stadium lighting and the operation of water pumps. Natural gas, diesel fuel and propane are used for heating and natural gas is used for cooking in the dining facilities. Natural gas use is the fastest-growing energy source, which, as previously discussed, has helped to reduce total campus GHG emissions (Figure 3) though the share of GHG emissions attributable to natural gas has increased (Figure 5).

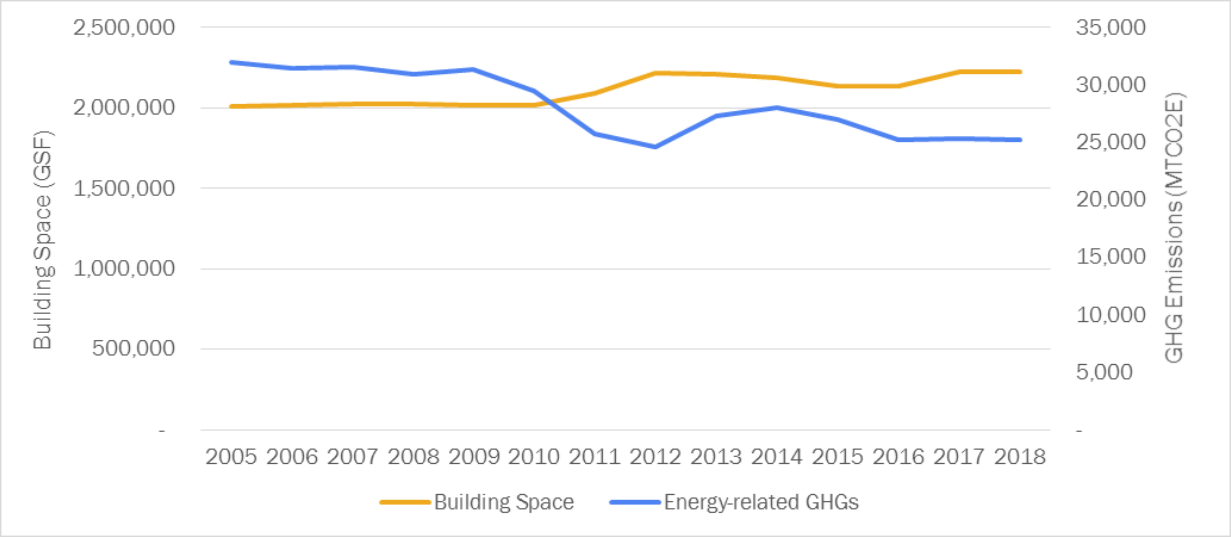
Figure 5 – Energy-related Greenhouse Gas Emissions by Fuel Type (2005-2018)[12]



Millersville has undergone significant recent changes to campus buildings—including constructing several large new residence halls, expanding and renovating the dining hall, and constructing a new zero energy welcome center. Despite growth in the total amount of building space, energy-related GHG emissions have decreased by 7 percent since 2015 and 21 percent since 2005 (Figure 6). As a result, energy-related GHG intensity (GHGs per square foot) has decreased by 28 percent since 2005.

[12] Purchased electricity emissions include GHG emissions associated with transmission and distribution of electricity.

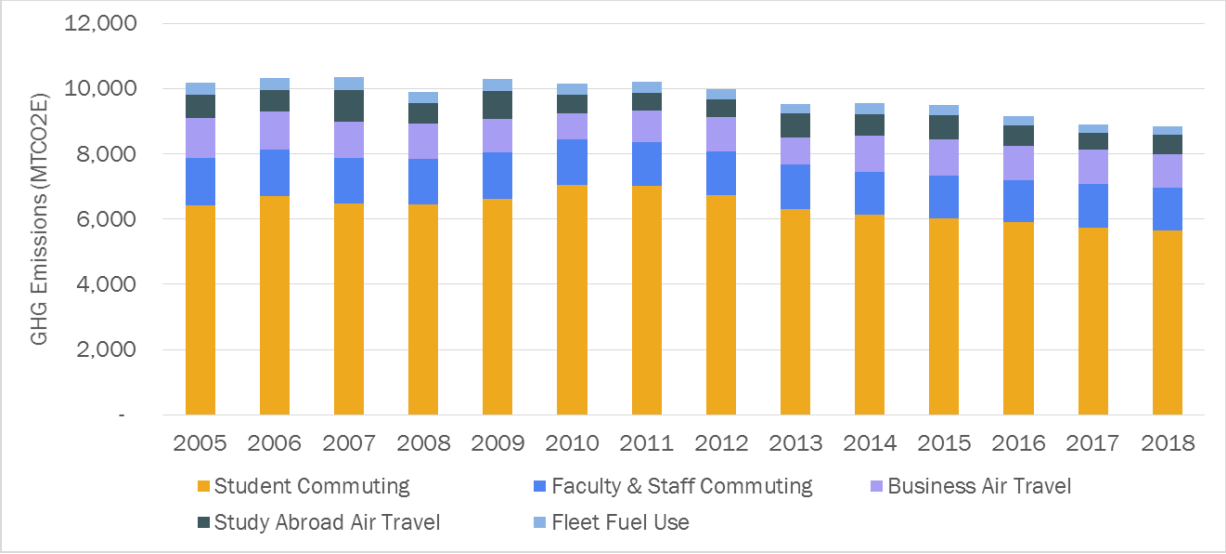
Figure 6 – Total building space and total energy-related greenhouse gas emissions (2005-2018)



Transportation-related Greenhouse Gas Emissions

Millersville's transportation-related GHG emissions stem primarily from student commuting and, to a lesser degree, faculty and staff commuting, business travel, travel for study abroad programs and University fleet fuel use (Figure 7). Greenhouse gas emissions have decreased within each transportation source since 2005. The largest decreases are associated with student commuting on a magnitude basis and fleet fuel use on a percent decrease basis.

Figure 7 – Transportation-related Greenhouse Gas Emissions by Travel Type (2005-2018)



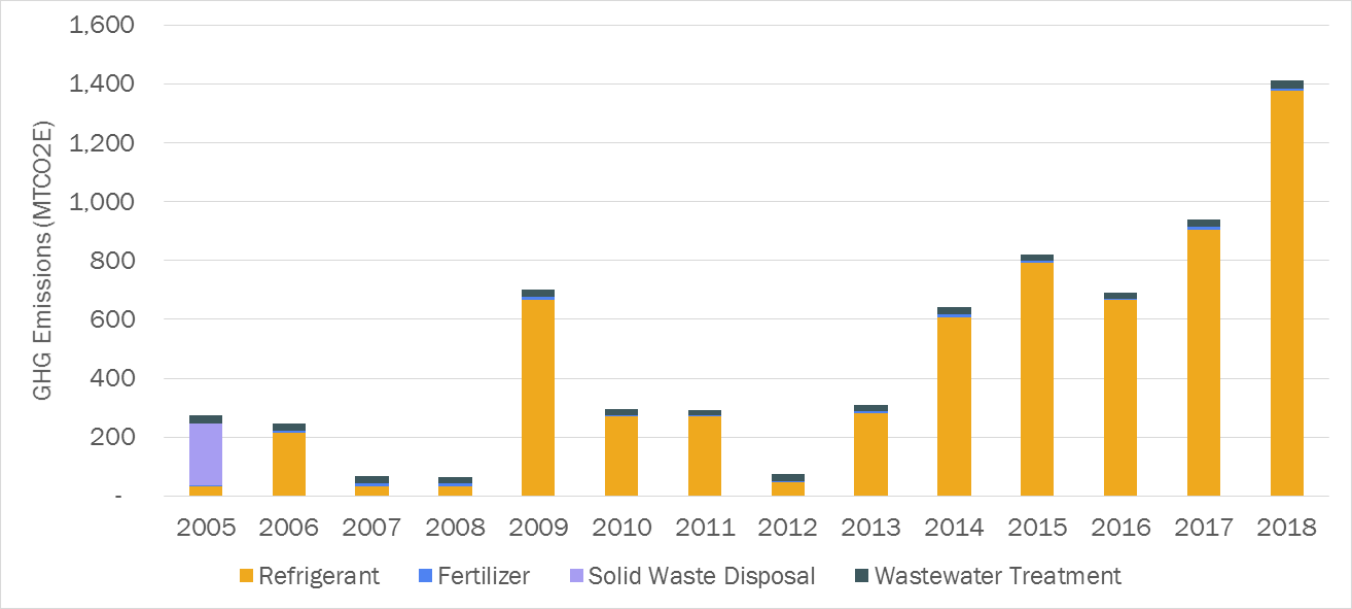
Other Sources of Greenhouse Gas Emissions

Other sources of GHG emissions account for a relatively small percentage of Millersville University's GHG emissions. The sector consists of GHG emissions associated with solid waste disposal[13], fertilizer use, wastewater treatment and refrigerant use. Refrigerant use is typically the largest emission source within

[13] Millersville University's solid waste is sent to Lancaster County Solid Waste Management Authority's waste-to-energy facility, which combusts waste to generate electricity and does not result in GHG emissions for the Unviersity.

this sector. GHG emissions associated with refrigerant use vary considerably from year to year depending on whether or not the University has experienced a refrigerant leak. As an example, 2018 GHG emissions from this source were greater than in any previous year—leading to a 1 percent increase in total GHG emissions relative to 2017. Alternatively, if refrigerant emissions in 2018 had been equal to the average of preceding years, the University would have experienced a 2 percent decrease in emissions between 2017 and 2018.

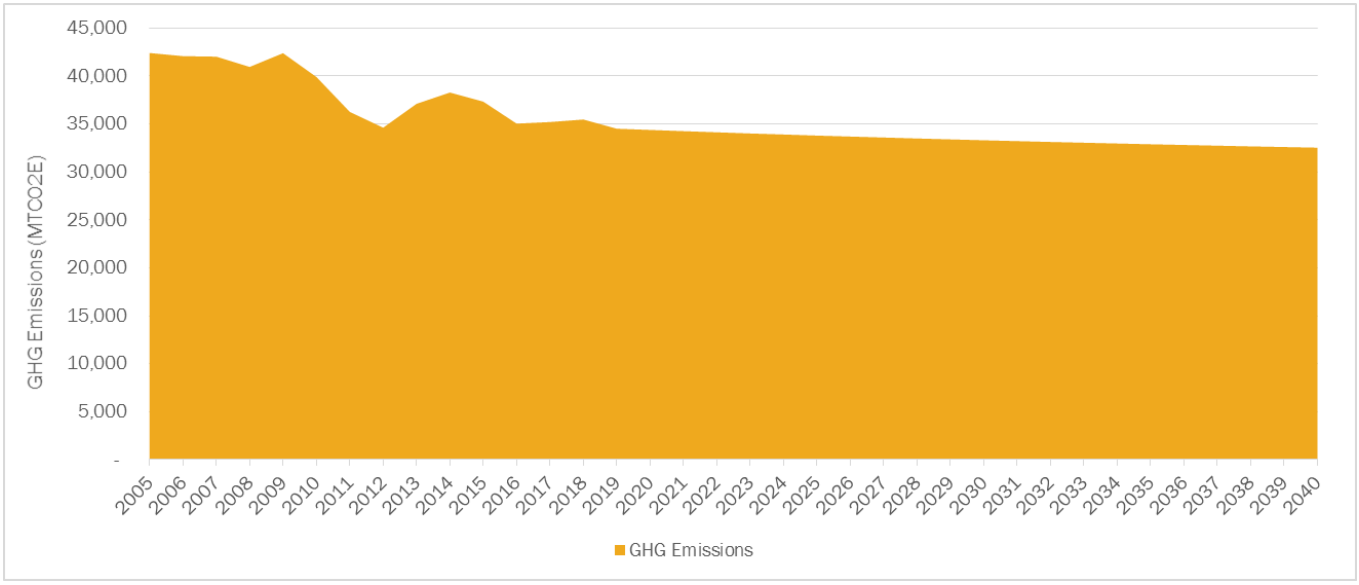
Figure 8 – Other Sources of Greenhouse Gas Emissions (2005-2018)



Greenhouse Gas Projection

If Millersville University does not implement additional efforts to reduce emissions, future emissions are expected to remain relatively constant through 2040. A slight decrease as shown in Figure 9 may occur due to improvements in national fleet fuel economy if the commuting population remains relatively constant.

Figure 9 – Projected Greenhouse Gas Emissions through 2040 without Additional Mitigation Efforts



Greenhouse Gas Mitigation Approach

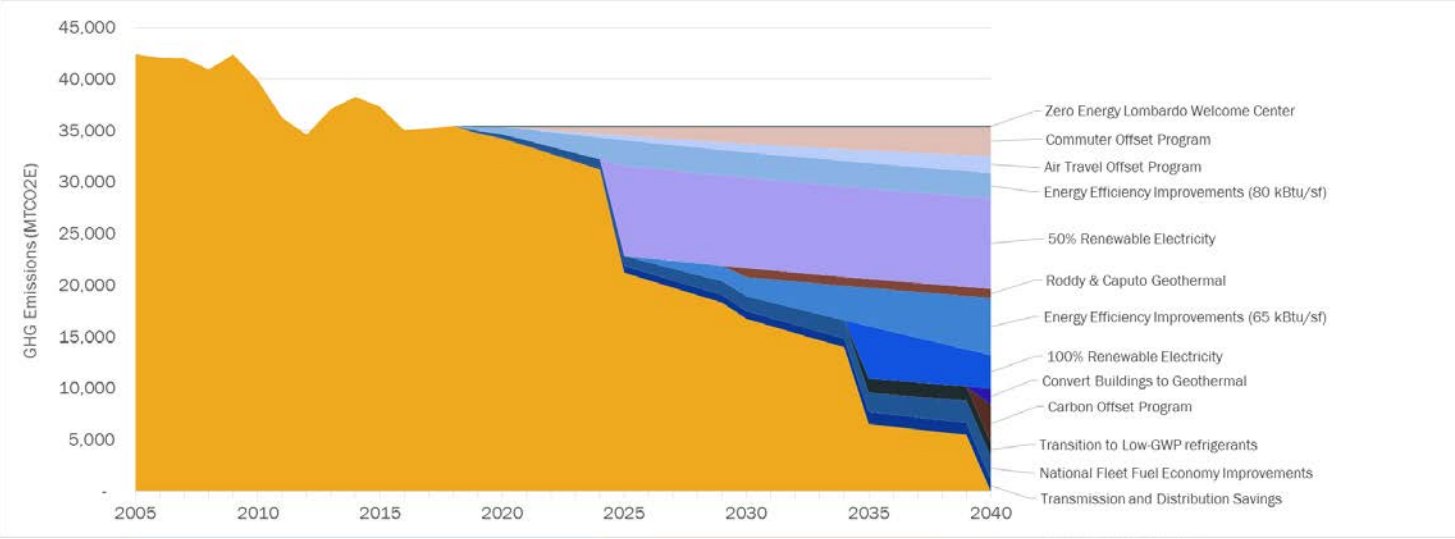
Millersville has established a goal to be carbon neutral by 2040. Achieving this goal requires significant reductions in GHG emissions, which stem primarily from Millersville University's building energy use and from transportation. This section presents an approach for reducing GHG emissions from these sectors as well as other smaller emission sources and sets specific objectives (Table 1) with performance metrics and targets to assist with tracking performance (Figure 10).

