



West Lafayette Climate Action Plan

May 2018



Acknowledgements

This Climate Action Plan was created through partnerships between the City of West Lafayette, the Division of Environmental and Ecological Engineering (EEE) at Purdue University, and the West Lafayette Go Greener Commission.

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Table of Contents

Message from the Mayor	4
Executive Summary	5
Background	6
Introduction	6
Terminology	7
Benefits of Local Action	7
Development and Emissions	8
A Phased Approach	8
City of West Lafayette's Phase I Climate Action Plan	8
Vision for the Plan	8
Public Engagement	9
Methodology, Inventory, and Projections	10
Overview	10
Emissions Reduction Goals	11
Triple Bottom Line Considerations	12
Inventory	12
Projections	13
Goals, Actions, and Implementation Strategies	15
Inventory of Departmental Goals	15
Goals for Each Department	16
Future Steps and Challenges	22
Community Involvement	22
List of local sustainability organizations	23
Appendices	30
Appendix A: U.S. Mayors Climate Protection Agreement	30
Appendix B: Emissions Factors	31
Appendix :C Emissions Data	32
Works Cited	34

Message from the Mayor

Dear Citizens of West Lafayette,

Global climate change is the most important issue facing the future of our city, state, country, and world. As uncertainty in climate leadership grows, cities around the world are stepping up with innovative solutions.

West Lafayette has joined cities across the country in filling the void left by the federal government in climate action. The City Council's unanimous approval in July 2017 of a resolution committing to the Paris Climate Agreement signifies the strength of our commitment. This Climate Action Plan serves as our first tangible step towards compliance with the Paris Agreement.

The City Council charged the Go Greener Commission with implementation of the Paris Agreement. They created our Climate Action Plan. This first phase details our commitment to streamlining city operations and reducing our carbon footprint. The Commission is also continuing their public outreach efforts by keeping you aware of the government's green actions and providing ways for households to limit climate impact.

We have a fantastic partner in Purdue University, whose ground-breaking interdisciplinary research gives our small city a big impact on addressing climate change worldwide. The Purdue Climate Change Research Center is at the forefront of research on the impacts of climate change on agricultural practices and communities worldwide.

The College of Engineering's Division of Environmental and Ecological Engineering has served as a collaborative partner for the city's green efforts, including providing a group of undergraduate senior design students to work hand-in-hand with city agencies.

We act not out of politics or ideology, but because leaving a healthy planet for our children and grandchildren is the most important legacy we can leave. This plan sets the bar for climate action for municipalities across Indiana.

Mayor John Dennis



Executive Summary

West Lafayette, through the initiative of Mayor John Dennis, has joined the Mayors National Climate Action Agenda (MNCAA). The MNCAA is committed to "working together to strengthen local efforts for reducing greenhouse gas emissions and to supporting efforts for binding federal and global-level policymaking" [1]. In addition, West Lafayette's City Council voted unanimously on Resolution 10-17 to support the Paris Agreement. This was supported and signed by Mayor Dennis.

To put these resolutions into action, the City of West Lafayette and the Go Greener Commission partnered with a Purdue Environmental and Ecological Engineering (EEE) senior design team to begin drafting a Climate Action Plan for the city. This partnership led to the creation of this Climate Action Plan.

This report, phase one of the Climate Action Plan, outlines the baseline emissions for city departments, creates a system to track emissions, and establishes short- and long-term goals for reducing emissions. Moving forward, the city, Go Greener Commission, and EEE will continue collaborating on subsequent phases of this Climate Action Plan. The next phase will include a more holistic and expanded GHG inventory of the entire city.

Mission of the Go Greener Commission

The West Lafayette Go Greener Commission promotes and enhances sustainable environmental well-being within the City of West Lafayette and among its residents for present and future generations.

Background

Introduction

The 2015 Paris Climate Agreement was the most far-reaching international agreement to address climate change. The United States led the way in crafting this agreement to facilitate unanimous support from the global community, and these efforts led to the most ambitious international climate agreement in history. The agreement calls on all signatories to work to limit global average temperature rise to 2°C from pre-industrial levels and establishes a Green Climate Fund to provide money to developing countries to adapt to and mitigate the effects of climate change. Following the 2016 election of President Donald Trump, the United States announced its withdrawal from the Paris Agreement. The US EPA then began to repeal the primary instrument for American compliance with the agreement: the Clean Power Plan.

On July 3rd, 2017 the West Lafayette city council unanimously agreed to sign Resolution No. 10-17, which supports the Paris Climate Agreement to reduce the city's greenhouse gas emissions. This Resolution, which can be found in Appendix F, is also strongly supported by West Lafayette's Mayor Dennis, who joined other US city's mayors in the Climate Mayors network. More information about the Climate Mayors network can be found in Appendix A. The resolution states that "impacts on climate change include... increased occurrences of extreme weather events, adverse impacts on ecosystems, demographic patterns and economic value chains." By acknowledging this, the resolution also states that it "provides communities an opportunity to access first mover advantage in the range of products, services, and know-how that transitioning to a climate-compatible future brings." The signed Resolution called for a Climate Action Plan as the design and implementation strategy. The city assigned the West Lafayette Go Greener Commission, a local sustainability organization, to take charge. In the Fall of 2017, a Purdue University Environmental and Ecological Engineering senior design team partnered with Go Greener to create an implementation plan for Phase I of the project.

The Purdue University Environmental and Ecological Engineering senior design team consists of four students: Meghan Adams, Michael Burnett, Lucy Kopchak, and Kyla Prendergast. To begin their project, the group first met with all ten city department heads as well as Mayor Dennis. The department meetings consisted of a discussion of both current actions that are being taken to reduce emissions, as well as future goals. Future goals were suggested by the senior design team and the department heads. During the meeting with the mayor, the team set goals for the process of tracking the city's emissions and promoting ways for both the city department and citizens to reduce greenhouse gas (GHG) emissions. Afterwards, the team started to collect data on consumption of fuel, natural gas, and electricity. This data was later converted into GHG emissions. Lastly, the team quantified each department's goals and compared it to the emission reduction goal originally set.

Benefits of Local Action

One of the largest components of a Climate Action plan is the power of local action. To achieve the goal outlined in the Paris Agreement of keeping our planet from increased global average temperature by 2°C, collective action is necessary. Collective action describes how a great accumulation of small positive impacts can make a large impact. This means that action is required at every country, state, and city level. When looking at the scope of the West Lafayette Climate Action plan, city action is being addressed. During Phase I of the project, the city departments will be the first sector to work to reduce the city's overall emissions.

Action on the city level can have large-scale impacts because urban areas are a significant consumer of resources. This consumption then leads to high GHG emission rates. In the United States 87% of people live in urban areas, which means that change at this level can have enormous impacts nation-wide [4]. Local governments have the power to use legislation and purchasing power to reduce their GHG emissions.

Development and Emissions

The rapid pace of development and population growth over previous generations has given an unprecedented standard of living to billions of people nation and worldwide. The population boom impacted West Lafayette, with its population growing 233% from the 1960 to the 2010 Census. Subsequent annexations grew the city's population by over 50% to its present size of 45,872 [4].

