City of Pittsburgh

CLIMATE ACTION PLAN

Version 3.0

ACKNOWLEDGEMENTS
Thank you to the following Organizations for their contributions to the Climate Action Plan

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-ACED
-ACTA
-Action Housing
-AgRecycle
-ALCOSAN
-Allegheny CleanWays
-Allegheny Conference
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-Allegheny County Conservation District
-Allegheny County Economic Development
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-Brazen Kitchen
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-Buro Happold
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-Carnegie Mellon University School of Art
-Carnegie Museum of Natural History
-Carnegie Museums of Pittsburgh
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East End Food Co-op
Eat n Park
Eaton Corporation
EcoCraft Homes
EIS Solar
EnerNoc
Ethos Collaborative
Eutectics
Ever Power
EvolveEA
Farmers Market City Parks
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GBA
Google
Green Building Alliance
Grow Pittsburgh
GTECH Strategies
HACP
Hillman Foundation
Homewood Children's Village
IBACOS
IMG Midstream
Itron Inc.
James Construction
Just Harvest
KeySource
Michael Baker International
Milcraft Industries Inc.
Mitsubishi Electric Power Products
Mount Washington CDC
NAIOP
National Academies
National Energy Technology Laboratory
National Renewable Energy Laboratory
New Burgh Real Estate
NRG Energy, Inc
Oakland TMA
OPDC
Oxford Development
PAAC
PASA
PCCR
PCRG
Penn State Extension
Penn Waste
PennDOT District 11-0
PennFuture
Pennsylvania Environmental Council
Peoples Natural Gas
PHFA
Phipps Conservatory
Pittsburgh Downtown Partnership
Pittsburgh Food Policy Council
Pittsburgh Parking Authority
Pittsburgh Parks Conservancy
Pittsburgh Pirates

Pittsburgh Water and Sewer Authority
Pittsburghers for Public Transit
PLI
PNC
Port Authority of Allegheny County
PPA
PRC
Putting Down Roots, Pittsburgh Botanical Garden
Q development
Ralph A. Falbo Inc.
RAND Corporation
Regional Industrial Development Corporation
Richard King Mellon Foundation
RIDC
Riverlife
Rye Development
Science & Engineering Ambassadors Program
SEA
Shadyside
Worms/Composting
Solarize Allegheny
SPC
Sports & Exhibition Authority
Steel City Soils
Stephanie Boddie Consulting
Sustainable Pittsburgh
The Efficiency Network
The Heinz Endowments
Thoughtful Balance
Tree Pittsburgh
TREK Development Group
University of Pittsburgh
UPMC - Director of Environmental Initiatives
URA
Urban Land Institute
UrbanKind Institute
Walnut Capital
Waste Management
Western Pennsylvania Conservancy
Westinghouse Electric Company
Women for a Healthy Environment
Zipcar
412 Food Rescue

EXECUTIVE SUMMARY

Climate change is a major threat to communities around the world. Potential consequences of climate change include an increase in extreme weather events, higher rates of infectious diseases and heat-related illnesses, the possible shortage of food and basic goods and an increase in public expenditures to mitigate these effects. The City of Pittsburgh has long recognized that extensive efforts must be made in order to mitigate the effects of climate change on both local and global communities.

On February 9, 2007, the City of Pittsburgh signed the U.S. Mayors Climate Protection Agreement, pledging to implement local global warming solutions that would save taxpayer dollars and reduce long-term energy use.

As part of the Pittsburgh Climate Protection Initiative, the Green Government Task Force (GGTF) was charged with developing the Pittsburgh Climate Action Plan. In July 2008, the City adopted the first *Pittsburgh Climate Action Plan,* which outlined specific strategies for achieving greenhouse gas emissions reductions.

In 2012, an updated *Pittsburgh Climate Action Plan, Version 2.0* was created to support and review the measures that government, businesses, institutions of higher education, and Pittsburgh residents had undertaken, while also proposing new measures that could be implemented in order meet the greenhouse gas reduction target of 20% below 2003 levels by 2023.

In 2017, it is clear that continued measures must be taken to help mitigate the local effects of global climate change. Building on the successes of the previous versions, *Pittsburgh Climate Action Plan, Version 3.0* has been created to track the progress that has been made on the recommendations from the first two plans and to propose new measures to counteract the potential adverse effects of climate change. This document aligns with Mayor William Peduto's Climate goals that he signed in 2015 at the Paris Accords, where he was one of the 12 U.S. Mayors representing our nation. In June 2017, Mayor Peduto also joined 175 other U.S. mayors in signing an Executive Order[1] to pledge efforts to meet the "1.5 degrees Celsius target" as set forth by the Paris Agreement.

The Climate Action Plan 3.0 takes a new approach toward climate-change mitigation. Action plans and strategies are presented around six key areas; Energy Generation & Distribution, Buildings & End Use Efficiency, Transportation & Land Use, Waste & Resource Recovery, Food & Agriculture, and Urban Ecosystems. While each area has specific goals and actions, there is significant overlap among many of the action areas which create a more wholistic plan which provides opportunities for the greatest impact. Coordination across sectors will yield the greatest benefits. Of the six sectors, the overlapping actions create two action clusters; energy and ecosystems.