Table 1 – GHG Mitigation Objectives with Projected 2040 GHG Savings

Objective	Projected 2040 GHG Savings ($MTCO_2E$)	
Achieve and maintain certification of the Lombardo Welcome Center as a zero energy building.	125	0.4%
Design and build all new buildings, and major renovations to existing buildings, to green building rating system standards.[14]	1,376	3.9%
Increase the energy efficiency of Millersville's existing buildings through retrofits and upgrades. (8% improvement over 2018 by 2025, 25% by 2040)	8,014	22.6%
Increase use of renewable electricity. (50% of demand by 2025, 100% by 2040)[15]	13,191	37.2%
Increase onsite renewable energy generation through use of geothermal energy in key campus buildings.	2,438	6.9%
Encourage climate-friendly travel, including carbon offset programs for business travel and commuting.[16]	6,646	18.7%
Increase waste diversion while continuing to reduce GHG emissions associated with the supply chain.	NE	NA
Establish a carbon offset program to offset remaining emissions.	3,680	10.4%
Total	35,470	

NE – Not Estimated. Millersville University's waste is sent to a waste-to-energy facility and supply chain emissions are not yet estimated.

Figure 10 – Projected Greenhouse Gas Emissions with Mitigation Actions



[14] Includes preventing refrigerant leaks and transitioning to refrigerants with low global warming potential when available.
[15] Includes 1,173 $MTCO_2E$ reductions associated with electricity transmission and distribution.
[16] Includes 2,208 $MTCO_2E$ reduction associated with projected national fleet fuel efficiency improvements.

In 2018, Millersville University finished building the zero energy Lombardo Welcome Center. The beautiful metal and glass building is the University's new front door and stands as a clear testament of Millersville's commitment to advancing climate change solutions. Over 500 solar panels, a geothermal heating system, and energy efficient design set the building on path to achieving zero energy certification through the Living Future Institute in 2019.

These objectives and supporting activities are discussed below, organized as follows Buildings; Energy; Transportation; Purchasing, Waste, Dining Services and Grounds; and Carbon Offsets.

Buildings

Millersville University's building portfolio includes more than 80 buildings and 2.2 million gross square feet (GSF) of building space. The buildings vary considerably in size, age and use—ranging from buildings constructed in the late 1800s, such as Dutcher Hall and the Biemesderfer Executive Center to a former junior high school (Susan P. Luek Hall) to single-family homes to modern performing arts centers (The Ware Center and The Winter Center) to a new zero energy building (The Lombardo Welcome Center).

Overall, small buildings (those that are less than 10,000 GSF) account for the greatest number of buildings on campus (57 percent), while large buildings (those that are greater than 50,000 GSF) account for the greatest share of building space (72 percent), energy use (78 percent) and GHG emissions (73 percent).

Millersville University has completed several major construction efforts within the past several years, including demolishing several old residence halls and constructing three new ones (East, West and South Village), renovating and expanding Gordinier Dining Hall, and establishing a new precedent for campus sustainable construction by building the zero energy Lombardo Welcome Center. The Lombardo Welcome Center is on track to achieve zero energy certification through the Living Future Institute in the spring of 2019. Moving forward Millersville seeks to:

Objective: Achieve and maintain certification of the Lombardo Welcome Center as a zero energy building.

Using the Lombardo Welcome Center as a new bar for building performance, Millersville will seek to incorporate sustainable design principles and green building rating system standards into new construction and major renovation activities to ensure that the University grows in a responsible manner. Additionally, the University will continue to evaluate the current use of space to identify opportunities for space consolidation and the disposition of assets as appropriate.

Objective: Design and build all new buildings, and major renovations to existing buildings, to green building rating system standards.

Energy

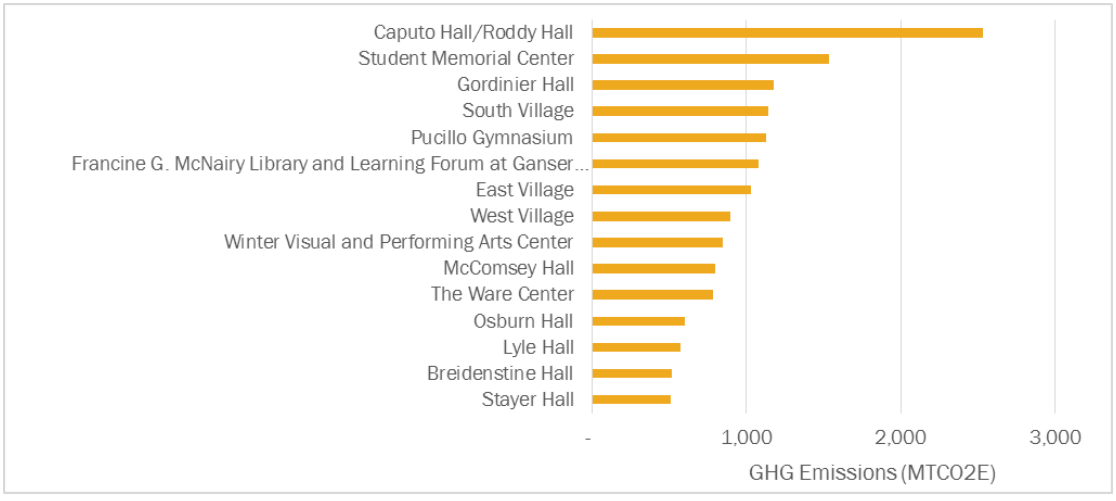
Millersville has a unique history associated with meeting the University's energy demand. Like many other universities in the Mid-Atlantic and Northeast regions of the United States, the University originally operated a centralized steam plant that provided heat to campus buildings. The steam plant was in use from the late 1930s to 1970 at which time Millersville transitioned away from meeting heating demand using centralized steam generation toward providing decentralized heating—primarily through electric heat.

Rising electricity costs and lower natural gas costs combined with an interest in converting to less-carbon intensive forms of energy spurred a recent transition toward natural gas heating. Approximately 15 campus buildings are now supplied by natural gas to meet either space heating or water heating needs or both. These fuel-switching efforts have reduced campus GHG emissions by approximately 5,000 to 6,000 $MTCO_2E$, annually.

While these efforts have led to an overall decline in GHG emissions, energy-related GHG emissions still account for approximately 70 percent of total GHG emissions, and are therefore the primary focus of GHG mitigation efforts.

The University recently completed a large upgrade to campus electrical infrastructure, which included installing meters on the largest campus buildings—comprising 98 percent of campus energy use. Millersville subsequently prepared an in-house energy management system that can be used to determine each building's contribution to Millersville's carbon footprint. Using this system, Millersville University determined that its 15 most GHG-intensive buildings account for 75 percent of total building GHG emissions (Figure 11).

Figure 11 – Building GHG emissions for 15 most GHG-intensive buildings



Millersville University has made significant progress over the past several years to understand the energy performance of its building portfolio. Moving forward the University will continue to evaluate building performance and use the information to guide performance improvements. The University will continue to create a culture of energy conservation while investing in building energy-efficiency upgrades and transitioning to renewable energy generation. Millersville's approach to reducing energy-related GHG emissions can be characterized by three activities:

1. Reduce overall energy demand through conservation,
2. Increase efficient use of energy by implementing energy efficiency measures, and
3. Transition toward alternative, less carbon-intensive, forms of renewable energy to meet remaining demand.

Conservation

Conservation can be as easy as turning off a light switch. It therefore offers the most cost-effective means of reducing energy consumption. While cost-effective, conservation also relies almost entirely on the energy consumers—the faculty, staff and students that use the classrooms, offices and residence halls. Through campaigns, competition and recognition, Millersville will further develop and enhance a culture that values energy conservation. Specifically, Millersville will:

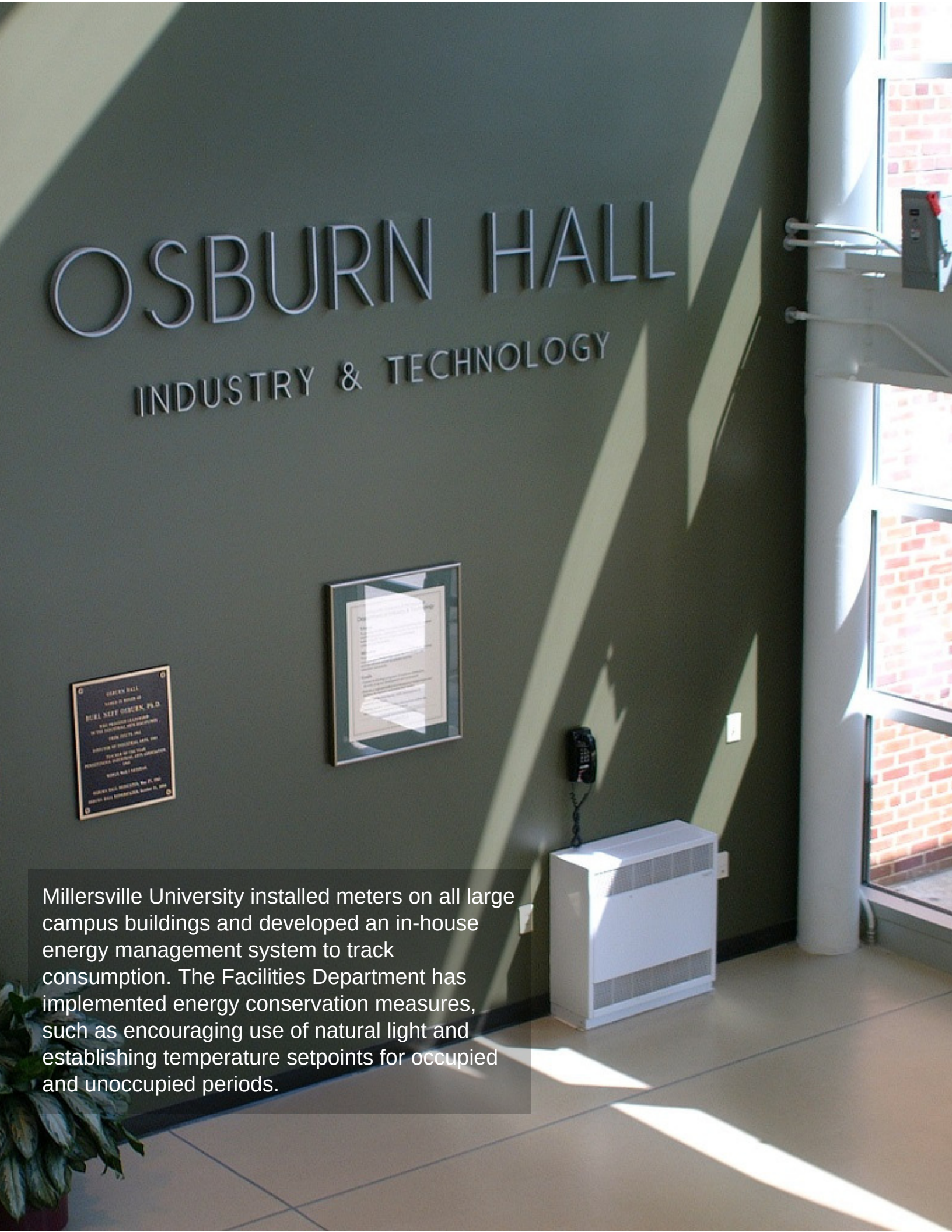
- Incorporate energy awareness and conservation practices into student life through activities such as the 'Ville Unplugged energy conservation campaign.
- Continue to develop and release education and outreach materials focused on energy conservation.
- Maintain and promote Millersville's web-based energy management dashboard, which encourages energy-conscious behaviors by providing real-time energy use information for the residence halls and classroom buildings.
- Maintain temperature set points for buildings during occupied and unoccupied hours that optimize building comfort while lessening overall energy demand.
- Encourage use of daylighting in campus classrooms, offices and common spaces.
- Identify opportunities to expand energy-reduction practices at appropriate buildings during minimal utilization periods such as winter break and summer months.

Efficiency

Coincident with energy conservation campaigns and other activities that lessen the overall demand for energy, Millersville will continue to implement a suite of energy efficiency upgrades to campus buildings with intent to reduce building energy use intensity (the amount of energy consumed per square foot of building space). While many campus buildings have energy-efficient appliances and lighting and up-to-date heating and cooling systems, many others do not. Energy efficiency upgrades will therefore be made in a deliberate and prioritized manner that begins by targeting those buildings that offer the greatest potential for improvement.

As discussed earlier, Millersville recently finished installing metering systems that allow for building-level tracking of energy consumption. Millersville uses this information to track building energy performance to identify opportunities to improve building performance.