This burgeoning population requires a large amount of natural resources to meet its need, and the development and transportation of these natural resources require extensive energy infrastructure.

A Phased Approach

City of West Lafayette's Phase I Climate Action Plan:

1. Collect GHG emission data for the city departments of West Lafayette
2. Create a report outlining the city's GHG emissions and the short- and long-term goals for reducing those emissions
3. Create a plan for educating the community about reducing the city department's GHG emissions
4. Establish a long-term GHG data collection and management plan

Vision for the Plan

The City of West Lafayette strives to bridge the gap left by America's abdication from the Paris Climate Agreement. In doing so, we look to be a leader for city residents, Tippecanoe County, and the entire State of Indiana in its commitment to addressing climate change.

Part of the city's vision is being fulfilled by the Go Greener Commission, which was established in 2008, and has a mission to "promote sustainable environmental well-being within the City of West Lafayette and among its residents for present and future generations."

Public Engagement

The city government is the level of governance with the closest connection to the people, so communication and engagement with the public is of utmost importance. To keep West Lafayette residents informed about their government's sustainability activities, citizens will be able to access the city's energy- and fuel-use data and keep track of the downward-trending carbon footprint of the city government.

Collective action is one of the best ways to address global climate change. To that end, the city wants to give its citizens tools they can use to reduce their own climate footprints. The Nature Conservancy, the US EPA, and many other organizations provide



Wabash Riverfest



Local Resident's Rain Garden



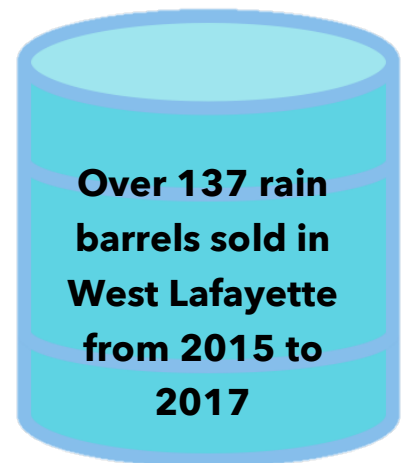
West Lafayette Farmers Market

free online carbon footprint calculators for households to establish and reduce their own carbon footprints. Links to these and other resources can be found online.

Future phases of the West Lafayette Climate Action Plan will include the city as a whole, beyond the auspices of government agencies. These actions will require commitment from members of the public, including individuals, businesses, and civic organizations to be most successful. Building public engagement is a significant priority for the city.

West Lafayette's citizens have consistently engaged in local sustainability initiatives in the past through participation in Wabash Riverfest, shopping at one of the many local farmers markets, purchasing rain barrels, implementing green infrastructure projects at their homes, and much more.

In 2016, the Wabash River Enhancement Corporation (WREC), a local non-profit organization dedicated to improving the Wabash River water quality, estimated around 5,500 people participated in Riverfest, a day-long festival designed to engage the community in local sustainability through games, canoe races, and countless activity booths [13, 14]. From 2015 to 2017, over 137 rain barrels were sold to residents of West Lafayette to collect stormwater runoff at their homes to improve water quality in the Wabash. The residents of West Lafayette have shown



Photos from top to bottom retrieved from:
(1) <http://www.homeofpurdueblog.com/tag/lafayette-farmers-market>
(2) <https://ag.purdue.edu/btny/ppdl/Pages/POTW2016/potw03282016.aspx>

that they want to participate in local action to support community health and sustainability, and this climate action plan can provide even greater opportunities to engage and take part in the push for sustainability in West Lafayette.

Methodology, Inventory, and Projections

Overview

From the onset of this Climate Action Plan, the City of West Lafayette wanted to collect a current GHG emissions inventory for the city's departments and create a method for continued collection and monitoring of each city department's GHG emissions. The collection method needs to be up-to-date with current emissions standards, easily accessed by each department, and reliable. The United States Environmental Protection Agency (EPA) maintains an energy reporting website, EPA Portfolio Manager, that meets all prescribed needs.

The team chose to focus mainly on natural gas and electricity usage for each department to quantify GHG emissions as these are typically the largest contributors to GHG footprints. This data was compiled from natural gas and electricity bills for each department building from the entirety of 2017. The usage and cost each month was input into EPA Portfolio Manager and the website used up-to-date direct and indirect emissions factors to calculate GHG emissions for each month. Total annual emissions for each of West Lafayette's city departments can be found in Figure 1. Detailed tables and data visualizations can be found in Appendix C.

In addition to natural gas and electricity related emissions, we quantified the emissions generated by vehicle usage for each department. Diesel and gasoline totals were collected and GHG emissions were calculated using current EPA defined emissions factors. Figure 2 shows the fuel-related emissions totals for 2008, 2016, and 2017 and emissions factors used can be found in Appendix B. This fuel data can also be found in tabular form in Appendix C.

This inventory only collected data from the city departments themselves; therefore, it is important to mention that the city's total emissions are much higher overall. Until further studies can be completed, the emissions are estimated to be around 1.42

million tons of carbon dioxide annually for the whole of West Lafayette [12]. This was found using Indiana’s yearly emissions and West Lafayette’s percentage of the state population.

Emissions Reduction Goals - 20% by 2020

The Paris Agreement set a target for limiting global average temperature rise and not total GHG, so it has been up to individual nations and cities to formulate their own emissions reduction goal. When first trying to decide West Lafayette's emissions reduction goal, the city considered the Clean Power Plan as a model. Using the same reduction ratio as the Clean Power Plan, it was calculated that the city maintain a 1.28% reduction per year.

Using this rate, the city could have a total reduction of 15.36% by 2030. This was a potential overarching reduction goal, but it was determined that a more ambitious target would not only be possible, but also beneficial.

The city agreed upon a goal of a 20% department-wide reduction by 2020. After looking at the largest contributors of GHG emissions, it was determined that certain departments would contribute more to the reduction than others, based solely on feasibility and percent of emissions. Table 1 provides the current total GHG emissions for the city and the target emissions reduction goal of 20% by 2020.

Table 1. GHG Emissions and Reduction Goal

Current	2020 Target
6,142 tons of CO ₂ eq	4,913 tons of CO ₂ eq

Triple Bottom Line Considerations

Triple Bottom Line refers to performance in three categories: people, planet, and profit. While there are not universally followed methods for calculating the Triple Bottom Line, several indices can be used to quantify economic, social, and environmental impacts of projects. Phase I recommendations for the city departments focus primarily on solutions with economic and environmental impact though there is likely added social benefit. In future phases of the Climate Action Plan, a comprehensive sustainability index may be found useful as a framework for decision-making and efficacy-monitoring.