[1] http://apps.pittsburghpa.gov/mayorpeduto/Climate_exec_order_06.02.17_(1).pdf

Many proposals related to energy sources and energy usage are presented throughout the first three chapters, Energy Generation & Distribution, Buildings, and Transportation & Land Use. The two main goals in these chapters are improved energy efficiency and increased fuel shift. In order to reach these ambitious goals, projects must address both goals. For example, when shifting to electric vehicles, carbon-free charging sources must also be implemented.

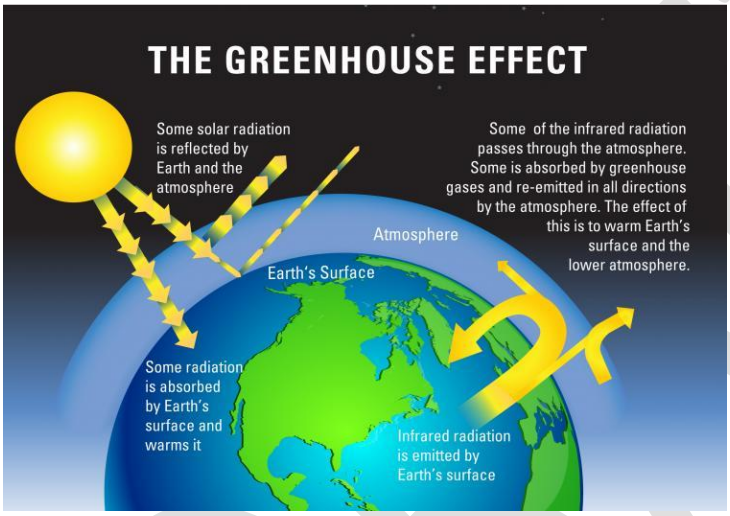
The remaining three chapters; Waste and Resource Recovery, Food & Agriculture, and Urban Ecosystems, follow a similar, overlapping plan. The main idea presented throughout all three chapters is waste reduction and proper resource management.

INTRODUCTION

In 2016, Earth's surface temperatures were the warmest since modern recordkeeping began in 1880, according to independent analyses conducted by National Aeronautics and Space Administration (NASA) and the National Oceanic and Atmospheric Administration (NOAA)[2]. Earth's average surface temperature has risen approximately 2.0 degrees Fahrenheit (1.1 degrees Celsius) since the start of the industrial revolution in the late 1700's, a change driven largely by increased activities releasing carbon dioxide and other human-made emissions into the atmosphere. Most of the warming occurred in the past 35 years, with 16 of the 17 warmest years on record occurring since 2001.

Background

Climate Change

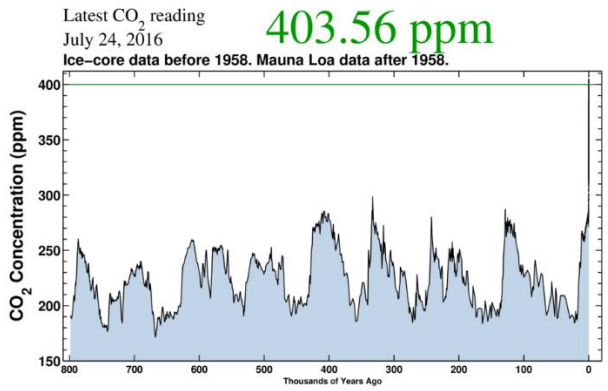


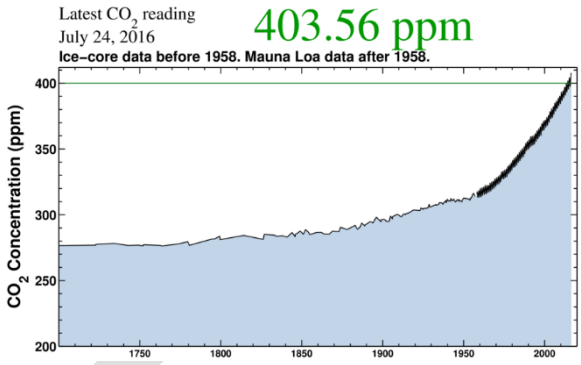
Greenhouse gases (GHGs) such as carbon dioxide (CO_2), methane (CH_4) and ozone (O_3) in the atmosphere, absorb some of the infrared radiation (heat) emitted by Earth's surface, which keeps our planet livable. Without the greenhouse effect, Earth's average temperature would be near 0 degrees Fahrenheit, rather than the 20th century average of 57.1 degrees F.

However, human activities such as burning fossil fuels, clearing forests, and raising livestock have increased the amount of GHGs in the atmosphere over the last 100 years. This is disturbing the optimum levels of GHGs, amounting to increased heating. As the emissions increase, more heat is trapped, leading to numerous changes in Earth's natural processes.

For over 800,000 years the atmospheric concentration of carbon dioxide has fluctuated but has not exceeded 300 parts per million (ppm). Currently, the levels hover above 400 ppm.
The dramatic increase in GHGs in the atmosphere has already led to a 1.5°F (0.85°C) increase in global average surface temperature from 1880 to 2015.