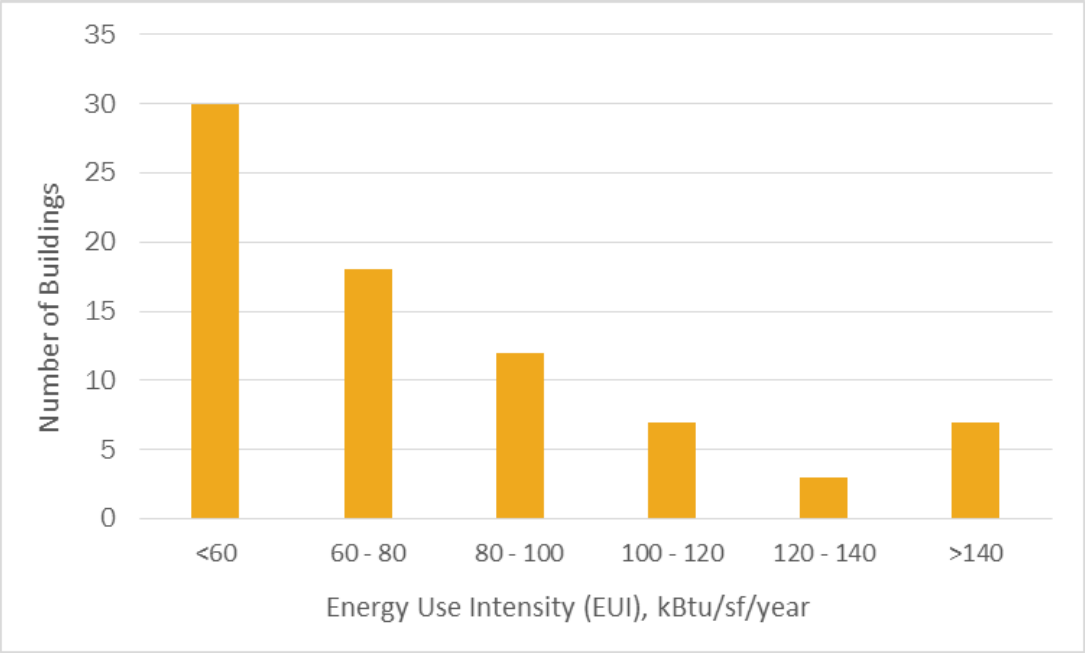
Metering campus buildings has provided insights into the range of performance among Millersville University's building portfolio. The campus-wide building energy use intensity (EUI) in 2018 was 87 kBtu per square foot, though this value varies between University buildings based on various factors such as age, building materials, and use. The majority of campus buildings have a lower EUI than the average



Millersville University installed meters on all large campus buildings and developed an in-house energy management system to track consumption. The Facilities Department has implemented energy conservation measures, such as encouraging use of natural light and establishing temperature setpoints for occupied and unoccupied periods.

because of the large number of buildings that were formerly single-family homes. Twenty-five buildings have an EUI that's greater than the average and, of these, seven buildings have an EUI that's significantly higher—greater than 140 kBtu/sf/year (Figure 12).

Figure 12 – Campus Building Distribution by Energy Use Intensity (kBtu/sf/year)



Millersville will continue to monitor and analyze building performance to identify energy conservation measures (ECMs). Millersville will compile ECMs for all target buildings and prioritize them for implementation based on available funding with a goal of achieving target EUIs as noted below:

Objective: Increase the energy efficiency of Millersville's existing buildings through retrofits and upgrades while creating a culture of energy conservation among Millersville's faculty, staff and students.

Performance Metrics
2005 Building Energy Use Intensity: 86 kBtu/sf/year
2018 Building Energy Use Intensity: 87 kBtu/sf/year
2025 Building Energy Use Intensity Target: 80 kBtu/sf/year
2040 Building Energy Use Intensity Target: 65 kBtu/sf/year

Renewables

A strong energy conservation program coupled with ongoing energy efficiency upgrades will position Millersville to achieve significant reductions in energy use intensity. As energy demand decreases and aligns more closely with target levels, Millersville will transition from investing primarily in energy efficiency upgrades to investing in alternative forms of energy supply. As previously noted, Millersville University recently completed construction of the zero energy Lombardo Welcome Center, which is completely powered by renewable energy. The building provides a tangible, on-campus demonstration of various renewable energy technologies, including solar glass, photovoltaic (PV) panels and ground-source heat pumps (colloquially referred to as geothermal). Millersville University plans to build on the success of the

Lombardo Welcome Center by increasing use of renewable electricity to account for 50 percent of University electricity use by 2025 and 100 percent by 2040 as noted below.

Objective: Increase use of renewable electricity.

Performance Metrics
2005 Renewable Electricity Use: 0% of campus demand
2018 Renewable Electricity Use: 0.5% of campus demand
2025 Renewable Electricity Use Target: 50% of campus demand
2040 Renewable Electricity Use Target: 100% of campus demand

Millersville University also intends to extend use of geothermal heating and cooling to other campus buildings with a focus on those buildings that have the largest thermal energy demands, including Roddy Hall, Caputo Hall, Gordinier Hall, the Student Memorial Center, the Village Residence Halls, and the Winter Visual and Performing Arts Center.[17]

Objective: Increase on-site renewable energy generation through use of geothermal energy in key campus buildings.

If achieved, the energy goals noted above will reduce Millersville's 2018 GHG emissions by 67% by 2040.

Transportation

Millersville's transportation-related emissions stem primarily from commuter travel (both student commuting, and faculty and staff commuting) and to a lesser degree travel for business and study-abroad programs. Additionally, on-campus travel contributes to the University's overall GHG emissions as do emissions from the campus fleet and equipment use. This section presents actions for reducing GHG emissions associated with transportation-related emission sources centered around the following objective.

Objective: Encourage climate-friendly travel, including carbon offset programs for business travel and commuting.

Commuting

Greenhouse gas emissions that result from commuting depend on the number of commuters, the distance traveled by each commuter, and the emissions intensity (expressed as GHGs per mile) of each commuter. The emission intensity is based on the commuter's travel mode. Commuters who walk or bike to Millersville have an emission intensity of zero while those who drive alone have an emission intensity closer to 1 pound of CO_2 per mile traveled.

Commuter emissions are further broken down by those associated with student travel and those associated with faculty and staff travel. In 2018, GHG emissions from student commuting accounted for approximately 16 percent of total University GHG emissions while emissions from faculty and staff commuting accounted for approximately 4 percent of total University GHG emissions.

[17] Campus planning conversations have included discussion of constructing a new science building. This Plan recommends incorporating a geothermal system into the design of a new science building if constructed.

More than 3,500 full time students commute to Millersville University each year as do nearly 2,000 part time students. Combined, these students represent a substantial portion of Millersville's student population. While Millersville offers transit services and other commuter benefits, a 2015 survey indicated that the majority of students (approximately 78 percent) commute alone. Those students who drive to campus average approximately 14 miles in each direction. Approximately 14 percent of Millersville's commuting students walk to campus.

Nearly all of Millersville's faculty and staff (900 employees) commute to campus and the majority (92 percent) drive alone. They average approximately 20 miles in each direction.

Millersville currently offers bus services for commuters through a contract with a local bus service. Students may use the bus service, which provides service to the City of Lancaster, free of charge using their student I.D. The bus service also provides access to downtown campus locations (e.g., the Ware Center) and local business attractions as well as connections to regional transit.

While core educational programs remain on campus, Millersville University has expanded its over 150 year tradition of providing quality education to include online programming. Millersville's Office of Online Programs provides an ever-growing catalog of online and blended courses as well as fully-online certificates and degrees that meet the needs of students where they are. Greenhouse gas reductions are a co-benefit of providing online programming—as online programs faculty services such as office hours continue to grow, commuting emissions are likely to decrease due to a reduction in the number of days per week that students and faculty commute to campus.

Millersville University has numerous resources in place to provide climate-friendly travel options to faculty, staff and students, including on campus ride share services, a campus shuttle, bike racks and repair stations, bus services, and connections to regional transit. Still the majority of commuters drive alone. Moving forward, Millersville will seek to expand its advanced transportation offerings as well as support regional, state and national efforts to increase vehicle fuel economy and transition to low GHG-emitting vehicles.

To provide encourage climate-friendly travel, Millersville will:

- Establish a commuter carbon offset program.
- Install additional electric vehicle charging stations.
- Establish a campus bikeshare program.
- Investigate options to designate parking spaces or provide parking permit discounts for individuals that carpool or use low-GHG emitting vehicles such as electric vehicles or hybrids.
- Continue to improve bicycle infrastructure (e.g., trails, bike repair services, shared-lane bicycle markings) to provide a bicycle-friendly campus and more bike-friendly access to campus.
- Continue to develop online and blended courses.
- Work with the bus vendor to provide bike racks on buses.
- Investigate options to establish a dedicated shuttle for access to regional rail.
- Continue to offer and expand ride share services, ride matching services, and transit.

In 2016, Millersville University began a partnership with Commuter Services of Pennsylvania to provide commuter services and resources to Millersville faculty, staff and students, including a ride matching service for commuters. Commuter Services of Pennsylvania annually holds a green commute month during the month of October to encourage use of advanced transportation options (e.g., local transit), and Millersville University has consistently ranked first among competing universities for commuter miles traveled using advanced options

Business Travel and Study Abroad Programs

In 2018, Millersville's GHG emissions from business travel and study abroad programs totaled 1,638 $MTCO_2E$. The majority (62 percent) of air travel emissions are attributable to faculty and staff travel for business purposes, while the remaining air travel emissions (38 percent) are associated with faculty and student travel for study abroad programs. Air travel emissions have decreased by 15 percent since 2005 due, in part, to efforts to limit business travel.

Historically, air travel has not seen as significant an increase in efficiency as other industries—meaning that, on a per mile basis, it still takes about as much carbon to travel in an airplane as it did years ago. The aviation industry has made efforts to increase fuel efficiency; however, in recent years progress made to increase fuel efficiency has been outstripped by an increase in overall miles traveled causing an increase in overall CO_2 emissions.[18] Notably, the U.S. EPA was working to establish CO_2 emissions standards for aircraft manufacturers under the Clean Air Act and in concert with the International Civil Aviation Organization's CO_2 rulemaking process; however, these efforts appear to have stalled.[19]

Additionally, the Federal Aviation Administration (FAA) has proposed various options for improving air travel efficiency—including adopting satellite-based air traffic procedures that will optimize flight routes and airport access—particularly during fuel-intensive takeoff and landing.[20] Other national mitigation strategies include aircraft engine efficiency improvements, improved operation and maintenance practices, and use of sustainable aviation fuels. While Millersville cannot directly influence these activities, part of the University's mitigation strategy can include preferential use of airlines that are early adopters of these strategies.

Despite these promising advancements, air travel is likely to be a carbon-intensive form of travel for the foreseeable future. Air travel is also necessary for providing faculty, staff, and students with valuable professional and academic experiences to help them grow and flourish. Still, the University does have a broad range of options available for offsetting the carbon associated with travel—including easy carbon offset options provided on most travel websites. To reduce GHG emissions associated with business travel and study abroad programs, Millersville will:

- Set university policy that encourages use of rental vehicles with high fuel economy or are low GHG-emitting (e.g., electric vehicles).
- Encourage faculty and staff to use public transportation instead of rental vehicles for conferences, meetings and other business travel.
- Establish a business travel carbon offset program.

Campus Travel

Once on campus, faculty, staff and students have several options for getting around. Most campus buildings are located within easy walking distance of one another and there are numerous pathways and walkways that connect campus buildings. Bike racks and bike repair stations are provided and a campus

[18] https://www.theicct.org/news/us-domestic-airlines-profits-and-carbon-emissions-surge-2015-16
[19] https://www.epa.gov/regulations-emissions-vehicles-and-engines/regulations-greenhouse-gas-emissions-aircraft
[20] https://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=19375

trolley shuttle travels a continuous loop that connects various key campus locations. Compared to commuting to campus the on-campus travel footprint is small; however, there is a tendency among some to drive, rather than walk or ride a bike, between campus locations. Doing so increases the amount of vehicle traffic on campus and impacts the bike-and-pedestrian friendly nature of some key campus locations.

A 2018 study by Millersville Geography students sought to determine whether it is faster to drive or to walk between campus locations. The students analyzed drive and walk times between McComsey Hall and Wickersham Hall (trip 1) and Roddy Hall and the Winter Visual and Performing Arts Center (trip 2). The findings indicated that driving takes less time between locations (particularly in afternoons), but walking can take less time during peak class times (e.g., mornings), particularly for the Wickersham Hall to McComsey Hall route. The findings can help students make informed decisions about whether savings in drive time between locations are worth the additional CO2 emissions and loss of health benefit associated with driving instead of walking.[21]

	Morning		Afternoon	
	Drive Time Minutes	Walk Time Minutes	Drive Time Minutes	Walk Time Minutes
Trip 1: Wickersham Hall to McComsey Hall	9.33	7.56	5.87	6.83
Trip 2: Roddy Hall to Winter Visual and Performing Arts Center	6.67	10.14	7.97	9.88

To reduce GHG emissions associated with campus travel, Millersville will:

- Encourage increased ridership and use of the campus shuttle system.
- Increase signage and other markings to encourage a bike-friendly campus.
- Establish a campus bikeshare program.
- Continue to improve bicycle infrastructure (e.g., trails, bike repair services, shared-lane bicycle markings) to provide a bicycle-friendly campus and more bike-friendly access to campus.
- Assess opportunities to improve bus tracking application to more accurately predict bus arrival times for the campus shuttle.
- Incorporate walk and bike flow considerations into the Campus Master Plan.

Campus Fleet

The University fleet consists of approximately 90 vehicles and an additional 20 pieces of medium and heavy-duty equipment, such as backhoes, tractors and mowers. GHG emissions from University vehicles and equipment are a small emission source that, on average, accounts for less than one percent of total

[21] Drive or Walk? MU Cross-Campus Travel Time by Mode & Time of Day. 2018 Made in Millersville Poster. Derek Boone, Audrey Esser, Cole Fitch, Christian Ott, Yamil Perez, Morgan Phillips, Edward Schick, Jessica Soullaird, Cameron Strosser, Nathaniel Sturgis. Faculty Mentor: Dr. Kathleen Schreiber.

GHG emissions. While this emission source is small compared to others, campus vehicles are a visible representation of the University's commitment to reducing GHG emissions. An appropriately-sized fleet that consists of fuel-efficient vehicles demonstrates Millersville's commitment to sustainability and carbon neutrality. Additionally, using vehicles that are powered with alternative-fuels demonstrates the technologies viability and encourages broader use within and beyond the campus gates. To reduce fleet-related GHG emissions Millersville will:

- Conduct a fleet optimization analysis that evaluates the purpose and use of each vehicle with intent to ensure that vehicles are matched to the right job.
- Adopt a vehicle replacement and purchasing methodology that considers the vehicle's fuel economy and fuel type along with other priorities related to purpose and use.
- Continue to implement vehicle maintenance practices that ensures that vehicles are routinely serviced and operating optimally.
- Identify opportunities to use low-GHG emitting modes of travel such as police officer use of bicycles.