Inventory

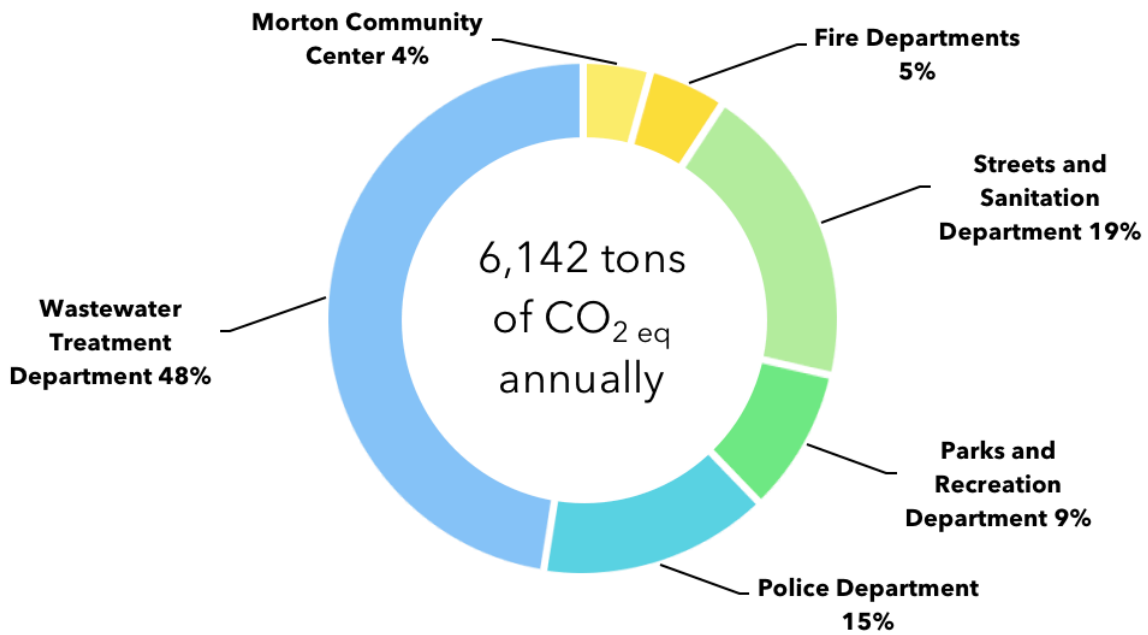


Figure 1. Total GHG emissions (tons) for West Lafayette and each departments contributions (2)

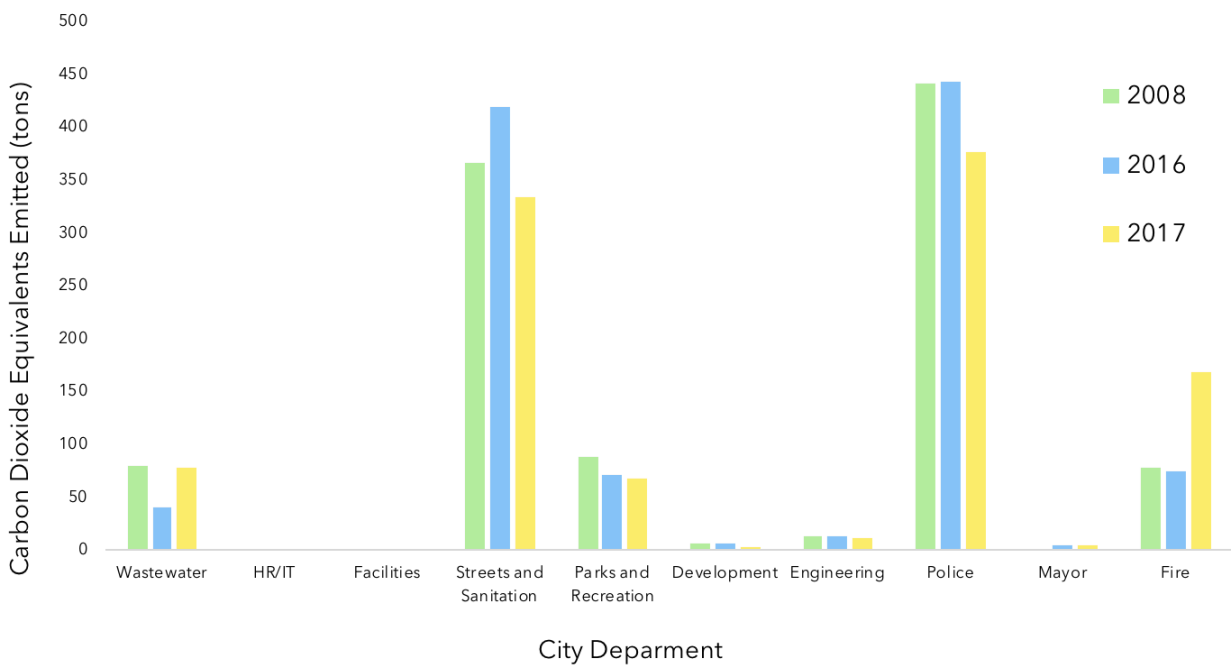


Figure 2. Total GHG emissions for West Lafayette city departments from vehicle usage

After collecting electricity and natural gas bills from each city department, the monthly usage and cost was input into EPA Portfolio Manager. This generated the monthly direct and indirect GHG emissions for each city building and these emissions were totaled and an annual value for each building was found. These values can be found in Figure 1 along with the total annual emissions for the entire city government.

Fuel usage for each city department was collected and GHG emissions were quantified for vehicle usage based on emissions factors found in Appendix B. Figure 2 outlines the emissions for 2008, 2016, and 2017 to show trends in vehicle usage for each city department. A detailed table with fuel usage and emissions can be found in Appendix C.

Projections

For West Lafayette to reach its goal of a 20% reduction in emissions by 2020, the city departments will need to work to reduce emissions by at least 410 tons of carbon dioxide equivalents each year from now until 2020. While this may seem a high-reaching goal, the Wastewater Treatment

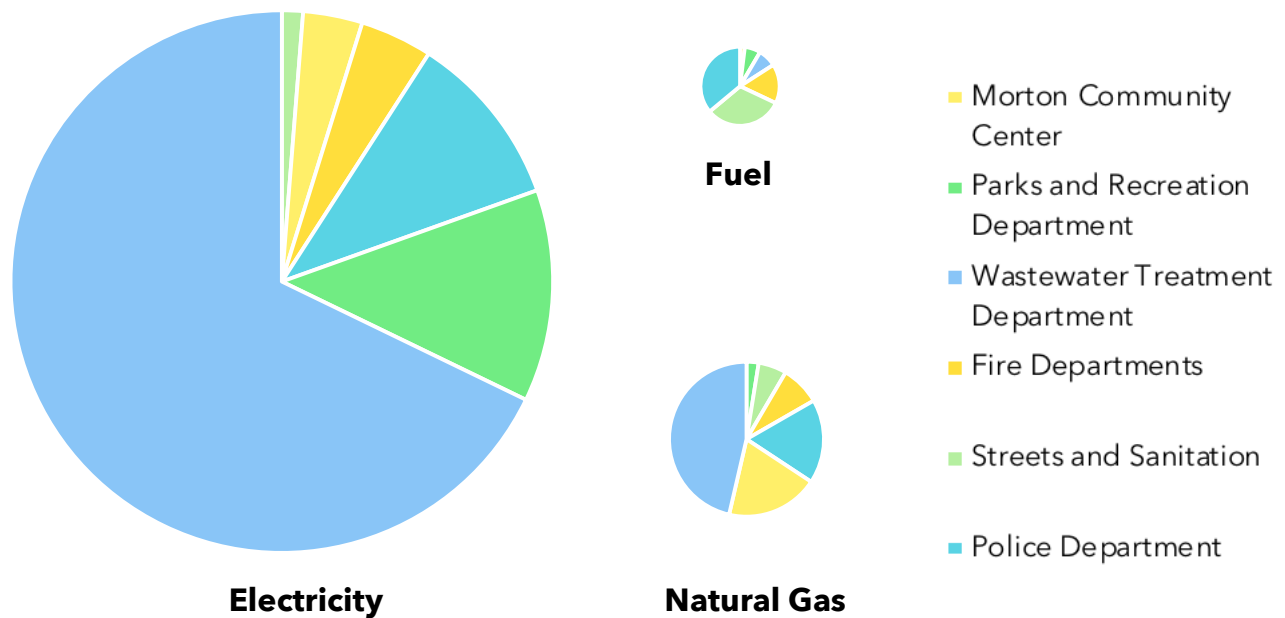


Figure 3. GHG emissions from each city department for the three energy sectors: electricity, natural gas, and fuel proportional to relative contribution