[2] https://www.nasa.gov/press-release/nasa-noaa-data-show-2016-warmest-year-on-record-globally


Latest CO_2 reading
July 24, 2016
403.56 ppm
Ice–core data before 1958. Mauna Loa data after 1958.
CO_2 Concentration (ppm)
Thousands of Years Ago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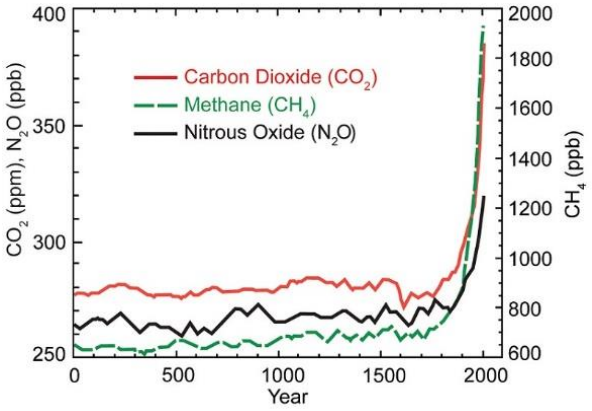
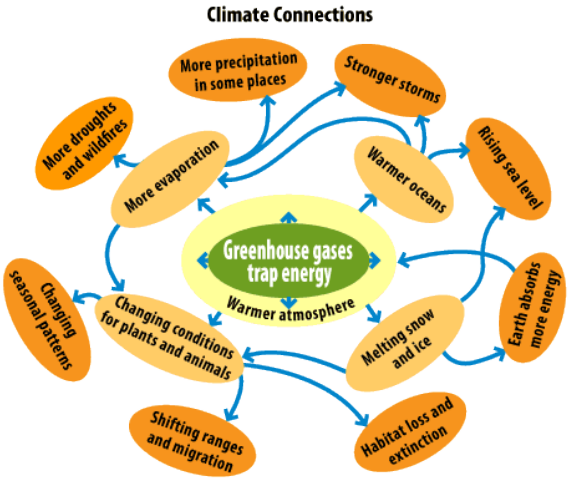

Carbon Dioxide (CO_2)
Methane (CH_4)
Nitrous Oxide (N_2O)
CO_2 (ppm), N_2O (ppb)
CH_4 (ppb)
Year