Purchasing, Waste, Dining Services and Grounds

Purchasing, waste, and dining services at Millersville are closely related. Purchasing decisions are largely decentralized to the various departments though policy and guidance are set (and support provided) by the Purchasing Department. Dining and Conference Services oversees their purchasing activities and is one of the main waste generators on campus. Dining and Conference Services has also made some of the greatest strides within the University to reduce waste and make purchasing more sustainable. Waste collection is managed by Housekeeping staff within the Facilities Department. Collectively and in collaboration with other University departments these entities have the potential to increase waste diversion and reduce GHG emissions associated with the supply chain.

Objective: Increase waste diversion while continuing to reduce GHG emissions associated with the supply chain.

Purchasing

At first glance, GHG emissions associated with purchasing account for a relatively small share of Millersville's GHG footprint; however, closer review and consideration reveals that wise purchasing decisions have some of the greatest potential to lessen the University's contribution to climate change. From a life-cycle perspective, the products and services that Millersville purchases come with embodied GHGs—GHGs that occur during the extraction of raw materials used in products we purchase, GHGs from energy used to manufacture the products, and GHGs that occur through the transport of materials from the manufacturer to the University doorstep. These embodied GHGs are, for the large part, not yet accounted for as a GHG source in Millersville's GHG emission inventory; however, those companies and organizations that have accounted for lifecycle GHGs often find that they can significantly outweigh emissions from other sources such as buildings and fleet operations.[22]

[22] WRI Scope 3 GHG Protocol FAQ, http://www.ghgprotocol.org/files/ghgp/public/FAQ.pdf

Millersville's Purchasing Department has already taken great strides to purchase sustainable products. As examples, the University has adopted an Energy Star Priority Purchasing Program to ensure that equipment for both single and mass purchasing actions are Energy Star compliant. Additionally, the University works with vendors, contractors and maintenance staff to purchase environmentally-friendly cleaning materials. Millersville has also implemented printing policies and transitioned to electronic file management in several departments (e.g., Admissions, Human Resources) to reduce paper use. Notably, several items of furniture in the new Lombardo Welcome Center are cradle-to-cradle certified and over 40,000 pounds of recycled materials were used in the furniture manufacture.

To reduce GHG emissions associated with purchasing, Millersville University will:

- Begin to analyze the life-cycle GHG emissions associated with material purchases.
- Continue to look for opportunities to implement sustainable purchasing policies (e.g., biopreferred) with an emphasis on reducing embedded GHGs within the supply chain.
- Develop a guidebook for sustainable purchasing for use by campus departments.
- Identify products with high embodied GHGs and determine low-carbon alternatives.
- Assess feasibility of incorporating language in contracts to encourage product and service providers to report GHGs.

Waste

Millersville has dramatically reduced waste generation since the 2005 from approximately 700 tons produced annually to approximately 350 tons generated in 2018. The improvements are due to a combination of waste diversion measures including source reduction (e.g., electronic file management replacing paper files), recycling, composting and repurposing. Highlights of Millersville's waste reduction efforts include:

- Dining and Conference Services composts approximately 60 tons of food waste from Gordinier Hall annually.
- The Grounds department composts yard trimmings, leaves and other organic materials from landscaping.
- The Housekeeping and Grounds departments recycle approximately 150 to 200 tons of material annually.
- The Purchasing Department beneficially reuses surplus materials through internal repurposing as well as donations to other universities and local charitable organizations.

While there has been significant progress over the past decade, recent developments within the recycling industry are creating conditions that may slow progress or even degrade the University's waste diversion efforts. The local waste management authority (Lancaster County Solid Waste Management Authority) has been forced to limit the types of materials it can recycle due to restrictions China has placed on materials

it will accept for recycling.[23] As a result, Millersville University has currently restricted comingled recyclables to plastic bottles and jugs, metal food and beverage cans, glass, and corrugated cardboard.

It is currently unclear whether the changes in recyclable materials will increase or decrease Millersville's waste diversion rates. While fewer materials can be recycled, the changes have increased awareness and interest in recycling and may result in a cleaner recycling stream. Less contamination in recycling bins may increase the amount of recyclable materials that get recycled rather than discarded due to high contamination levels. Additionally, from a GHG perspective, Millersville is fortunate that the Lancaster County Solid Waste Management Authority disposes of waste using a waste-to-energy facility that is essentially carbon neutral.[24]

Moving forward the University will focus on increasing waste diversion rates with intent to achieve a 50 percent waste diversion rate in the near-term and long-term goal of incorporating broader net-zero waste principles into purchasing and waste disposal procedures.[25] Incorporating zero waste principles into University operations will challenge us to change our perception of waste as a natural byproduct of our activities to a resource that should be looped back into the supply chain. Pursuing net zero waste principles will require broad evaluation of the supply chain and coordination among various University departments—including Purchasing, Facilities, and Dining and Conference Services.

Dining Services

Millersville's dining services are managed in-house. This provides Millersville with an opportunity to directly oversee dining service operations—including managing the sustainability of the supply chain as well as managing the purchase, maintenance and use of food service equipment. A variety of on-campus dining halls and retail operations are provided—ranging from small convenience store operations and a food truck to a full-service dining hall.

Sustainability is at the heart of day-to-day operations within Dining and Conference Services. All food waste at the University's largest dining facility (the Upper Deck) is collected by Dining staff and composted by a local vendor for use as fertilizer at local farms. The Dining Hall has been recently renovated, including upgrades to many of the appliances and HVAC systems to energy efficient units. Notably, the Dining Hall recently converted all fryer oil from individual 5 gallon jugs to an oil delivery system where oil is stored in tanks and spent oil is recovered by a vendor for repurposing. Moving forward Dining and Conference Services plans to continue to reduce GHGs, including efforts to reduce waste, provide more sustainable food options, and reduce embodied GHGs in the supply chain.

Grounds

While not included in the GHG emission inventory, land management practices can contribute to the loss of carbon or, alternatively, to carbon storage (sequestration). Millersville's campus consists of approximately 250 acres ranging from parking lots to a biological preserve. The center of campus features

[23] https://www.lcswma.org/lcswma_recycling.cfm
[24] https://www.lcswma.org/lcswma_facilities_wte.cfm
[25] According to the U.S. EPA, different organizations define zero waste differently. Millersville University currently adopts the Solid Waste Association of North America's definition, which considers zero waste, "efforts to reduce Solid Waste generation waste to nothing, or as close to nothing as possible, by minimizing excess consumption and maximizing the recovery of Solid Wastes through Recycling and Composting." https://www.epa.gov/transforming-waste-tool/how-communities-have-defined-zero-waste

Millersville University's Dining and Conference Services captures and composts 60 tons of organic waste every year. Other waste is sent to Lancaster County Solid Waste Management Authority's waste-to-energy facility, which produces electricity for local homes.

well-maintained grassy lawns crosscut by walkways that carry pedestrians around the Millersville pond. Numerous mature trees line the walkways and grassy areas. Much of the campus boundary is lined by forested areas—including the campus's biological preserve.

Millersville's grounds staff strive to manage the grounds responsibly and do so at times through collaborations with University faculty and students. Notably, faculty in Millersville's Biology Department have installed interpretive markers that identify "Trees of Distinction" throughout campus. Faculty and students also maintain a campus apiary and pollinator gardens. Campus gardens have been designated as monarch waystations and several new rain gardens have been installed on campus to manage stormwater. Sections of the biological preserve that were lost during construction activities around 2015 were recently reforested by the Biology Department. The grounds of the new Lombardo Welcome Center consist entirely of native plants and the lawn behind the Huntingdon House features several raised bed organic gardens that are maintained by faculty, staff and students. To reduce GHG emissions associated with land management practices, Millersville University will convert mowed areas to native vegetation to cut down on mowing at appropriate locations along the perimeter of campus and continue to implement green infrastructure projects across campus.

Carbon Offsets

While Millersville plans to reduce GHG emissions as much as possible, it will not be possible to eliminate all GHG emissions from University activities. Remaining emissions will need to be offset by phasing in viable and broadly beneficial carbon offsets. Carbon offsets refer to GHGs that are avoided or carbon that is sequestered by a separate entity to compensate for emissions generated by Millersville. Millersville recognizes that achieving carbon neutrality will not be possible without purchasing carbon offsets; however, the University also values investing first in reducing the emissions included within the campus inventory as much as possible.

In addition to the air travel and commuter carbon offset programs previously discussed, Millersville will identify local carbon offset opportunities that the University can pursue in line with the intent to achieve carbon neutrality by 2040.

Objective: Establish a carbon offset program to offset remaining emissions.

Millersville will conduct the due diligence necessary to identify offsets that are:

- *Real* – The offset represents GHGs that are reduced as a result of activity undertaken for the purpose of reducing GHGs,
- *Permanent* – The GHG reduction is not reversible,
- *Additional* – The offset occurs as a direct response to the investment,
- *Verifiable* – The offset can be monitored and verified by an independent and qualified third party, and

- *Enforceable* – The credit can be tracked and attributed to the purchaser to avoid double counting.[26]

Additionally, Millersville values pursuing carbon offsets that contribute to the economic well-being of the local economy while providing a local demonstration of GHG reduction techniques. Example carbon offset projects include dairy farm methane digesters and implementing energy efficiency projects for in low-income housing areas.

[26] The Bottom Line on Offsets, http://www.wri.org/publication/bottom-line-offsets

BUILDING RESILIENCE TO CLIMATE CHANGE

As changes to climate become more pronounced, Millersville University and the surrounding region must not only take action to reduce GHG emissions, but also increase resilience to climate change impacts. As discussed in the Community Climate Change Response section of this Plan, Millersville University faculty, staff and students are involved in community climate change response planning. These collaborative efforts seek to build resilience to climate change impacts in the region.

Millersville University has also engaged in preliminary efforts to assess the University's resilience to climate change and begin to identify opportunities to increase resilience. Doing so not only builds the University's resilience, but also increases faculty, staff and student familiarity with resilience planning so that we may be a better resource within our community.

This section presents the results of Millersville University's campus resilience planning efforts. After a discussion of future climate scenarios and associate climate change hazards, the University's strengths and assets, vulnerabilities, indicators and response activities are discussed, organized into built environment, natural environment and human environment categories.

Future Climate Scenarios

Tomorrow's climate depends on how humans behave today and how they will behave in the future. If we reduce global GHG emissions quickly, the changes to Earth's future climate will be less extreme than if we continue to emit GHGs at current or higher levels. Therefore, when considering future climate, it's helpful to consider different emissions scenarios. For the purpose of this Action Plan, Millersville University considered a lower emissions scenario and a higher emissions scenario based on information provided in the U.S. Climate Resilience Toolkit's Climate Explorer and defined below.[27]

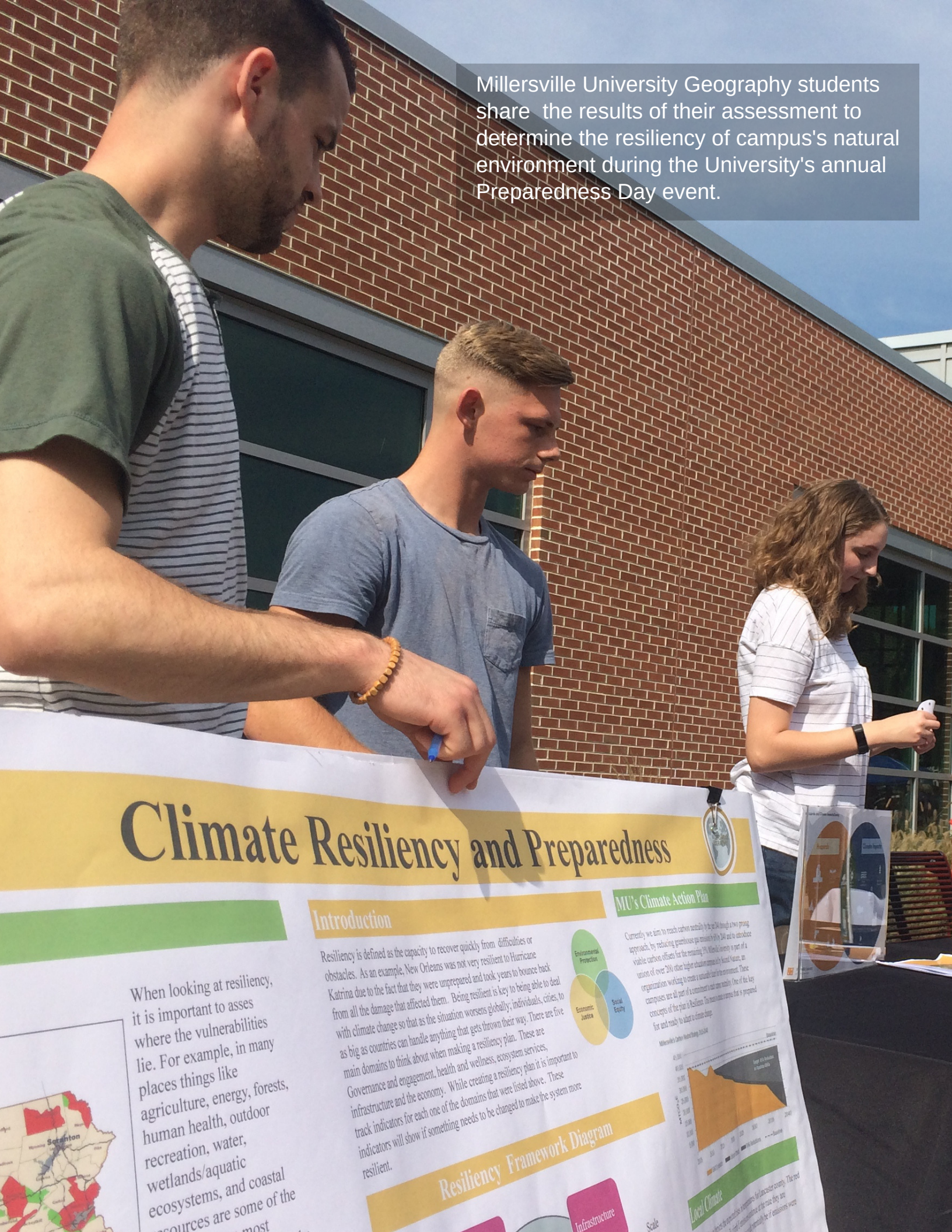
Lower emissions scenario: A possible future in which global emissions of heat-trapping gases peak around 2040 before declining. Scenario RCP 4.5.[28]

Higher emissions scenario: A possible future in which global emissions of heat-trapping gases continue to increase through 2100. Scenario RFP 8.5.[29]

Pennsylvania's climate future can be captured in two words, warmer and wetter. As described below, yearly average temperatures are expected to increase in and around Lancaster County as are annual precipitation amounts and intensity. For the purposes of this Action Plan, stakeholders were asked to consider a warmer and wetter future that produces such events as winter storms with more snowfall, summer storms with more intense wind and heavier precipitation, and longer periods of warm weather during the summer, as examples.