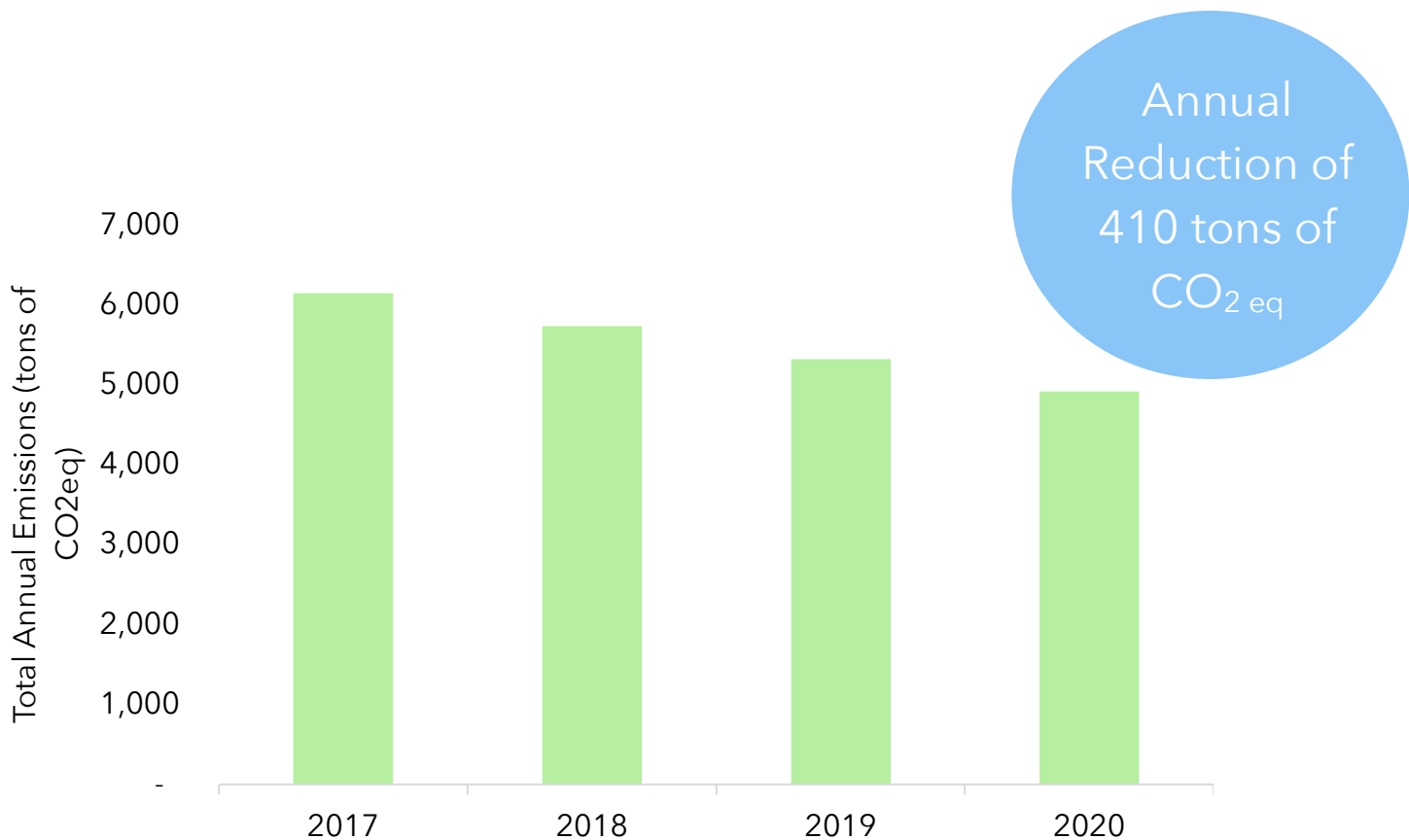


Figure 4. Total GHG emissions and target projections for meeting Climate Action Plan goal

The city's street lights contribute 287 tons of CO₂ eq yearly and about 25% of the Streets and Sanitation Department emissions.

Department aims to reduce its emissions by 50% by 2025. Due to the large electricity demands of the wastewater treatment process, if the department reduces emissions by around 7% of its 2017 total annually until 2025 it will have reduced its emissions by 50% and the city's emissions by 27%. This 7% reduction in emissions each year from the Wastewater Treatment Department will contribute to 50% of the 410 tons of emissions reduction annually required to meet the 2020 goal. Coupling the Wastewater Department's reductions with the work each of the other departments to reduce emissions, the city will reduce its impact 20% by 2020.

Goals, Actions, and Implementation Strategies

Table 2. Inventory of departmental goals

Department	Goals
Wastewater Treatment	<ol style="list-style-type: none"> 1. Reduce department's energy usage by 50% by 2025 with 2017 as a benchmark 2. Replace existing blowers with new high-efficiency blowers 3. Increase usage of anaerobic digester
Streets and Sanitation	<ol style="list-style-type: none"> 4. Optimize garbage and recycling pick-up routes 5. Increase collection of recyclable materials to 50% of the total waste of the city 6. Perform study on the street lights around the city to reduce areas of darkness and optimize light usage.
Parks and Recreation	<ol style="list-style-type: none"> 7. Increase bike lanes and walking trails around the city 8. Include environmentally-friendly practices at the new Cumberland Indoor Recreation and Aquatics Center
Police	<ol style="list-style-type: none"> 9. Consider options for reducing fuel demand including: hybrid patrol cars, installing idle-reduction technology in existing cars, and electric motorcycles
Fire	<ol style="list-style-type: none"> 10. Consider electricity emissions reduction by implementing motion activated lighting systems and solar-thermal heating systems for building water use 11. Consider reducing municipal water demand by implementing rainwater storage systems or efficient showerheads and faucet aerators
Facilities	<ol style="list-style-type: none"> 12. Follow LEED program guidelines in buildings 13. Set a minimum of 16 SEER rating for HVAC systems as they get replaced 14. Include motion-sensor lights in buildings used 24/7 such as the police and fire stations 15. Consider adding solar panels to buildings and switching to GoGreen Indiana power from Duke
Development	<ol style="list-style-type: none"> 16. Construct all new road projects to have dedicated bike lanes and suspended sidewalks 17. Require all new building projects have green spaces 18. Require new apartment building projects have on-site recycling pick-up
Human Resources/IT	<ol style="list-style-type: none"> 19. Switch to online and computer-based systems rather than printing paper
Engineering	<ol style="list-style-type: none"> 20. Increase walkability in the city to reduce vehicle usage

Goals for Each Department

Wastewater Treatment

Due to the nature of the work conducted, the Wastewater Department has the largest carbon footprint of the city departments. Dave Henderson, the department head, is working to reduce the department's current (2017) GHG emissions by 50% by 2025. To achieve this goal, they have replaced two of the blowers in the wastewater treatment plant. These new high-efficiency blowers have been found to dramatically reduce the energy use associated with aeration. The Wastewater Department has estimated that this project will have a return on investment of four to five years.