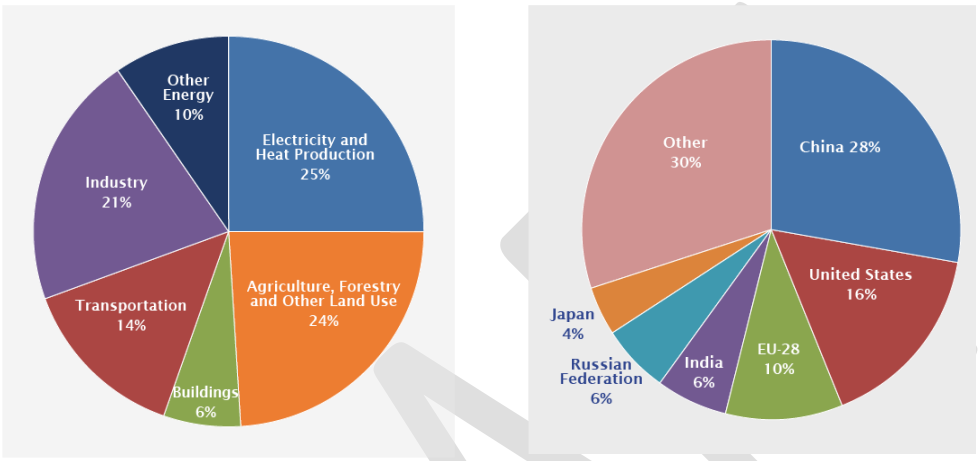
Climate Change Consequences

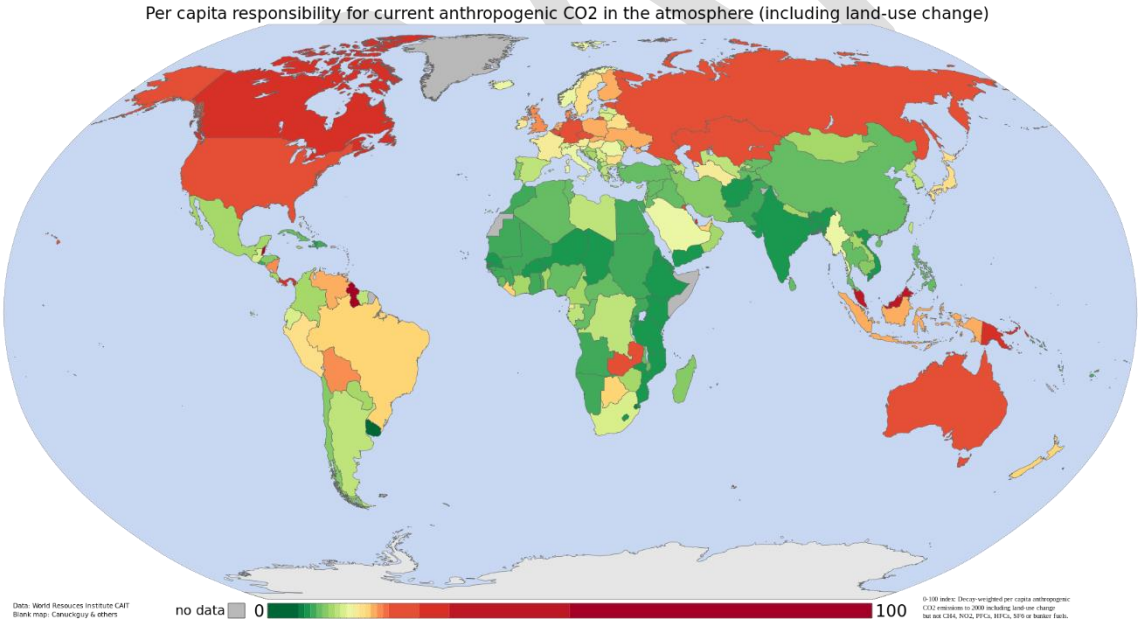


Earth is a resilient planet with many complex interconnected systems that work to keep the planet in balance. However, global warming has already changed climates by altering evaporation and precipitation patterns, melting snow and ice and warming the ocean. This has caused heat waves, droughts, extreme storms, wildfires, hurricanes and tornadoes of varying severity across several regions of the world. If carbon emitting activities continue at the same rate, the planet could see an 8.1°F (4.5°C) increase over preindustrial temperatures by 2100. This could result in the extinction of 16% of the species on Earth.

Global Sources of Emissions

The majority of human-caused GHG emissions are due to burning fossil fuels like coal, natural gas, gasoline and diesel for electricity, heat and transportation. However, it is important to recognize that almost 24% of global emissions are due to deforestation, industrial agriculture and the impact of other land uses. China, the United States, the European Union, Russia and Japan are responsible for 70% of the world's GHG emissions. Developed nations with relatively small populations are disproportionately responsible for climate change, largely driven by resource intensive lifestyles.





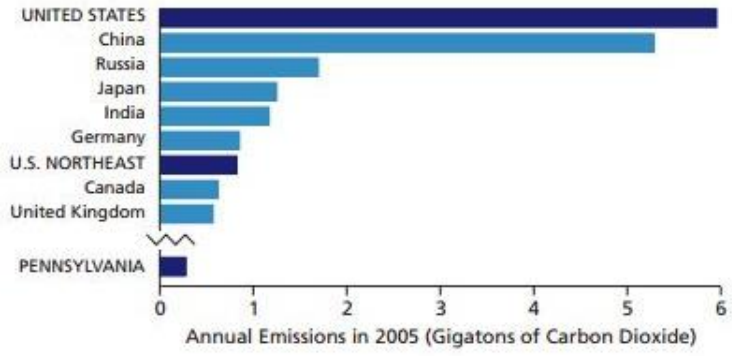
The Paris Agreement

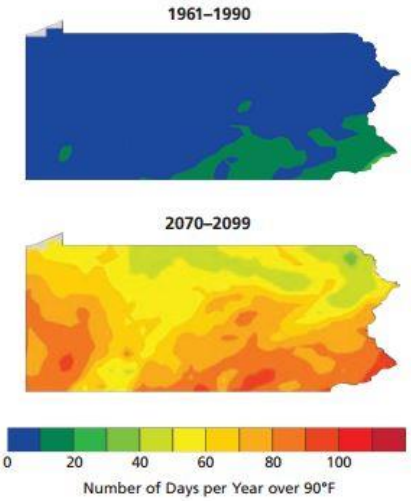
In December 2015, global leaders from 195 countries met in France for the 21st Conference of Parties (COP 21) of the United Nations Framework Convention on Climate Change (UNFCCC). The mission of COP21 was to "achieve a legally binding and universal agreement on climate, with the aim of keeping global warming below 2°C." Prior to the conference, 185 countries submitted an Intended Nationally Determined Contributions (INDC) that outlined their strategies and goals for reducing their carbon emissions as a basis for negotiation. However, these INDCs put the world on track for 2.7 to 3.7°C increase, surpassing the COP21 2°C goal. Meanwhile, leading climate scientist James Hansen published a paper outlining the dangers of feedback loops caused at 2°C. Vulnerable countries, such as low-lying island nations- the Maldives, the Marshall Islands and the Seychelles, have long called for a 1.5°C ceiling.

On December 12, 2015, the Paris Agreement was adopted by consensus, and the treaty has been signed by 179 parties and ratified by 20. Article 2.1 says parties agree to "Hold[ing] the increase in the global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change." However, even if all emissions ceased tomorrow, GHGs already in the atmosphere would still trigger an additional 0.6°C rise above the current 0.85°C, causing a 1.45°C increase overall. Therefore, immediate action is needed to minimize emissions as soon as possible, and also sequester atmospheric carbon in large quantities.