[27] Climate Explorer. U.S. Climate Resilience Toolkit. Lancaster County. https://toolkit.climate.gov/tools/climate-explorer
[28] RCP 4.5: A Pathway for Stabilization of Radiative Forcing by 2100. Thomson et al. https://asr.science.energy.gov/publications/program-docs/RCP4.5-Pathway.pdf
[29] The Representative Concentration Pathways: An Overview. van Vuuren, D.P., Edmonds, J., Kainuma, M. et al. Climatic Change (2011) 109: 5. https://doi.org/10.1007/s10584-011-0148-z

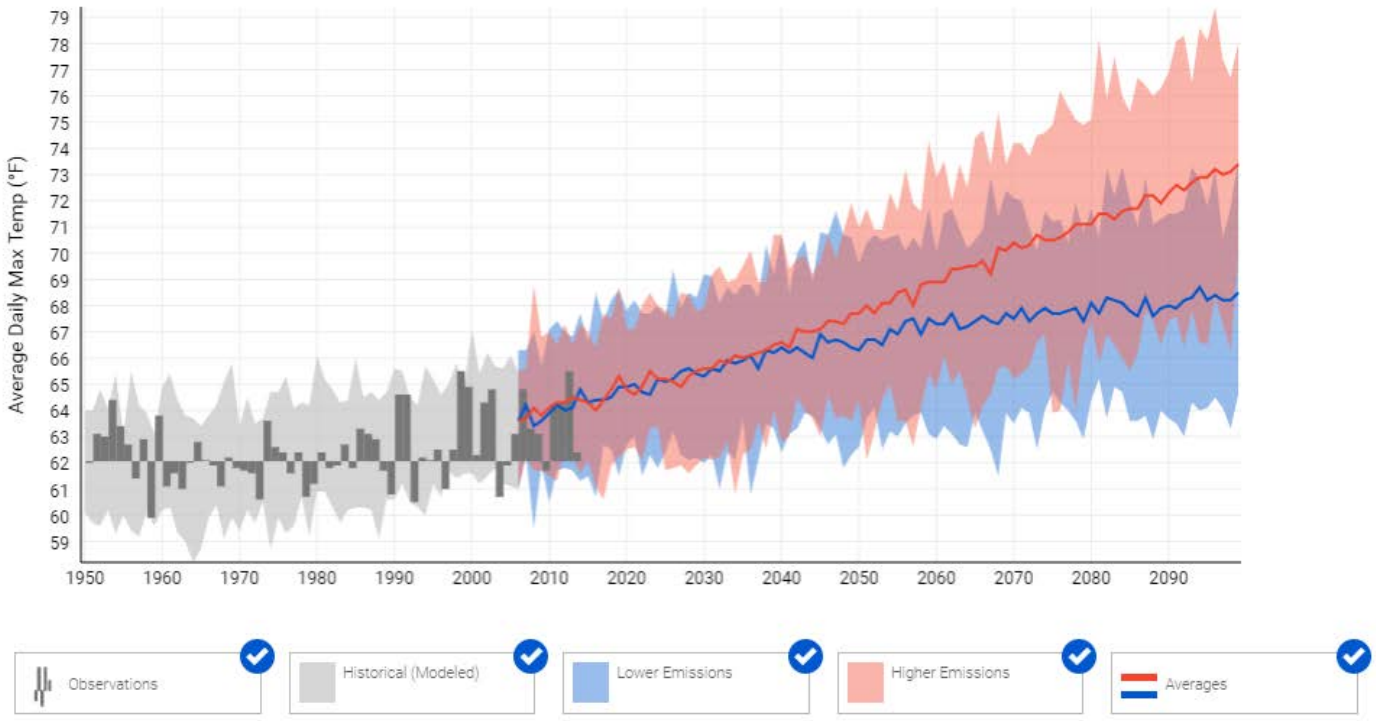
Millersville University Geography students share the results of their assessment to determine the resiliency of campus's natural environment during the University's annual Preparedness Day event.



Temperature

According to the Climate Explorer, average daily maximum temperatures in Lancaster County are already about 5 percent higher than they were in the 1950s and by mid-century they could be 7 to 9 percent higher depending on emissions scenarios (Figure 13). As previously discussed, according to the Millersville University weather station records, 1998 was the hottest year on record (since local records began in 1914) and 9 of the 10 hottest years on record have occurred since 1990 (Figure 1). The number of hot days is likely to increase as well. Between 1950 and 1980, Lancaster County on average experienced about 10 days each year where the maximum temperature exceeded 90°F; whereas by mid-century the number of days that exceed 90°F is expected to be closer to 39 under low emissions scenarios and 48 under high emissions scenarios.

Figure 13 –Lancaster County Average Daily Maximum Temperature: Observed (1950-2013) and Projected Low and High Emissions Scenario (2014-2099)



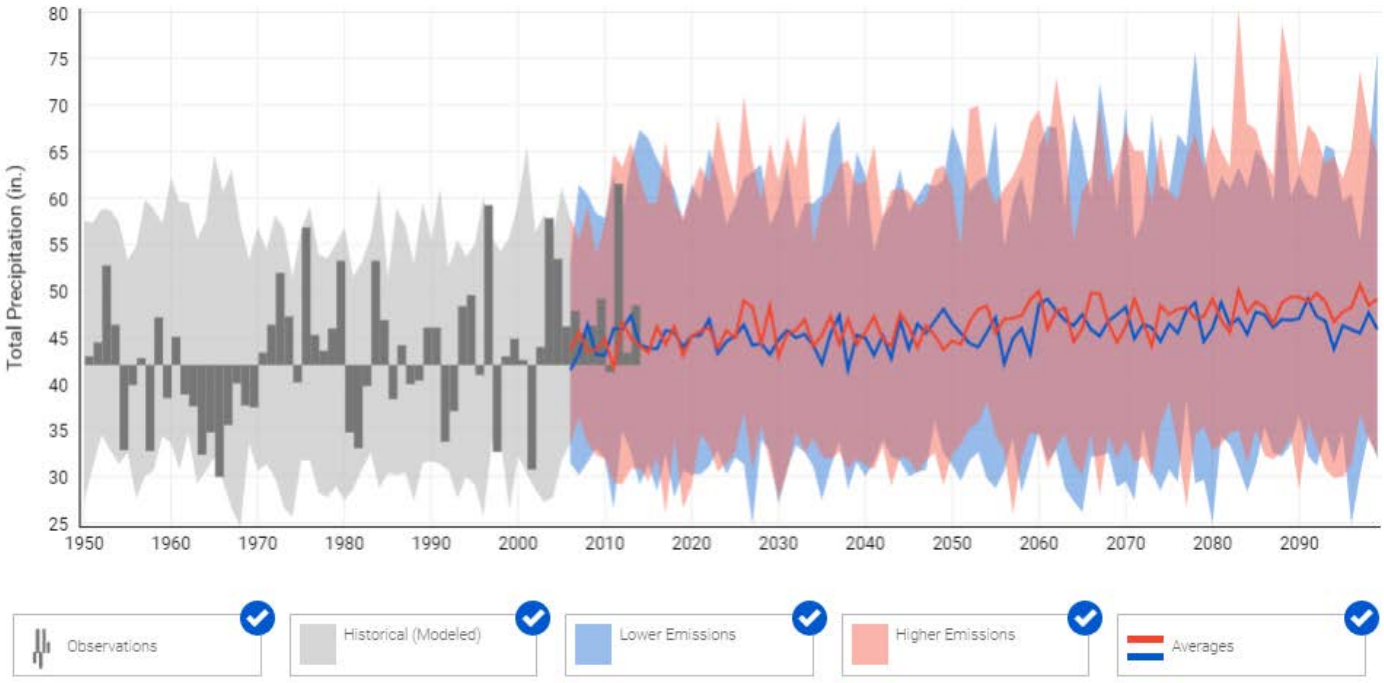
Precipitation

According to the Climate Explorer, average annual precipitation amounts in Lancaster County are already about 7 percent higher than they were in the 1950s and by mid-century could be 9 to 10 percent higher depending on emissions scenarios (Figure 14). Heavy precipitation events could also increase from about 5.5 days per year with more than 1 inch of precipitation in the 1950s to between 7 and 8 days by the end of the century.[30]

[30] Climate Explorer. U.S. Climate Resilience Toolkit. Lancaster County. Accessed, 1/29/19 https://toolkit.climate.gov/tools/climate-explorer.

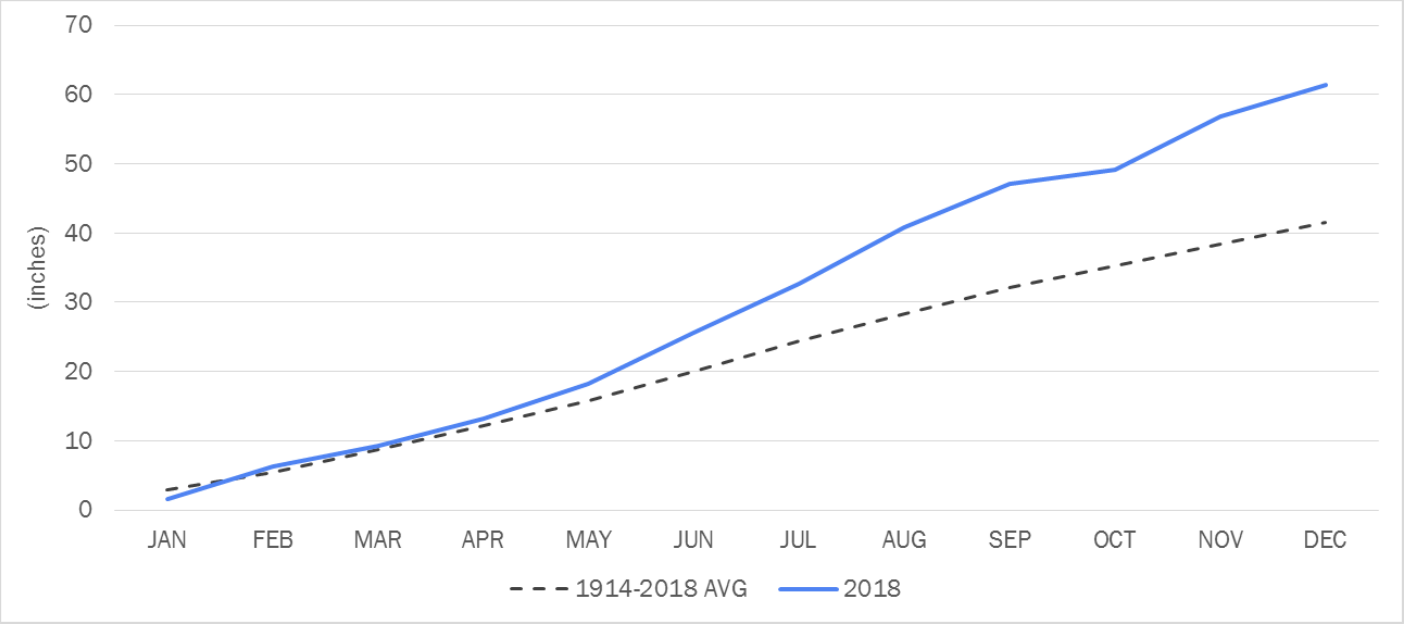
Notably, 2018 was the wettest on record for Millersville University and the surrounding region. According to Millersville's Weather Information Center, Millersville received 61.3 inches of rain in 2018, 48 percent more than the average annual totals experienced between 2014 and 2018. The most precipitation occurred during the summer months of June, July and August (averaged 7.5 inches per month) as well as November. [31]

Figure 14 –Lancaster County Average Annual Precipitation Amounts: Observed (1950-2013) and Projected Low and High Emissions Scenario (2014-2099)



[31] Datasets provided by the MU Weather Information Center (http://www.atmos.millersville.edu/~wic/climatology.html), Local Data Archives: Monthly Temp. Departures and Monthly Precip. Departures. Charts prepared by MU Student, Zachary Dodson.

Figure 15 – Cumulative Precipitation Totals for Millersville, 1914 – 2018 Average vs. 2018



Climate Change Hazards

In 2016, Millersville University completed an update to the University's Hazard Mitigation Plan, which identifies over 30 University hazards ranging from hurricanes to poor air quality and ranks them according to risk exposure. The Hazard Mitigation Plan is a valuable resource for identifying, contextualizing and proposing solutions to hazards; however, climate change does not appear to have been incorporated meaningfully into this version of the Plan.

For Millersville's climate resilience assessment, climate change hazards were identified by crosswalking the list of potential climate change hazards and climate impacts provided by the 100 Resilient Cities list (among others) with those hazards identified in Millersville's Hazard Mitigation Plan. Priority was given to those hazards that received the highest risk factor in Millersville University's Hazard Mitigation Plan. Climate change hazards (e.g., drought) not considered in the Hazard Mitigation Plan were considered however none were considered to be higher risk than hazards identified in the Hazard Mitigation Plan.

2018 was the wettest year on record for Millersville University and the surrounding region. According to Millersville's Weather Information Center, Millersville received 61.3 inches of rain in 2018. The heavy rains provided the University with an opportunity to identify areas that are prone to flooding. While the surrounding region experienced heavy flooding during several events, the University did not experience severe flooding.