Photo retrieved from:
<http://www.activatedsludge.com/wordpress1/west-lafayette-in-wwtp/>

The department will also increase usage of its anaerobic digester to reduce the need to purchase off-site electricity. The anaerobic digester uses food waste and biodegradable material to generate biogas that is used to generate part of the electricity for the treatment plant. A visualization of this process can be found in Figure 5. The expansion of electricity generation will be facilitated by the addition of a compost drop-off location being added to the West Lafayette Recycling Center maintained by the Streets and Sanitation department. In addition, the wastewater department is considering the addition of solar panels onto some of its buildings to further reduce the need to purchase electricity.

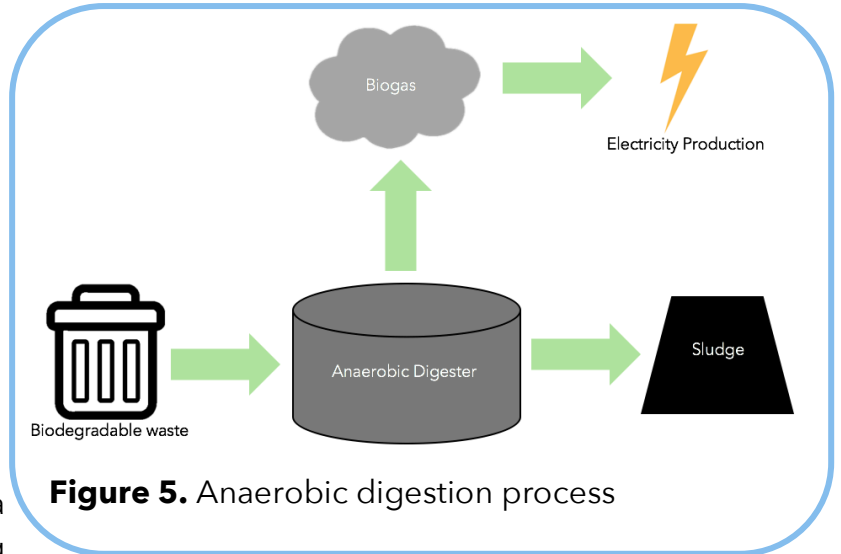


Figure 5. Anaerobic digestion process

The increased use of the anaerobic digester and the addition of solar panels will greatly reduce electricity demands from the department and help it to reach its individual goals, as well as the goals of the city.



Photo retrieved from:
<http://www.westlafayette.in.gov/topic/index.php?topicid=16&structureid=18>

Streets and Sanitation

The fuel usage of the Streets and Sanitation Department contributes over 80% of its total annual GHG emissions due to city-wide trash and recycling pick up and street maintenance. With this in mind, the department is working to optimize its pick-up routes to reduce driving and GHG emissions. Streets and Sanitation will be expanding building space at their recycling center and is considering the addition of solar panels to

provide its electricity. This will greatly reduce GHG emissions from electricity usage by the department.

The department is also working to increase collection of recyclable materials to account for 50% of the total waste they dispose of for the city. This will be accomplished through the creation of a new city ordinance requiring recycling be available in all newly constructed apartment complexes. This will reduce the amount of waste from the city entering the landfill that causes the emission of methane into the atmosphere. Similarly, to reduce the amount of waste entering the landfill the department is looking to add a compost drop-off area to their current recycling location. This will be available to any West Lafayette resident and the food waste and biodegradable material will be used at the wastewater treatment plant in the anaerobic digester.

Streets and Sanitation is contracting a streetlight study to examine where streetlights currently are and where they are needed. The study will identify “dark areas” across the city to improve the safety of both drivers and pedestrians. The study also looks into the advantages and disadvantages of the city owning their own poles or using Duke Energy's light poles. The city is billed per light to rent in addition to paying per kilowatt-hour for each streetlight. If they opted to purchase their own light poles the city would be responsible for the upfront cost, but then they would subsequently pay only per kilowatt-hour. This could potentially save the city money, which they could use towards other sustainability initiatives



Parks and Recreation

West Lafayette is currently developing its newest park! The Parks and Recreation Foundation is raising funds to renovate and preserve the historic Morris Schoolhouse. Cason Park, named after its donor, will include the schoolhouse, a playground, and trails to connect it to West Lafayette's existing 27-mile trail system. The current trail system consists of 5 miles of nature paths and 10 miles of marked bike lanes. These bike lanes will soon be expanded with the completion of the State Street redevelopment project increasing bike-ability and reducing emissions due to city driving.

The department also manages 464-acres of green space around the city including 195-acres of wetland habitat and 100-acres of marsh land. These green spaces provide ecological benefits to the city and act as carbon sequestration mechanisms.

The Parks and Recreation Department's main goal is to begin construction on a recreation center to support various city programs and organizations. Parks and Rec plans on implementing several environmentally-friendly practices at the Cumberland Indoor Recreation and Aquatics Center, such as stormwater infrastructure, green building techniques, and the potential installation of solar panels to generate electricity.

Police

From 2010 to 2016, the Police Department switched from V8 to V6 engines in order to increase efficiency and decrease gas consumption. This switch has cut gas emissions by 25%. There are several options for police departments to reduce emissions further. The Ford Defender is the first pursuit-rated hybrid on



Photos from top to bottom retrieved from:

- (1) <http://www.homeofpurdueblog.com/lilly-nature-center-and-celery-bog/>
- (2) <http://www.lafayettology.com/2012/10/happy-hollow-park-west-lafayette-indiana/>
- (3) <http://www.jconline.com/story/opinion/columnists/dave-bangert/2016/09/12/bangert-welcome-back-happy-hollow-trails/90277866/>

the market. Hybrid cars reduce the carbon footprint of idling because the lithium-ion battery is capable of running the car entirely up to 60 miles per hour. A hybrid vehicle can also save up to \$3,877 per year based on a \$2.50/gallon average. With the Police Department contributing 35% of fuel related emissions for the city departments, a switch to hybrid vehicles would drastically reduce the total GHG emissions [5].

Another option to reduce the Police Department's carbon footprint is to install an idle-reduction technology in the fleet's engines. This technology was implemented and proved to be successful in Orlando's police fleet. The technology cut fuel consumption by 30% and increased fuel economy by 12% [6].