Climate change in Pennsylvania

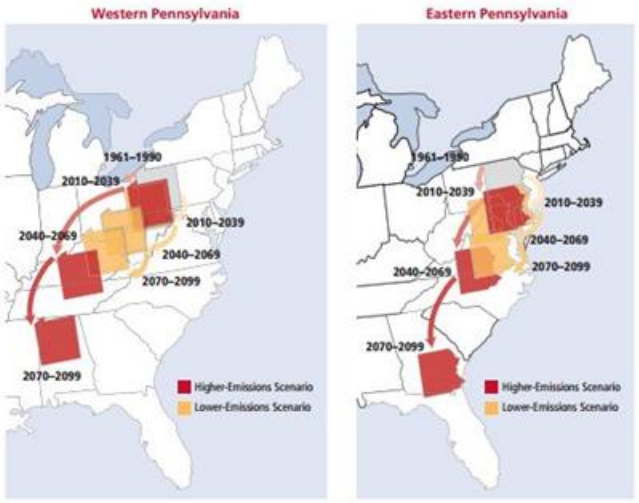
Pennsylvania's emissions are high enough to compare with some of the largest nations in the world. The Energy Information Administration (EIA) conducted a study in 2005 and found that, when compared globally, Pennsylvania's emissions were high enough to rank as world's twenty-second largest emitter of CO_2. For comparison, Pennsylvania's emissions are higher than those of the states of New York and Wyoming combined, and the per capita emissions are more than double those of New York State.





Statewide, Pennsylvania is projected to experience dramatic increases in the number of extremely hot days over the coming century, especially under the higher-emissions scenario. The greatest warming will be in the southwest and southeast regions, where daytime temperatures by late century (2070–2099) could hover over 90°F for nearly the entire summer.

In addition to being a significant contributor to climate change, Pennsylvania is also projected to see significant impacts as a result of climate change. By the end of the century, Pennsylvania is projected to experience a dramatic increase in the number of extremely hot days. The regions to experience the greatest warming will be in the southwest and southeast.

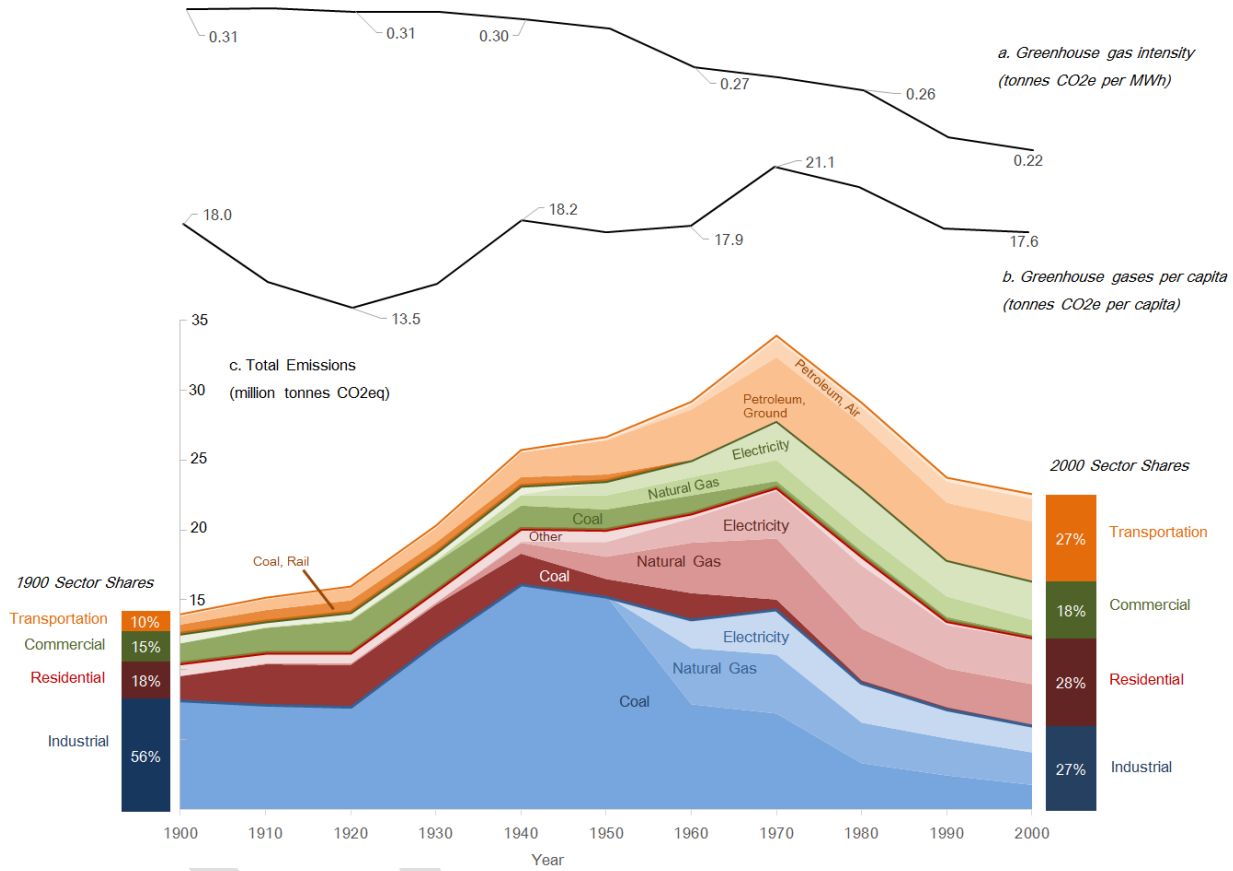


Migrating Climates

Changes in average summer "heat index"—a measure of how hot it actually feels with a given combination of temperature and humidity—could strongly affect quality of life for residents of Pennsylvania in the future. Red arrows track what summers could feel like over the course of the century in western and eastern Pennsylvania under the higher-emissions scenario. Yellow arrows track what the summers could feel like under the lower-emissions scenario.