Figure 16 – Millersville University Priority Climate Change Hazards

Hazard	Risk Factor (0 – 100)
Severe Storm*	61
Winter Storm	60
Extreme Heat	49
Extreme Cold	49

** Includes hurricanes, tornado, windstorm, severe thunderstorm, etc. HMP considered tornado separately. Winter storm considered separately here.*

Climate change impacts associated with these hazards were identified within the following affected environments:

- Built Environment
- Natural Environment
- Human Environment

The remainder of this section discusses Millersville University's strengths and assets and vulnerabilities associated with the climate change impacts by affected environment. Indicators of resilience and response activities are also discussed. This Plan captures the results of early resiliency planning efforts, which is anticipated to grow over time; in part by incorporating these findings into planning efforts such as facilities master planning and hazard mitigation plans.

Built Environment

Millersville University's built environment consists of more than 80 buildings that range in size, age and purpose; miles of University-owned roadway as well as Millersville Borough roads that crosscut campus; thousands of feet of electric, water, and natural gas lines; exterior lighting; and parking lots. Using the priority hazards of severe storms (e.g., severe thunderstorm), winter storm, extreme heat and extreme cold, Millersville University has identified flooding and infrastructure failure as primary climate change impacts related to the built environment. The remainder of this section describes the University's strengths and assets, vulnerabilities, priority indicator, additional exacerbating factors, and response measures associated with the impacts.

Primary Built Environment Climate Change Impacts
Flooding
Infrastructure Failure (e.g., Utility Disruption)

Strengths and Assets

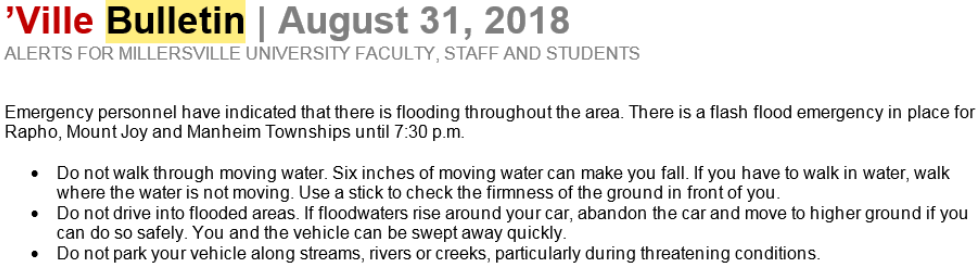
Strengths and assets within Millersville University's built environment include:

Electrical Infrastructure. In 2015, Millersville University completed a large upgrade to the University's electrical infrastructure by converting an aged radial-feed electrical delivery system to a loop-feed system that connects over 40 campus buildings. The new loop feed system greatly increases the flexibility, safety and resiliency of the University's electrical system. It provides redundancies and allows the University to take individual buildings offline for preventative maintenance and emergency purposes. Additionally, Millersville installed utility-grade meters on all major buildings during the project, which greatly improved the University's understanding of building energy performance.

Alert Systems. Millersville has several emergency notification systems in place to alert faculty, staff, students and the surrounding community in the event of emergencies, including:

- 'Ville Bulletin. An email notification for faculty, staff, and students.
- MU Alert. Subscription based text notification system.
- Weather Information Center. Website maintained by the Millersville meteorology department that provides real-time weather updates.

Figure 17 – 'Ville Bulletin Provides Email Emergency Alerts to the University Community


'Ville Bulletin | August 31, 2018

ALERTS FOR MILLERSVILLE UNIVERSITY FACULTY, STAFF AND STUDENTS

Emergency personnel have indicated that there is flooding throughout the area. There is a flash flood emergency in place for Rapho, Mount Joy and Manheim Townships until 7:30 p.m.

- Do not walk through moving water. Six inches of moving water can make you fall. If you have to walk in water, walk where the water is not moving. Use a stick to check the firmness of the ground in front of you.
- Do not drive into flooded areas. If floodwaters rise around your car, abandon the car and move to higher ground if you can do so safely. You and the vehicle can be swept away quickly.
- Do not park your vehicle along streams, rivers or creeks, particularly during threatening conditions.

Upgraded Data Center. In 2017, Millersville University completed an upgrade to its data center that transitioned the University from using computer room air conditioning units to a closed-room system with a central air-conditioned passage that greatly reduces the amount of cooled space needed to keep the servers operating optimally. This not only improved the energy efficiency of the data center, but also increased resiliency by providing a dedicated, confined cooling corridor that less susceptible to building temperature fluctuations.

MU Weather Information Center. Millersville University's Department of Earth Sciences maintains a Weather Information Center that provides weather forecasting for Millersville and the surrounding region. Faculty are well-known within the community and provide valuable, localized and current weather forecasting and analysis. Facilities staff, the University administration and students rely on the reports provided by this group to make decisions regarding campus operations and their own activities. The Weather Information Center also includes detailed records extending back to 1914 that provide insights (included in this Plan) regarding current climate as it relates to the historic record. These resources will be extremely valuable moving forward to provide a perspective on the local impacts of climate change.

Vulnerabilities

Flooding. Most of Millersville University's campus is located about 80 feet higher than the Conestoga River, which runs along the southeast border of campus, and is therefore not prone to flooding. No facilities are located within the 1 percent annual-chance-floodplain.[32]

However, the University does have low lying areas relative to other adjacent areas of campus that include surface streams and ponds. Most notable is the University pond (the Pond), which began as a clay brick quarry and is located in the center of campus adjacent to historic buildings, such as the Biemesderfer Executive Center and Dutcher Hall. The Pond, along with other relatively low-lying areas on campus (Roddy Pond, Cove Dr. stormwater catch basin) can experience flooding during significant rain events.

Additionally, during heavy rain events water can travel quickly along impervious roadways and can lead to minor flooding in areas of campus if the flow is greater than storm drains can accommodate. For example, excess water can flow down roads that lie south (and downhill) of George Street, such as Dilworth Road and the paved road between Columbia and Somerset houses. The record-setting rains experienced in Lancaster County in 2018 provided an opportunity for Millersville staff to assess areas that are prone to flooding during periods of prolonged precipitation, as follows:

- The westernmost extent of Dilworth Drive, downhill from George Street and south of Lyle Hall.
- The grass lawn west of the Dilworth upper parking lot.
- The small side street between Columbia and Somerset Houses leading to the Stayer upper parking lot.
- From the gate at Penn Manor School down the small drive toward Roddy/Caputo Halls.
- The Bucks House site and the lawn at Creek Lodge.

[32] Millersville University Hazard Mitigation Plan (update), 2016. Delta Development Group. Page 62.

Aging and Failure-Prone Equipment. Older equipment can be prone to failure during periods of extreme temperatures, such as heat waves or cold snaps. In recent years, Millersville University has experienced significant failures in equipment such as chillers and compressors, resulting in costly repairs and creating discomfort and/or disrupting schedules for faculty, staff and students. In some cases, equipment failure can disrupt operations such as food services. Recent periods of extreme cold, such as those associated with the "polar vortex" in 2014, 2015 and 2019 force the University to temporarily cancel nighttime temperature setback activities to maintain building temperatures—particularly in buildings with inadequate insulation of sensitive equipment. Additionally, the University has experienced challenges in the past with inadequate natural gas pressure in the residence halls during periods of extreme cold. Too low pressure makes it challenging to fire the boilers adequately and can prevent the buildings from meeting their temperature setpoints. The natural gas utility addressed the problem; however, it remains an area of focus during extreme cold weather.

Subsidence and Sinkholes. Sections of Millersville University's campus sit atop limestone and dolomite bedrock, which can prone to subsidence and sinkholes if water passing through fractures and bedding planes dissolves the rock. Heavy rains can wash out materials that otherwise fill voids left by the dissolved rock, which can collapse. Areas on and around Millersville's campus have experienced small- to moderately-sized sinkholes in the recent past—including a 2003 sinkhole on East Frederick St. that engulfed a truck (no serious injuries occurred), a 2007 sinkhole on West Frederick Street that temporarily disrupted travel along a key campus roadway and a 2013 sinkhole associated with a sewer line break on West Charlotte St. [33] Additionally, the broader region experienced substantial sinkholes during the summer of 2018.[34] An increase in the frequency and intensity of rain events or an increase in the number of broken water pipes during extreme cold events could increase the risk of subsidence and sinkholes.

Indicators

Event-related Equipment Failures

Extreme weather events, such as heat waves, extreme cold and severe storms, have caused equipment failures at Millersville University in the past and are likely to cause them again in the future. Resilient infrastructure should increasingly be able to experience these events without equipment failure; therefore tracking the frequency and magnitude (measured in replacement cost) of equipment failure should provide insight into the resiliency of Millersville's built environment. Additionally, assessing the cost of failure may help to justify expenditures to upgrade or otherwise replace aging equipment earlier in its lifecycle to avoid potentially more costly replacements associated with failures.

Response

Based on Millersville's strengths and assets and perceived climate change vulnerabilities, the University has identified the following response activities for the built environment:

- Create and implement cold- and warm-weather checklists that identify the steps the University needs to take each year to prepare the infrastructure for seasonal changes. Update over time to

[33] Millersville University Hazard Mitigation Plan (update), 2016. Delta Development Group. Page 91.
[34] Sinkholes, sinkholes everywhere. What can we do? Penn Live, Aug 2018. https://www.pennlive.com/news/2018/08/sinkholes_sinkholes_everywhere.html

reflect new experiences (e.g., increased mold concerns in warm, wet summer months, weather-related equipment failures). Include inspections of equipment that has experienced failure during previous cold- and warm-weather events.

- Increase building preventative maintenance measures to ensure that each building operates optimally to prevent costly failures or performance issues brought on by extreme weather events such as prolonged or intense heat.
- Prepare and maintain a priority list of HVAC equipment (e.g., boilers, chillers) that may be vulnerable to failure during periods of extreme heat or cold. Establishment replacement schedule.
- Incorporate climate change scenarios in future hazard mitigation plan updates and facilities master planning.
- Keep storm drains clear of leaves and other debris in areas that could flood if drains become clogged.
- Install rain gardens and other water catchment features to capture water in areas that experience minor flooding (e.g., grass area south of Dilworth North Parking Lot).
- Consider options for installing green infrastructure in locations that experience pooling or minor flooding during intense or prolonged rain events (e.g., former Bucks House site, Creek Lodge).
- Conduct an inventory of all locations that require uninterrupted power and natural gas supply, including those locations that currently have backup generators, and assess ability to maintain that power.

Natural Environment

Millersville University's campus consists of over 250 acres of varied landscape ranging from maintained grass lawns to a forested biological preserve. The core areas of campus consists of hardscapes (e.g., parking lots) as well as large maintained lawns, but also well-established trees, aquatic features, and small wildlife. The outskirts of campus transition into suburban areas on some boundaries while others consist of forested areas that abut agricultural lands and the Conestoga River.

The natural features on campus provide a variety of ecosystem services including carbon storage, oxygen generation, hydrological services (e.g., infiltration, reduced runoff), wildlife habitats, aesthetics, recreational areas, and microclimate modification, among others.

Based on the priority hazards of severe storms (e.g., severe thunderstorm), winter storm, extreme heat and extreme cold, Millersville University has identified flooding, runoff and soil saturation, and wind, heavy snow and ice impacts as primary climate change impacts or threats related to the natural environment. The remainder of this section describes the University's strengths and assets, vulnerabilities, priority indicator, additional exacerbating factors, and response measures associated with the impacts.

Primary Natural Environment Climate Change Impacts
Flooding, runoff and soil saturation
Wind, heavy snow and ice impacts

Campus rain gardens, such as the rain garden located next to Cambria House and several located around the Lombardo Welcome Center, capture and treat rainwater on site. This form of green infrastructure builds resilence to climate change by reducing impervious surface area and reducing surface stormwater flow.

Strengths and Assets

Strengths and assets associated with Millersville University's natural environment include:

Faculty Knowledge. Millersville is fortunate to have many experts in the areas of ecology, ecosystem dynamics, hydrology, wildlife management, dendrology, etc. among its faculty. These faculty members can provide expert advice and counsel on management of campus wild and managed areas in the face of climate change and considering other stressors such as invasive species and campus development.

Biological Preserve. Established in 2013, Millersville University's Biological Preserve lies along the southeastern border of campus. Affectionately referred to as "The Bush" the Biological Preserve provides wildlife habitat, stores carbon, and serve as a riparian buffer for the Conestoga River, which runs along its edge. The Biological Preserve also serves as a living laboratory for faculty and students to study the local impacts of climate change as well as other pursuits.[35]

Wildlife Habitats. In addition to the Biological Preserve other smaller areas of campus, such as the native plantings around the Lombardo Welcome Center and the Library Reading and Sculpture Garden as well as the University Pond provide micro-habitats for insects and small mammals. The University Pond is a certified wildlife habitat and a combination of pollinator gardens provide a certified Monarch Waystation.

Vulnerabilities

A review of the assets determined that wildlife habitat, aesthetics and campus trees are the most vulnerable natural assets on campus. Each varies in its sensitivity to the primary climate change impacts—across asset and within asset class. As an example, saturated soils associated with heavy rains may affect certain types of campus trees with shallow root systems while not affecting those with deep root systems. Additionally, each asset varies in its ability to adapt (a.k.a., adaptive capacity) to climate change impacts. As an example, if the University finds that a particular section of grass lawn is prone to drying out during summer months, Millersville can convert the area to a drought-tolerant plant relatively easily. However, if the University Pond is prone to frequent flooding due to an increase in the precipitation volume of summer storms, adaptive measures may be more costly and less easy to implement.

Overall, the campus's vulnerability to climate change impacts was deemed to be relatively low when compared to other factors (e.g., campus development). Areas of vulnerability are most associated with extreme events, such as high winds and severe ice storms that can uproot trees and cause dead or dying tree limbs to fall—potentially harming individuals or damaging infrastructure.

Millersville must also look beyond its borders to consider how its activities impacts or reduces regional vulnerabilities. As an example, water quality is expected to worsen in the region due to climate change as waterborne pathogens increase due to changes in temperature and runoff and variable precipitation increases pollution-containing runoff. Managing more of campus using techniques that minimize runoff generally, and during periods of dryness followed by intense precipitation, ensures that the University is not contributing to the problem and takes a leadership role in demonstrating restorative land management practices.