Lastly, the department could consider adding electric motorcycles to the fleet. Electric motorcycles cost only pennies per mile to charge. They also provide additional patrolling benefits, such as instant acceleration from idling, complete silence, and riding without the need to shift [7].

Fire

The Fire Department contributes most of its greenhouse gas emissions from electricity needed to power the three fire stations within West Lafayette. Potential solutions to mitigate these emissions include motion activated lighting systems and solar-thermal heating systems for building water use.

Additionally, the Fire Department could reduce its water footprint by installing a rainwater storage system on each building to collect water for the fire engines. The department could also invest in efficient showerheads and faucet aerators in each fire station. These, in turn, would reduce the strain on municipal sources and the amount of water treated through the Wastewater Department.

Facilities

The Facilities Department is located within West Lafayette Fire Station No. 1, so its building-related GHG emissions are included within the Fire Department's GHG contributions. This department also creates relatively minor GHG emissions from departmental vehicle usage. The Facilities Department is also in control of the utilities for each of the city's buildings. With all of this in mind, the Facilities Department is looking to contribute to the reduction of city GHG emissions through future changes in city utility use.

These goals include considering solar panels to generate electricity for future city-owned buildings and any building renovations, expansions, or updates. In cases where solar panels are not possible, the city may consider switching their Duke Energy plan to Duke's GoGreen Indiana. This plan allows for a municipal or personal Duke Energy account to allocate funds specifically to green energy. The customer must purchase a minimum of 200 kWh blocks of green power for an additional \$1.80 per month or \$21.60 per year. This charge guarantees that amount of power is coming from green power. 200 kWh of green power reduces carbon emissions by 4800 lbs. each year.

The department has also committed to ensuring a minimum of 16 SEER rating for all replaced HVAC systems within city-owned buildings and to follow LEED certifications guidelines. This ensures increased efficiency overall and reduced energy usage for heating and cooling. In addition, the department is looking to implement motion-activated lights in all city-owned buildings to ensure lights are turned off while rooms are not in use. These small changes will make a large-scale impact toward reducing the GHG emissions generated by the city's energy usage.

Development

The Development Department is located within the Morton Community Center, so its electric and heating GHG emissions are enveloped within the emissions generated by the Morton building. The departments fuel emissions are also minimal in relation to the other city departments, so its GHG reduction goals are related directly to community development.

The department has decided that each new road project will have a dedicated bike lane and all new building projects have a requirement for green space. In addition, all new apartments must provide the opportunity to have on-site recycling pick-up. These initiatives will reduce GHG emissions from vehicle usage and decrease the amount of waste being taken to the landfill from the city. New road development will also include the addition of suspended sidewalks to increase tree root growth and promote the health of our urban tree canopy. This increases the carbon sequestration potential of trees.

Human Resources and Information Technology

The Human Resources (HR) and Information Technology (IT) departments are located within the Police Department, so their building-related GHG emissions are included

within the Police Department's GHG contributions. Both departments do relatively minimal driving that would contribute fuel-related GHG emissions.

To reduce environmental impact, currently, the HR department has switched over to an online employee application and distribution system to cut down on a large amount of paper use. They are also hoping to begin using an online signature system to have city employees acknowledge agreement with the annual update of the Personnel Manual. Previously, this large manual was printed off for each city employee to read and sign annually. Moving forward the HR Department will work to reduce paper use when possible and continue to keep fuel usage to a minimum.

Engineering

The Engineering Department is located within Morton Community Center, so its building-related GHG emissions are included within Morton's GHG contributions. In terms of car usage, this department contributes about 10% of the fuel related emissions for the city. This brings into consideration the goal of obtaining a hybrid or electric vehicle for the departments' driving needs. This would cut fuel-related emissions and reduce the city's overall GHG emissions.

The department is also working toward goals related to creating a more sustainable city overall. This includes facilitating the increase of bike lanes and walking trails around this city in partnership with the Parks and Recreation Department. Increasing access to bike lanes and trails, reduces driving needs and promotes the upkeep and use of the West Lafayette park system. The Engineering Department is also working to increase walkability around the city and increase the centrality of the city's shops and restaurants. This reduces resident driving, vehicle emissions, street maintenance, and promotes a more sustainable community.

Future Steps and Challenges

In order to ensure long term viability and future phases of this project, a process for ongoing data collection is required. Because the Purdue EEE Senior Design team will not continue working past graduation in May 2018, it was decided that Dave Henderson, head of the Wastewater Treatment Department, would take over with collecting and organizing the city's emission data. This decision was made because Mr. Henderson is already very familiar with the EPA Portfolio Manager software.

When looking at continuing the project and moving on to Phase II and III, there has been a discussion between Purdue EEE faculty and Go Greener on creating another Senior Design group for the 2018-2019 school year. This would allow these new students to use the current Climate Action Plan as a foundation to continue helping the city reduce their GHG emissions.

Along the lines of future long-term tracking, it is suggested that West Lafayette create either a Sustainability Office within the city or a single position for a Sustainability Officer or Intern. This would allow more organization and focus on sustainability and reducing emissions for West Lafayette. This would also guarantee that all emissions would be tracked through 2020. A sustainability office would also allow the city to expand their efforts in allowing the city to protect the environment.

Community Involvement

One of the best ways to make an impact is getting involved in a community group or club focusing on the environment. There are countless groups that West Lafayette citizens and Purdue students can join across all backgrounds, interests, and majors. You can also reach out to your government representatives to discuss important **local** and **state** topics. Share your local actions on social media, and tag @WestLafayetteIN on Twitter or @WestLafayetteGoGreener on Facebook!

The webpages are hyperlinked to blue text or listed below each organization.

Community organizations:

1. Go Greener Commission

For more information or to become involved, please complete the Go Greener Commission Application and email Lindsey Payne, paynel@purdue.edu. The application may be turned in to the Mayor's Office located, 222 N. Chauncey Ave., West Lafayette, IN or emailed to Lindsey Payne at the above email address.

<http://www.westlafayette.in.gov/department/board.php?structureid=26>

2. West Lafayette Tree Friends

"To create and sustain economic, environmental, health, and aesthetic benefits in our West Lafayette community through planting and nurturing trees in our public right-of ways."

<https://wltreefriends.org/>

3. Hoosier Environmental Council

Ways to get involved

- Join us on Facebook and Twitter
- Become an HEC Environmental Advocate
- Greening Your Community

<https://www.hecweb.org/>

4. Wabash River Enhancement Corporation

"The Wabash River Enhancement Corporation (WREC) brings together residents, experts, and governments to improve water quality and expand public access. WREC is your portal to making the right decisions for your river!"

<http://www.wabashriver.net/>

5. Indiana Organic Gardeners Association

"IOGA Mission: To educate ourselves and others in reasons for and methods of environmentally friendly gardening; and to encourage the reduction of chemical dependency in gardens, lawns and farms. Our name describes our goal: ecologically friendly growing. We are a group of mostly "backyard" gardeners who aspire to grow safe food and uncontaminated flowers using natural methods. We are fortunate to have a few market farms and herb growers among us. Join us at a meeting and see what we're about."