Pittsburgh: Carbon Legacy to Climate Leadership

Pittsburgh first rose to prominence through fossil fuel extraction and carbon-intensive industries, and thus developed its legacy as the ‘Steel City’. Coal was mined from Pittsburgh’s hillsides, and then burned to forge steel. For several decades, the city was polluted with smoke and particulate matter that choked out the sky and required streetlights to be lit during the day. Along with being the “City that Built America” Pittsburgh earned the nickname “Hell with the Lid Off” due to the extreme air pollution created by the steel industry.



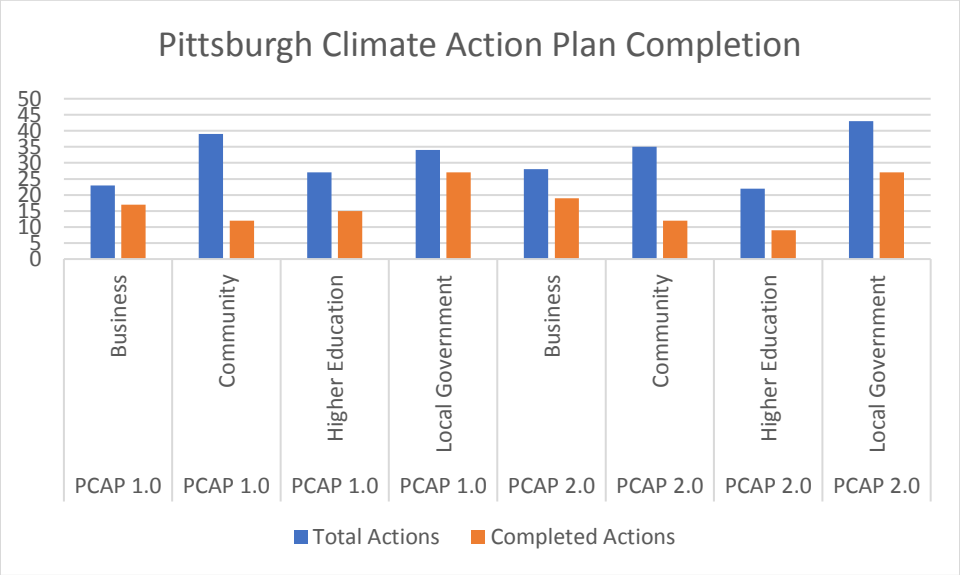
The above diagram for Allegheny County shows the decline of industry, the rise of natural gas and electricity use over coal, and the expansion of on-road transportation and fuel usage over the 20th century. The precipitous decline in emissions starting in the 1970s aligns with the economic collapse that caused the loss of 50% of manufacturing and 30% of population in the region. Per capita GHG emissions hit a peak of 21.1 metric tons per Allegheny County resident per year in 1970, declining to 17.6 MT in 2000. The 2013 Pittsburgh GHG inventory estimated 15.9 MT per city resident for the year.*

Pittsburgh has made great improvements in air quality since the height of the steel industry, including enacting the nation’s first Clean Air Act. However, the American Lung Association still ranks Pittsburgh the eighth worst of more than 200 metropolitan areas in the nation for long-term (annual) soot pollution; the 14th worst for short-term or daily soot pollution, and the 29th worst for ozone, the main precursor for unhealthy smog. Air quality has significant health implications in our region. A recent study, conducted by Dr. Deborah Gentile of the Pediatric Alliance, showed that while the national average for pediatric asthma is about 8%, nearly 23%

of children in the Pittsburgh region have been diagnosed with asthma. In Southwestern Pennsylvania, there is an estimated 1500 additional deaths each year that can be attributed to air poor quality. As Pittsburgh strives to reduce GHG emissions, there is also a focus on improved air quality and related human health benefits.

Pittsburgh Climate Action Plans

PCAP 3.0 builds upon the actions and lessons learned from PCAP 1.0 and 2.0.The first two climate action plans were organized by four sectors: Business, Community, Higher Education and Local Government. Within each sector, actions targeted energy, transportation, waste management as well as education, advocacy and coordination. Most actions were framed as suggestions without a clear measure of success, making it difficult to gauge completion. However, PCAP 1.0 & 2.0 set in motion several important measures.



The first two climate action plans laid the groundwork and supported successful programs like the Green Workplace Challenge and the Pittsburgh 2030 District, which encouraged sustainable practices and energy and water conservation in local businesses. From 2011-2015 over 100 groups have completed 5,787 actions in the Green Workplace Challenge and prevented 23,283 metric tons of CO2e.

The 103 Property Partners managing over 78.7 million square feet across 491 commercial buildings in the Pittsburgh 2030 District have reduced energy use by 10.7%, water use by 7.4%, and carbon emissions from transportation by 24.2% below baselines. The 2016 energy use reduction of 982 million kBtu is equivalent to 113,540 metric tons of CO2e.

The Higher Education Climate Consortium has collectively achieved a 20% reduction in carbon emissions since 2003.

PCAP 1.0 led to the creation of the position of Sustainability Coordinator at the City of Pittsburgh, which has since evolved into the Office of Sustainability and Resilience with four full time staff. PCAP 2.0 created sustainability coordinator positions at Pittsburgh Water and Sewer Authority (PWSA) and the Urban Redevelopment Authority (URA) of Pittsburgh. These are in addition to the sustainability coordinator at the Pittsburgh Sports & Exhibition Authority (SEA).