[35] http://millersville.com/millersville-university-biological-preserve/

Impervious surfaces, such as parking lots, sidewalks, roadways, and rooftops, contribute to the runoff because water runs over them rather than being absorbed by them. Additionally, large sections of campus consist of large grass lawns. While these areas align with the aesthetic expectations often placed on campus grounds, they are prone to drying out during long periods without rain. The dry grass and ground are less capable of absorbing rain water when storms do occur, which can increase runoff and diminish the hydrologic services that campus could provide. Additionally, many managed gardens consist of non-native species that do not provide healthy habitat for local insects and small birds and mammals in the manner that native plants do.

Indicators

Impervious Surface

While parking lots, sidewalks and roadways are all necessary features of a commuter campus, the impervious surfaces created by these features in their current form also increases runoff and pollution, competes with natural habitats, and detracts from campus's natural beauty. In preparing this Climate Action Plan Millersville University conducted an initial assessment of the amount of impervious surface on campus using a GIS analysis. That analysis characterized areas of campus land as either 1) water, 2) trees and shrubs, 3) herbaceous, 4) barren, 5) impervious surfaces (roads) and 6) other impervious surfaces (Figure 18). Based on the findings of the analysis permeable surfaces (trees and shrubs and herbaceous areas) make up the majority of campus (57 percent), but a substantial portion (42 percent) is impervious with the remaining percentage apportioned to surface water and barren areas. While the amount of impervious surface on University grounds is not likely to change rapidly, it does serve as an indicator of whether or not campus grounds are trending toward habitat-supporting, runoff-reducing spaces.

Indicator Species

Nature Atlas is an online biodiversity resource for documenting species including invertebrates, birds, fishes, fungi, amphibians and reptiles, plants and mammals developed by faculty in Millersville University's Biology Department.[36] To date, the resource contains over 50,000 records identifying nearly 8,000 species. The program has a robust dataset for Millersville's campus because biology students annually populate the dataset as part of their coursework. Species that are indicators of a changing climate could be identified and catalogued in this resource to help Millersville University evaluate changes in campus ecosystem health over time.

[36] Nature Atlas. (https://natureatlas.org/all/earth) Hardy, C; Hardy, N; Ambler, J; Ambler, J; Faccenda, K.

Figure 18 – Millersville University Campus Land Cover[37]

Response

Based on Millersville's strengths and assets and perceived climate change vulnerabilities, the University has identified the following response activities for the natural environment:

- Establish a Sustainable Landscape Committee that consists of grounds crew staff and faculty. The Sustainable Landscape Committee will make recommendations to University leadership concerning options to manage campus grounds using sustainable landscaping techniques.

[37] Source: Millersville University Climate Resiliency Assessment, Ecosystem Services. Prepared by Millersville University Geog 350: Applied Climate Planning students using Chesapeake Bay Watershed-Baywide Dataset. (Students: Sabrina Rowe, Nathan Bauer, Derek Boone, Tucker Cavallo, Arynn Cooper, Christian Ott, Angel Yamil Perez-Irizarry, William Todd Edward Schick, and Cameron Strosser; Faculty Instructor: Dr. Ethan Frost)

- Increase use of permeable materials, such as gravel or pervious cement, in hardscaped areas to limit the amount of runoff and erosion associated with heavy precipitation events. Doing so will reduce the amount of pollutants that reach local freshwater streams from campus.
- Increase green infrastructure such as green roofs, rain gardens and bioswales to reduce runoff as well as raise awareness of this stormwater management technique within the broader community.
- Increase use of native plants on campus to provide plants that are adapted to surviving in local conditions, may require less maintenance, and provide habitat that supports local species.

Human Environment

Millersville University's campus is home to thousands of students and a workplace and community for several hundred faculty and staff. Additionally, the University welcomes visitors year-round for workshops, conferences, camps and other activities. Campus bustles during fall, winter and spring while students are on campus, and transitions to have fewer students and more visitors for camps and other activities during the summer months. Campus populations are generally found to have low-to-moderate vulnerability to anticipated climate change impacts; however certain populations may be vulnerable to certain climate change impacts. Strengths and assets, vulnerabilities, indicators, and the University's response pertaining to building resilience within the human environment are discussed below.[38]

Primary Human Environment Climate Change Impacts
Heat-related Stress and Injury
Vector-borne Disease
Vehicle Accidents and Emergency Transport
Respiratory Disease Aggravation

Strengths and Assets

Strengths and assets associated with Millersville University's human environment include:

Proper Precautions. According to Millersville's Hazard Mitigation Plan, University Health Services has reported only one instance of frostbite and one instance of heat exhaustion since 2012. This indicates that while there have been periods of extreme heat and extreme cold, the University community takes proper precautions (e.g., clothing, rest) to deal with the elements.[39]

Seasonal Student Presence. The seasons in which the more extreme weather events such as heat waves and thunderstorms are likely to occur are also those in which there are very few faculty members and students on campus. This trend may continue as summer online programs and distance education grow.

[38] This section was informed by stakeholder meetings conducted by Dr. Kathleen Schreiber and the 2018 Geog 306 Climate and Society Class (Steven Copertino, Robert Helmerick, Sarah Holland, Drew Hughes, Jason Malkowski, William Matthews, Brandon Mitchell, Katie Prichard, Jessica Stokes, and Derek Yoder). Additional resilience team members included: Sharmon Brant, Larry Earnesty, Duane Hagelgans, Chris Steuer, and Patrick Weidinger of Millersville University and Dr. Alan Peterson, MD; Lancaster General.

[39] Millersville University Hazard Mitigation Plan (update), 2016. Delta Development Group. Page 45.

Majority Student Population. The campus community consists primarily of students, of which a majority are young adults who are generally in good health. This population is likely at lower risk to the health impacts of climate change than other populations, such as older adults or the very young.

Health Services. Millersville University has numerous health and wellness resources that provide information and services to faculty, staff and students included campus Health Services, the Elsie S. Shenk Center for Health Education and Promotion and the Employee Wellness Committee.

MU Alert. MU Alert is a notification system that Millersville employs to provide emergency text messages and email messages to campus constituents. The service allows University officials to communicate short emergency messages to a broad audience to help avoid potential dangers. The service increases Millersville's adaptive capacity by making it possible to raise awareness and provide guidance during extreme weather events and other emergencies.

Vulnerabilities

When considering vulnerability associated with Human Health, the Millersville University planning team specifically discussed affected populations such as student athletes, commuters, summer camp attendees and campus groundskeepers. The population is largely comprised of young, healthy adults, which were determined to have low-to-moderate risk exposure to climate change hazards such as heat waves.

Grounds Crew and Student Athlete Heat Stress and Other Weather-related Injuries. Millersville University's grounds crew works year round to maintain over 250 acres of campus grounds. This includes working through weather events ranging from snowstorms to heatwaves that can cause weather-related stress or injury, such as heat stroke or injury from falls or repetitive work (e.g., shoveling). Additionally, student athletes practice during summer months when outdoor temperatures are at their warmest.

Vector-borne Disease among Affected Populations. A substantial portion of Millersville's peripheral grounds are wooded or grassy—including the Biological preserve and Watershed Education and Training Institute. Prolonged seasons and warmer winters, combined with other factors, may increase populations of ticks and other vectors, raising concerns over increased incidents of Lyme disease and other vector-borne diseases among students, campus visitors and the Grounds Crew.

Vehicle Accidents among Commuters and Emergency Transport Challenges. The potential for an increase in extreme weather events, such as heavy snow and rainstorms, winter storms and microbursts can affect transportation. Millersville has a large commuter population that comes to campus each day during the school year with peak periods of increased traffic between classes—particularly in late mornings and early-to-mid afternoons, Monday through Thursday. Heavy rain events during these periods, for example, can increase the likelihood of vehicle accidents. Roadway flooding, icing or heavy snow cover on campus and Millersville Borough roads could slow emergency vehicle access to accidents should they occur as well as to other campus locations.

Respiratory Disease Aggravation. Millersville University is located in Lancaster County, PA, which received a "D" rating for ground-level ozone days in the 2018 State of the Air report released by the American Lung

Association.[40] Upstream point sources of industrial air pollution, vehicle traffic, and wood-burning stoves all negatively affect regional air quality, which can worsen with changes in climate. In particular, warmer temperatures under climate change can create meteorological conditions that are conducive to forming ground-level ozone, which can cause airway inflammation and reduce lung function—particularly in individuals with asthma, children, older adults and those who are active outdoors.[41]

Indicators

Reported Incidents of Heat-related Illness

While extreme weather events and periods of prolonged cold are likely to occur in the future due to the dynamics of the climate system, average annual temperatures are expected to increase overall. This change is reflected in Millersville's temperature record; wherein, nine of the ten warmest years on record have occurred since 1990 (Figure 1). For this reason, Millersville has chosen reported incidents of heat-related illness as human health resilience indicator.

Response

The health resilience stakeholders determined that the University's sensitivity to climate change health impacts are low to moderate overall; however, there are some populations that are higher risk.

To avoid incidents of heat stroke and other heat-related illness, Millersville should continue to implement measures such as working and practicing earlier in the day during hot summer days, providing plenty of access to water, and concluding practice and outdoor work if temperatures exceed safe limits. Additionally, Millersville can plant trees and provide sheltered spaces in areas such as bus stops where students may spend extended periods of time outside.

Millersville will continue to promote and invest in MU Alert to provide warnings during extreme weather.

Millersville will provide flu vaccines to faculty, staff and students to reduce promulgation of the disease, which may increase following warmer winters.[42] Additionally, Millersville will provide information to summer camp attendees and students on measures to prevent tick bites and other vector-borne illnesses.

[40] State of the Air 2018. https://www.lung.org/our-initiatives/healthy-air/sota/city-rankings/states/pennsylvania/
[41] USGCRP. Climate and Health Assessment. https://health2016.globalchange.gov/air-quality-impacts
[42] https://www.concentra.com/resource-center/articles/the-impact-of-climate-change-on-flu/

Student athletes are among the campus populations that can be affected by extreme weather events such as heat waves.

COMMUNITY CLIMATE CHANGE RESPONSE PLANNING

In 2017, the City of Lancaster, with support from various community partners, including Millersville University, began climate change planning. The City prepare a greenhouse gas emission inventory and in the spring of 2019 identified goals to reduce GHG emissions from the City's municipal operations.

Millersville University's Sustainability Director sits on the City's Climate Action Plan Steering Committee and members of the University's faculty and students participate in the Climate Action Plan development process. Both Millersville University and the City of Lancaster are signatories to We Are Still In. Additionally, Millersville collaborates with various community groups to host climate-focused events.

City of Lancaster Greenhouse Gas Inventory

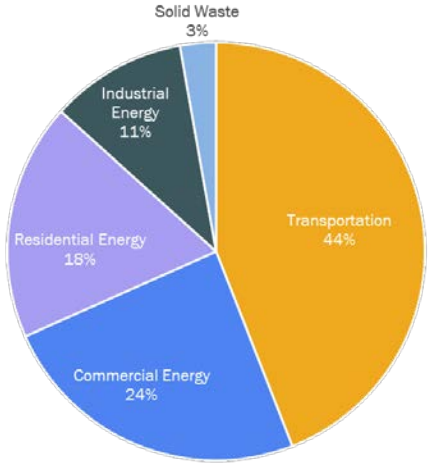
The City of Lancaster conducted two GHG emission inventories in 2017, a community GHG emission inventory and a municipal operations GHG emission inventory.

Community GHG Inventory

The City of Lancaster's 2015 GHG emissions were 684,920 MTCO2E. At 301,702 MTCO2E, Transportation is the largest emission sector, followed by Commercial Energy (166,382 MTCO2E), Residential Energy (125,602 MTCO2E), and Industrial Energy (72,198 MTCO2E). Solid Waste was the least emissive emission sector at 19,036 MTCO2E (Figure 19).[43]

City of Lancaster Climate Action Plan Steering Committee Meeting

Figure 19 - City of Lancaster Community GHG Emissions

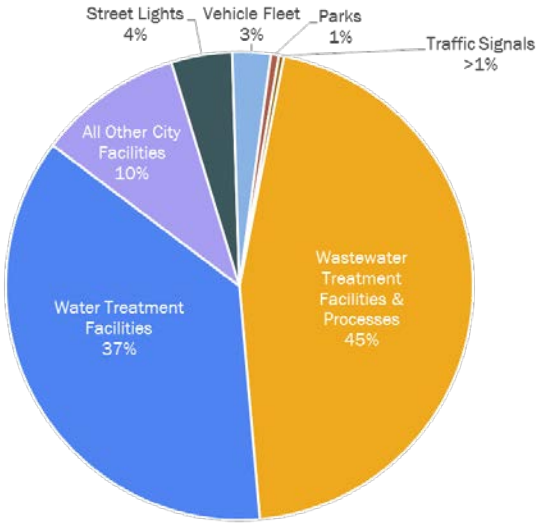


[43] City of Lancaster Greenhouse Gas Inventory: A Community-wide and Municipal Operations Greenhouse Gas Inventory for 2015 (page 11). http://www.cityoflancasterpa.com/government/sustainability-program

Municipal Operations GHG Inventory

The City of Lancaster's 2015 municipal operations GHG emissions totaled 27,283 MTCO2E. At 12,427 MTCO2E, the majority of these emissions resulted from wastewater treatment facilities and processes. Water treatment facilities accounted for an additional 10,004 MTCO2E. Energy use associated with all other city facilities accounted for 2,732 MTCO2E, followed by street lights (1,152 MTCO2E), the vehicle fleet (724 MTCO2E), parks (151 MTCO2E) and traffic signals (93 MTCO2E).[44]

Figure 20 - City of Lancaster Municipal GHG Emissions



Municipal Operations Climate Action Plan

On May 9th, 2019 the City of Lancaster held a public meeting to introduce the City's Municipal Operations Climate Action Plan. City officials, community leaders and university researchers discussed climate change and its likely impacts on the City. During the meeting, the City introduced a goal to reduce City municipal operations emissions by 79 percent by 2025.