<http://www.gardeningnaturally.org/>

6. Sierra Club Hoosier Chapter

"The Sierra Club is the oldest, largest, and most influential grassroots environmental organizations in the United States with more than three million members and supporters. It was founded in 1892 by the conservationist John Muir. The Sierra Club has hundreds of thousands of members in chapters located throughout the United States. The Hoosier Chapter has more than 10,000 members. Local Sierra Club groups are active in different parts of the state, working on conservation-related issues, sponsoring outdoor activities, and educating members on issues. Indianapolis (Heartlands), southwest Indiana,

Greater Columbus (Winding Waters), and northwest Indiana (Dunelands) have active Sierra Club groups. [Find your local Indiana group](#), and be sure to check out our [events and outings page](#) for more ways to get involved."

<https://www.sierraclub.org/indiana>

7. NICHES

"Protects, restores and sustains Northern Indiana's ecosystems by providing habitat for native species and offering natural places for the education, appreciation and enjoyment of current and future generations."

<http://nicheslandtrust.org/>

8. Talk to your elected officials

Find your elected officials here: <http://iga.in.gov/legislative/find-legislators/>

Purdue Student Organizations

1. Boiler Green Initiative

"Boiler Green Initiative is a multidisciplinary, campus-wide student organization that focuses on the evaluation and continued enhancement of the sustainability of [Purdue University](#) and its surrounding communities. Its ongoing mission is to facilitate green initiatives by challenging the Purdue community to become environmentally engaged."

<http://boilergreen.com/>

2. Purdue Student Sustainability Council

Purdue Student Sustainability Council advises the University Sustainability Council and Purdue University from the student's perspective, promote economic responsibility, environmental stewardship and social justice, and engage the Purdue University Student Body in these issues. This organization also serves as an umbrella for nineteen other student sustainability organizations including Boiler Green Initiative, Eco Reps, Green Greeks, and many more.

<http://purduessc.weebly.com/>

3. Society of Environmental and Ecological Engineers

"The purpose of SEEE is to introduce students to the new division of engineering, the Environmental and Ecological Engineering program. SEEE serves to provide a link between students, faculty, administrators and alumni in efforts to increase awareness and growth of this organization. SEEE will form social and professional gatherings where SEEE participants will be able to hear speakers, learn of job opportunities, practice volunteer work in the community, as well as have interactions with other related student groups. SEEE will also provide an easy and efficient way to form study groups for those in common classes and a place for those with common interests in environmental and ecological studies, to unite and share ideas to better the world."

<https://boilerlink.purdue.edu/organization/seee>

4. Engineers for a Sustainable World

"Our mission, as a national organization, is to design and implement sustainable projects through our student and professional chapters, educate and train individuals and organizations on sustainable policies and practices, and build a global network of communities with a shared culture of sustainability."

<https://eswpurdue.weebly.com>

5. Purdue Engineers Without Borders

"Engineers Without Borders- Purdue is a student chapter of Engineers Without Borders- USA committed to using our skills as innovative individuals to enrich to education and pre-professional experience of its members while promoting community development, locally and abroad. Our mission is to partner with the Purdue community, professional EWB chapters, and developing communities worldwide to implement sustainable engineering projects that promote the advancement of global community development through engineering skills and knowledge."

<https://epics.ecn.purdue.edu/ewb/>

6. Purdue Solar Racing

"We are Purdue Solar Racing, a student-run organization at Purdue University that designs, builds, and races solar-powered vehicles in national and international competitions. In addition to developing advanced vehicle systems, we participate in a variety of outreach events to educate the local community about the possibilities of sustainable transportation. Our multidisciplinary team consists of a

diverse set of students who work in business, operations, and engineering functions."

<http://purduesolar.org/>

7. Environmental Science Club

"The Environmental Science Club is a student organization looking to increase the education, awareness, and community involvement of its members in a positive and engaging social setting."

<https://boilerlink.purdue.edu/organization/environmentalscienceclub>

8. Students Growing Sustainable Communities

"Students Growing Sustainable Communities is a Purdue University student organization powered by highly motivated students to grow local and global communities through sustainability-focused projects. We believe that the best solutions to sustainability draw from collaboration between multiple disciplines. Each of our project teams contains students from a broad range of majors from engineering to interior design to agriculture. Our members are motivated and engaged by the work they do. We strive to give our members the opportunity to engage in hands-on projects that will provide them with valuable experiences."

<https://boilerlink.purdue.edu/organization/SGSC>

9. American Nuclear Society

"The Purdue American Nuclear Society (ANS) student branch at Purdue University is a non-profit organization whose purpose is to serve the students of Purdue University and support our School of Nuclear Engineering."

<https://engineering.purdue.edu/NE/people/student-orgs/ans>

10. Eco Reps

Students in Eco-Reps at Purdue University serve as student ambassadors to promote sustainability and environmental stewardship in University Residences (a unit of Purdue Housing & Food Services). With almost 90% of incoming students choosing to live in residence halls, and almost 12,000 total students living in University Residences, this program enables a small group of dedicated and enthusiastic students to greatly influence Purdue's culture of sustainability.

The Eco-Reps train these students as peer educators, providing them with resources and knowledge to help change personal and collective behaviors and create a more sustainable, green campus.

https://www.purdue.edu/sustainability/initiatives/education_research/eco-reps.html

11. Purdue PETA

PPETA's focus is to raise awareness of animal rights issues to fellow Boilermakers and the community of West Lafayette. We work to educate Purdue students and members of the community on these issues and create an overall improved livelihood for animals everywhere. :) Join us in creating a better life for our animal friends!

<https://boilerlink.purdue.edu/organization/ppeta>

12. Purdue Student Farm

The Student Farm is a working small farm near the Kampen Golf Course and Daniel Turf Center off Cherry Lane. We grow beautiful vegetables, herbs, and cut flowers using the principles that naturally govern balanced eco systems, including emphasis on diversity, healthy soil, healthy plants, and healthy people. Our educational work is all about food: how to grow it on a small, ecological scale, the art of marketing produce for profit, how to eat vegetables in delicious, nourishing ways, understanding how food intersects with environment and economy and community.

<https://www.purdue.edu/dffs/studentfarm/>

13. Purdue Student Government

Purdue Student Government (PSG) is a student-run and operated organization that serves the student body by advocating student concerns to students, faculty, community members, administration and alumni. In other words, PSG is the voice of the student body.

<https://www.purduesg.org/>

14. Student Council of Environmental Education

We are a student organization at Purdue University. We strive to educate others about the natural world and environmental issues. We provide educational opportunities for youth such as our Family Nature Programs. Our efforts aren't limited to youth, we also work on outreach programs that allow us to reach a wider audience.

<https://purduescee.wordpress.com/>

15. Green Greeks

We seek to create a more perfect union of Greek and non-Greek member participation in order to further sustainable development here at Purdue. We aim to make Fraternity, Sorority, and Cooperative Life more sustainable by educating members of the Greek community, creating opportunities for Greek and Cooperative Life members to join the Purdue Sustainability movement, and serving as a philanthropic arm for Greeks to get more involved.

<https://purduegreengreeks.weebly.com/>

16. Krannert Energy Club

Founded in 2013, the Krannert Energy Club is a professional club that endeavors to connect students to the energy industry through networking opportunities, social events, and case competitions.