Many of the successful actions from PCAP 1.0 and 2.0 were energy conservation actions in the business, higher education and local government sector, where organizations and key stakeholders made a commitment to the goals and invested in programs. The Community sector suffered from a lack of clear direction, leadership and participation.

Building on information from PCAP 1.0 and 2.0, PCAP 3.0 is structured according to emission sources, with a focus on instrumental, measurable actions with assigned stakeholders. Action plans are broken into six categories or chapters;

1) Energy Generation and Distribution
2) Buildings and End Use Efficiency
3) Transportation and Land Use
4) Waste and Resource Reduction
5) Food and Agriculture
6) Urban Ecosystems

The PCAP 3.0 aims to lay out the pathways and strategies for achieving the Pittsburgh 2030 goals and created the framework for making progress towards long term emission reduction goals.

Pittsburgh Greenhouse gas emission reduction goals (Based on a 2003 Baseline)

- 20% GHG Reduction by 2023
- 50% GHG Reduction by 2030
- 80% GHG Reduction by 2050

Pittsburgh 2030 Goals

Internal City Operations:

1) 100% renewable energy use
2) 100% fossil fuel free fleet
3) Divestment from fossil fuels

City of Pittsburgh:

1) 50% energy use reduction
2) 50% energy use reduction
3) 50% transportation emission reduction
4) Zero Waste- 100% diversion from landfills

Climate Action Plan at a Glance resources

Chapter	Goal	Objective
Measurement		
	Measure Pittsburgh's climate and ecological impact and report annually	
Built Environment		
	Reduce emissions from the built environment by 50%	
Buildings		
		Reduce energy and water use in existing buildings by 50%
		Achieve carbon neutrality and location efficiency in all new construction by 2030
Energy & Utilities		
		Reduce natural gas fugitive emissions by 50%
		Reduce electricity conversion and line loss by 50%
		Reduce potable water loss by 50%
		Reduce wastewater volume by 50%
		Install 200MW of renewable energy in Pittsburgh by 2030
		Achieve 25% of Pittsburgh customers on 100% renewable by 2030
Transportation & Mobile Sources		
	Reduce on road transportation emission by 50%	
		Reduce vehicle miles traveled by 50%
		No net increase in vehicle ownership
		Increase pedestrian commute trips by 50% by 2030
		Increase bicycle commute trips by 50% by 2030
		Increase transit commute trips by 100% by 2030
		Decrease drive alone commute trips by 50% by 2030
		Shift 25% of fleet vehicles to electric by 2030
		Convert Port Authority buses to 100% electric by 2030
		City of Pittsburgh - 100% fossil fuel free by 2030
		Reduce freight emissions by 25% by 2030
Consumption & Resource Recovery		
	Eliminate landfill emissions by 2030	
		Reduce consumption by 25% by 2030
		Reduce landfill waste by 90% by 2030
		Increase reuse by 100% by 2030
		Increase recycling by 200% by 2030

	Divert 90% of organic waste by 2030
	Divert 90% of privately collected waste by 2030
Food & Agriculture	
Reduce food and agriculture emissions by 50% below baseline by 2030	
	Reduce meat consumption by 50% by 2030
	Increase local food production by 200% by 2030
	Reduce food waste by 90% by 2030
	Increase local composting by 200% by 2030
Urban Forest, Natural Systems & Carbon Sequestration	
Increase sequestration by 100% by 2030	
	Increase Urban Forest Canopy to 60% by 2030
	Protect 200% more open space by 2030
	Restore 50% of Pittsburgh's damaged soil by 2030
	Implement technological solutions to sequester carbon by 2020

CHAPTER ONE: Green House Gas Inventory
Measuring Pittsburgh's Impact

Goal: Measure Pittsburgh's climate and ecological impact and report annually

Scope	Definition
Scope 1	GHG emissions from sources located within the city boundary
Scope 2	GHG emissions occurring as a consequence of the use of grid-supplied electricity, heat, steam and/or cooling within the city boundary
Scope 3	All other GHG emissions that occur outside the city boundary as a result of activities taking place within the city boundary

In order to manage climate change a Green House Gas Inventory is needed. The Green House Gas Inventory quantifies emissions and analyzes the sources. This data informs mitigation strategies and help track progress towards reduction goals. A greenhouse gas inventory, using 2013 data was compiled and used to inform the Climate Action Plan 3.0.

Sector Based Inventory
GHG inventory protocols tend to focus on scope 1 and scope 2 emissions, as defined in Table 1, while scope 3 is more difficult to quantify. Scope 1 emissions come from sources within the city limits, which include natural gas, gasoline and diesel. Scope 2 emissions occur as a consequence of electricity demand within city limits, where the fossil fuels are burned outside of the city limits but the consumption is within the city. Scope 3 emissions are other emissions associated with activities that occur within city limits. For example, Pittsburgh residents generate waste, but that waste is hauled to landfills outside of the city. The methane from that waste is therefore part of Pittsburgh scope 3 emissions.

In the 2013 GHG Inventory, included as an appendix to this Climate Action Plan, emissions are categorized by sources and activities in each sector: Residential, Commercial, Industrial, Transportation and Waste.