City of Lancaster Mayor, Danene Sorace, introduces the City's goal to reduce municipal operations GHG emissions by 79 percent by 2025 during a May 9th, 2019 public meeting at Millersville University's Ware Center.

[44] City of Lancaster Greenhouse Gas Inventory: A Community-wide and Municipal Operations Greenhouse Gas Inventory for 2015 (page 15). http://www.cityoflancasterpa.com/government/sustainability-program

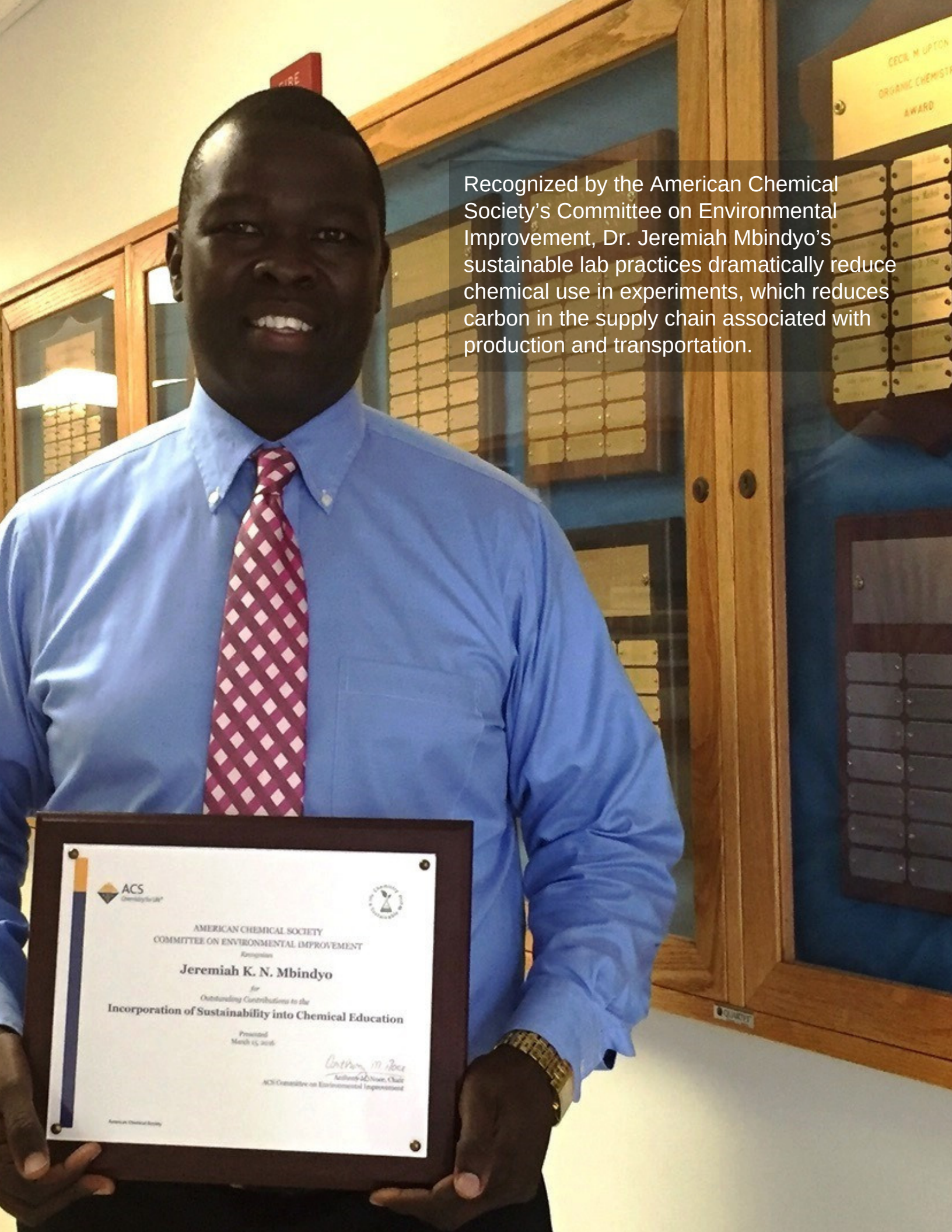
INCORPORATE CLIMATE CHANGE AND SUSTAINABILITY INTO THE CURRICULUM

The greatest potential for reducing GHGs comes in creating the next generation of thought leaders. Millersville will use the curricular and co-curricular activities and research to increase our students understanding of how human society influences the climate system and how climate change will affect global populations and individuals while creating opportunities for students to address the challenge of climate change. The University will develop and implement educational programs for students as well as consider opportunities to develop more sustainability-focused areas of study and incorporate climate change discussions into General Education. Millersville University will reinforce these efforts by developing sustainability and climate change learning opportunities in co-curricular activities such as experiential learning and internships. Specifically, Millersville will:

- Track existing and incorporate new sustainability and climate change considerations into General Education.
- Track existing and incorporate new learning outcomes into the curriculum that focus on understanding and applying sustainability principles—in part to improve each student's ability to lessen their climate impact.
- Develop sustainability and climate change student learning opportunities (e.g., experiential learning, internships).

Millersville will also encourage and incentivize faculty and students to conduct research on climate change and sustainability topics. Millersville currently supports individuals who are conducting research in the areas of climate change and sustainability and values programs that apply sustainable principles to address challenges on campus and beyond. Research activities benefit from the rich academic culture at Millersville and include such varied areas as understanding how art can be used to expose various audiences to climate change topics, techniques that can be used to encourage adoption of sustainable behaviors, the impact hands-on activities such as gardening have on influencing perceptions of climate change and sustainability, and exploring the effects of climate change on endangered species. To continue to support faculty and students interested in conducting climate change related research, Millersville will:

- Provide incentives (e.g., funding, recognition program) for climate change and sustainability-related research and creative works, such as through the Positive Energy Fund.
- Further define specific on-campus climate change and sustainability challenges and align them with research activities.
- Engage with community partners, such as the City of Lancaster and Millersville Borough, to identify and develop solutions to climate-change related challenges.



Recognized by the American Chemical Society's Committee on Environmental Improvement, Dr. Jeremiah Mbindyo's sustainable lab practices dramatically reduce chemical use in experiments, which reduces carbon in the supply chain associated with production and transportation.

INTEGRATE CLIMATE CHANGE CONSIDERATIONS INTO CAMPUS PLANNING AND ENGAGEMENT

Achieving the goals of this Climate Action Plan will require raising awareness of the climate change challenge within the University community, integrating the climate change response activities into other University planning documents, and establishing mechanisms to implement effectively and evaluate progress over time. Additionally, implementation will require appropriate levels of management and oversight provided by accountable authorities within Millersville's administrative system and University leadership.

Engagement

At Millersville, engagement activities centered on climate change and sustainability are organized by the Office of Sustainability as well as other University departments and programs in coordination with the University's Communication Department. Millersville will incorporate climate change messages into existing engagement programs and initiatives to reduce redundancy, ensure that climate change and sustainability messages and materials are aligned, and provide consistent sources of information for faculty, staff, and students. The various activities will include incorporating climate change and sustainability considerations into education and outreach materials, campus events and campus life, and public engagement. Collectively, these activities will further advance a burgeoning culture of sustainability at Millersville.

Education and Outreach

Millersville will incorporate climate change and sustainability messaging into outreach mechanisms such as the University's website, social media accounts and news releases. Millersville's Office of Sustainability will coordinate with the University's Director of Communications to highlight the University's efforts to address climate change and advance sustainability. Specifically the University will:

- Convey core messages that highlight Millersville's climate change commitment.
- Provide updates on Millersville's climate change and sustainability work and accomplishments.
- Share relevant information with appropriate audiences to increase awareness of the climate change challenge.
- Develop newsletters to update the University community on climate change and sustainability activities.
- Maintain social media accounts, webpages and related resources to update the University community of climate change and sustainability activities.
- Develop press releases and articles for the University Review and other magazines to share progress related to climate change and sustainability.

Millersville University annually holds sustainability focused events, such as Campus Sustainability Month, a three-week energy conservation competition entitled 'Ville Unplugged, and an Earth Day celebration.

Sustainable Events

Millersville will also incorporate climate change and sustainability considerations into University events including student admission and orientation activities, employee orientation activities and campus events such as guest speakers, workshop and conference activities. Climate change and sustainability event activities will focus both on conducting events with topics focused specifically on climate change and sustainability as well as making the events more sustainable by lessening environmental impacts. Specifically, Millersville will:

- Host speakers, workshops and conferences that focus on sustainability and climate change.
- Participate annually in Campus Sustainability Month to highlight campus sustainability efforts.
- Provide tours of the Lombardo Welcome Center to community groups to raise awareness of zero energy building technology.
- Coordinate with University offices to incorporate information on climate change and sustainability into University events such as open house, new student orientation and health and wellbeing events.
- Incorporate the Lombardo Welcome Center into community workshops, conferences and fairs.
- Annually hold an energy conservation campaign.

Campus Life

Millersville's student body has the ability to affect change on campus and beyond through their individual actions and as members of broader communities. The University will create programs and initiatives that engage students on the topics of climate change and sustainability, that encourage them to consider their impact and that empower them to be agents of change today and into the future. Millersville will incorporate climate change and sustainability considerations into campus life by identifying touchpoints where current student activities can provide enhanced messaging and by developing entirely new programs dedicated to climate change and sustainability. Specifically Millersville will:

- Provide peer-to-peer information on climate change and sustainability through the Sustainability Ambassadors program.
- Maintain a University Sustainability Committee, Student Sustainability Committee, and Climate Action Plan Committee among other committees or task forces to advance climate change and sustainability on campus.
- Establish living-learning communities dedicated to sustainability and climate change mitigation within student housing.
- Provide dashboards and other resources that allow students to compare sustainability performance (e.g., energy conservation) in student housing.

Public Engagement

Millersville's responsibility to raise awareness of, and accelerate solutions to, the climate change challenge doesn't end at the campus gates. It extends into surrounding communities. To engage the public Millersville will:

- Provide information on the University's climate change and sustainability efforts to alumni, community partners, and national organizations.
- Develop partnerships with local, regional and national organizations that are accelerating solutions to climate change.
- Conduct campus activities and events focused on raising awareness of the climate change challenge.
- Participate in local, regional and national workshops and conferences to share knowledge on climate change response activities.
- Increase student service-learning and volunteer opportunities focused on climate change and sustainability.
- Incorporate discussions of climate change and sustainability into campus meetings with community groups and other partners.
- Support the City of Lancaster and other communities with their climate change response efforts.
- Participate in national campaigns, such as We Are Still In and the Climate Commitment, aimed at galvanizing organizations that are responding to climate change.

Planning and Administration

Millersville's climate change response goals require a concerted effort across University departments, colleges, and offices to further integrate climate change considerations into University planning, administration and daily activities. This Plan provides a vision and the implementation steps needed for Millersville to achieve carbon neutrality and to begin to build resilience to climate change. Achieving the vision will take additional planning and integrating climate change response activities into other University plans. To do so, Millersville will integrate the climate change response activities from this plan into other planning documents, such as future hazard management plans and facilities master plans.

Management, Oversight and Implementation

The management, oversight and implementation of this Plan will require coordination and collaboration among several individuals and groups. The roles and responsibilities of these individuals and groups are described below followed by a discussion of planned updates to the Plan and additional documents that will support the Plan's implementation.

University President and Cabinet

The University President in coordination with the University Cabinet will have final authority regarding the implementation of the Climate Action Plan. The University President and Cabinet will review information provided by the Climate Action Plan Subcommittee and Sustainability Director and will oversee the strategic direction of all mitigation activities and progress toward meeting the Climate Action Plan goals.

Office of Sustainability

Responsibility for achieving the goals of this Climate Action Plan rests on the University Sustainability Director within the University's Office of Sustainability. The Sustainability Director will be responsible for coordinating mitigation activities on and around campus, for reporting progress to various stakeholders

and organizations, and for providing the Climate Action Plan Subcommittee and University leadership with the understandings needed to make informed decisions regarding Climate Action Plan implementation. The Sustainability Director will also be responsible for ensuring that the Climate Action Plan activities support the University's broader sustainability goals.

Climate Action Plan Committee

The Climate Action Plan Committee oversaw developing this Plan, including preparing the actions, goals and strategies, and designing the performance metrics that will be used to evaluate progress. Moving forward, the Climate Action Plan Committee, led by the Committee Chair, will be responsible for guiding Climate Action Plan implementation. The Committee will guide decision making and prioritization of Climate Action Plan implementation activities and will work with the Sustainability Director to provide recommendations for achieving Climate Action Plan goals to University leadership.

University Departments

University departments will help to guide the strategic implementation of this Plan by recommending specific actions and tactics for achieving the broad goals of this Plan and by helping to set priorities and implement the programs, policies and procedures needed to achieve carbon neutrality. Management and staff within the University departments as represented by the President's Cabinet members, through representation on the Sustainability Committee and through individual interest will help generate additional ideas, actions and projects for achieving the Plan's goals.

Tracking Progress

In creating this Climate Action Plan, Millersville's faculty, staff and students were very aware that success necessitates setting a clear vision that is supported by meaningful and measurable goals. Moving forward the University must continually track progress and evaluate performance and use the information to make course corrections as needed an appropriate. Moving forward, Millersville University will;

- Conduct annual greenhouse gas emission inventories,
- Evaluate performance relative to previous years and toward the specific performance targets articulated in this Plan, and
- Update the Plan every three to five years while incorporating recommendations into other plans.

CONCLUSION

Realizing the climate change response goals articulated in this Plan will require a longstanding commitment by members of the University community, continual pursuit of new thoughts and ideas, and an endless willingness to adopt and apply new information and insights.

This Plan identifies specific actions that the University will take to achieve carbon neutrality, build climate resilience and support and engage the community. The Plan builds upon progress that Millersville has already made to reduce GHG emissions and create a sustainable vision of the future. Further progress requires not only implementing the actions identified in this Plan, but also developing new ideas and planning new measures to address the challenge of climate change—as a University and within our community.

Perhaps most importantly, Millersville intends to use our climate change response to provide learning experiences for the next generation of leaders, thinkers and doers. Success will be measured not only in the work performed within the campus gates, but also in the work performed by our graduates to better society.