Mission:

- Foster a passion among Krannert graduate students for careers in the energy industry
- Strengthen member's knowledge of industry fundamentals
- Cultivate a network for career opportunities
- Provide applied learning and leadership opportunities for students

<https://www.krannert.purdue.edu/krannertlife/clubs/professional-club/energyclub.php>

17. Purdue Energy Forum

The Purdue Energy Forum is a group of Boilermakers devoted to exploring scientifically and economically focused solutions to the energy demands around the planet. We make a point of reaching out to the rest of the Purdue student body and Midwestern community to explain why the impending energy crisis, despite being overlooked by many, is the greatest challenge of our time.

<https://www.purdueenergyforum.org/>

18. Purdue Agricultural Council

The Purdue Agricultural Council is a student organization ran by approximately 22 undergraduates in various College of Agriculture majors and with a variety of backgrounds and experiences. The members work as one cohesive unit toward one focus goal, promoting unity throughout the college. Unity amongst all members of the college, both students and faculty, is accomplished by providing educational enrichment and promoting social interaction. Some notable events include beginning of semester socials and leadership development opportunities.

<https://ag.purdue.edu/oap/agcouncil/Pages/default.aspx>

19. Purdue Heifer International Chapter

"The mission of Purdue Heifer International Chapter is to work with communities locally and globally to end hunger, poverty and to care for the earth through education, volunteer work and fundraising."

<http://heiferinternational.wixsite.com/purduechapter>

Appendices

Appendix A: U.S. Mayors Climate Protection Agreement

The President's denial of global warming is getting a cold reception from America's cities. As 392 US Mayors representing 69 million Americans, we will adopt, honor, and uphold the commitments to the goals enshrined in the Paris Agreement. We will intensify efforts to meet each of our cities' current climate goals, push for new action to meet the 1.5 degrees Celsius target, and work together to create a 21st century clean energy economy.

We will continue to lead. We are increasing investments in renewable energy and energy efficiency. We will buy and create more demand for electric cars and trucks. We will increase our efforts to cut greenhouse gas emissions, create a clean energy economy, and stand for environmental justice. And if the President wants to break the promises made to our allies enshrined in the historic Paris Agreement, we'll build and strengthen relationships around the world to protect the planet from devastating climate risks.

The world cannot wait—and neither will we.

Appendix B: Emissions Factors

Table 3. Vehicle fuel emissions factors [11]

Fuel Type	Emissions Factors
Gasoline	8.78 kg of CO ₂ eq per gallon
Diesel	10.21 kg of CO ₂ eq per gallon

Appendix C: Emissions and Cost Data

Table 4. Fuel-related GHG emissions data for each city department

City Department	2008	2016	2017
Wastewater	80.5	39.8	78.2
IT	0	0.53	0.78
Facilities	0	0.74	0.71
Streets and Sanitation	366	419	334
Parks and Recreation	88.1	71.3	68.1
Development	6.98	6.36	3.79
Engineering	13.8	13.7	12
Police	442	444	377
Mayor	0	5.46	4.58
Fire	77.4	75.3	168

Table 5. City building GHG emissions from electricity and natural gas usage

City Building	Tons of Carbon Dioxide Equivalents
Morton Community Center	267
Fire Departments	301
Streets and Sanitation Department	1189
Parks and Recreation Department	565
Police Department	900
Wastewater Treatment Department	2919

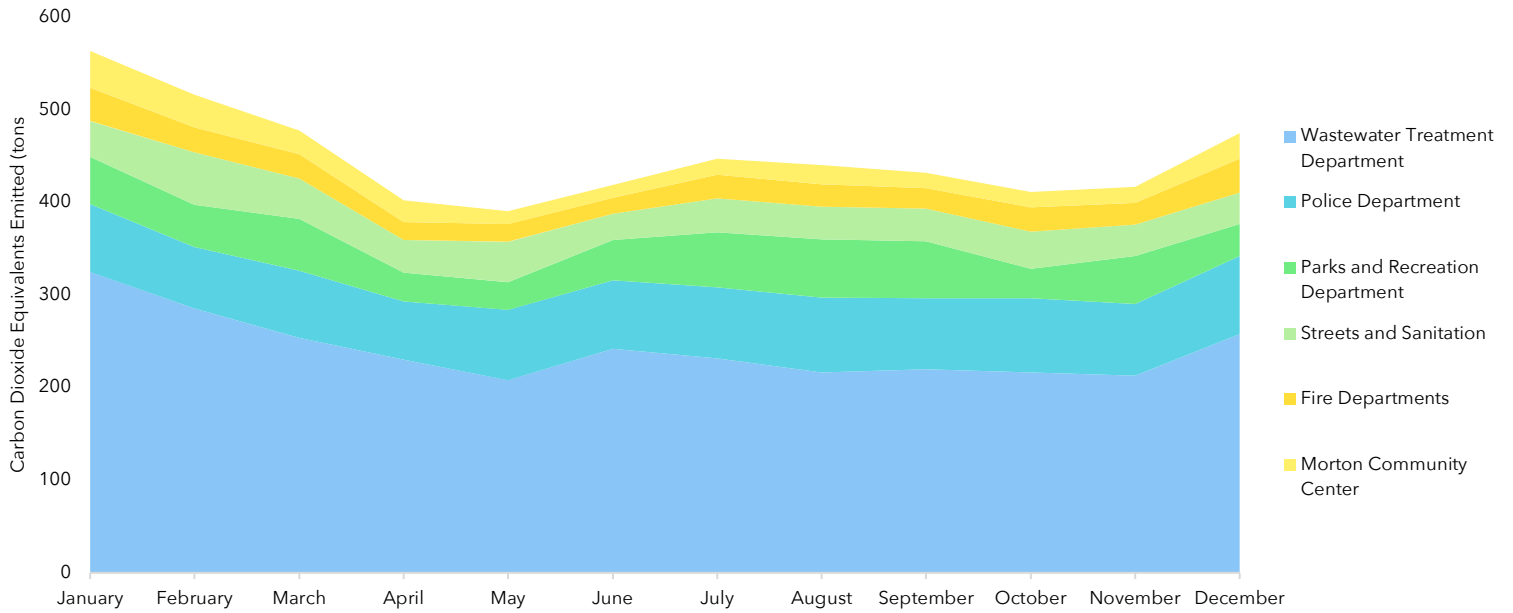


Figure 6. Total GHG emissions for each department monthly in 2017

Table 6. City building annual costs from electricity and natural gas usage

City Building	Total Annual Cost of Natural Gas and Electricity Usage
Morton Community Center	\$36,535.16
Fire Departments	\$28,774.30
Streets and Sanitation Department	\$155,181.18
Parks and Recreation Department	\$70,852.38
Police Department	\$66,165.48
Wastewater Treatment Department	\$364,872.13

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Cover page photos from top to bottom and left to right retrieved from:

(1) <http://www.homeofpurdueblog.com/weekend-update-wabash-riverfest-gallery-walk/>

(2) <http://www.homeofpurdueblog.com/spring-is-here-and-we-are-heading-to-the-celery-bog/>

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