Several cities are adjusting inventory protocols to account for more scope 3 emissions, such as the carbon and ecological footprints associated with the consumption of products and services within city limits. Pittsburgh also plans to take steps to further understand and track its Scope 3 emissions for the future exercises in GHG inventory management.

Greenhouse Gas Emission Calculations

Greenhouse gas emissions are expressed in *carbon dioxide equivalent* (CO_2e) according to each gas's *global warming potential* (GWP) which represents the amount of heat the same mass of carbon dioxide will retain over an 100 year period.

Greenhouse Gas	Global Warming Potential
CO2 (Carbon Dioxide)	1
CH4 (Methane)	28
N20 (Nitrous Oxide)	265

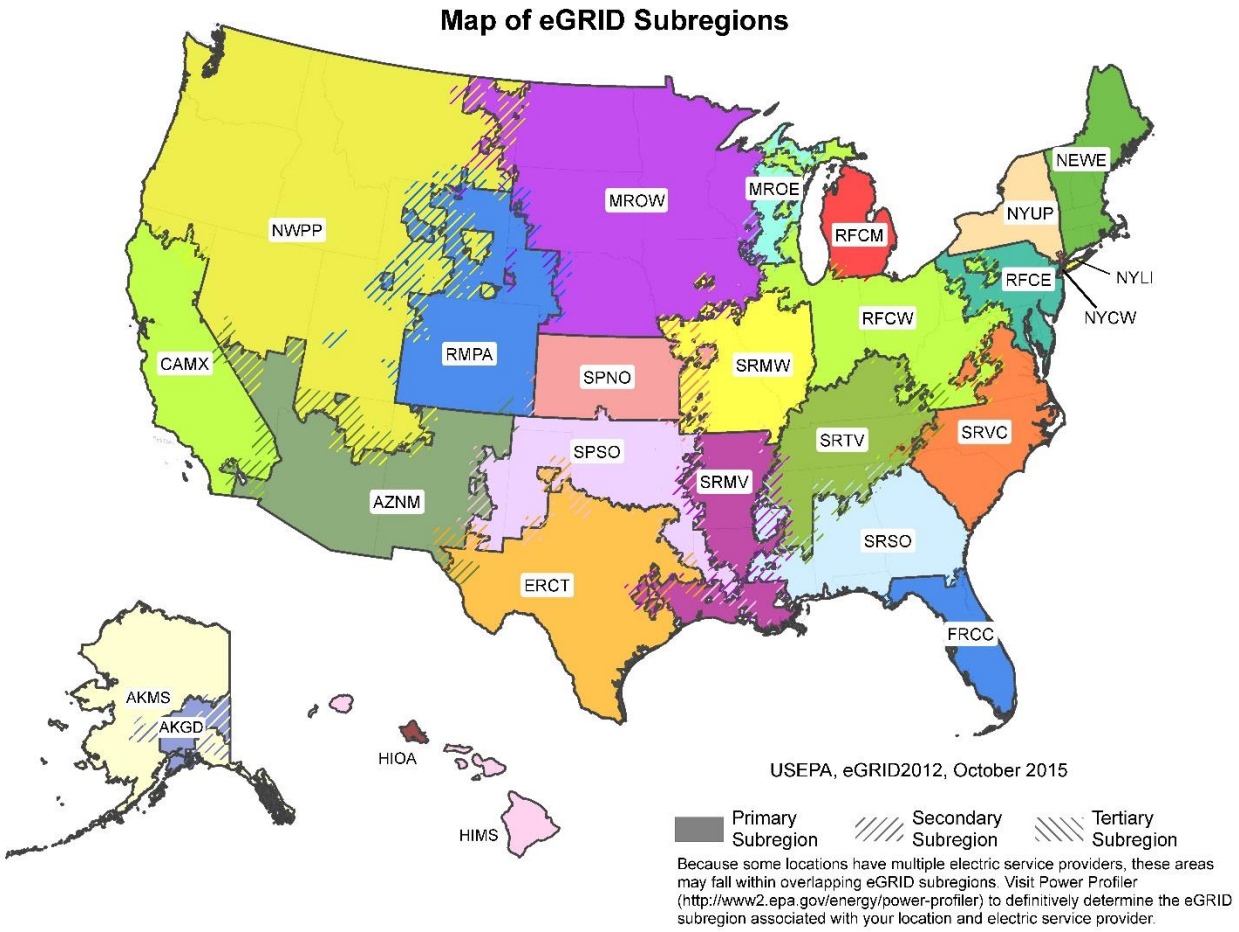
As noted above, methane is 28 times more potent than carbon dioxide and retains proportionally more heat in the atmosphere. The mass of each gas emitted is multiplied by its global warming potential to calculate its carbon dioxide equivalent, which are then summed.

Greenhouse gas emissions are calculated using *emission factors* for each fuel that show how much carbon dioxide, nitrous oxide and methane are released per unit of fuel burned.

For example, burning one MMBtu of natural gas releases the following quantities of GHGs:

Greenhouse Gas	Emissions per MMBtu Natural Gas
CO2	53.02 kg
CH4	5g
N20	0.1g
CO2e	53.187 kg

The emissions factor for electricity is more complicated, because electricity is generated by a variety of different methods and fuels. The recommended method to estimate greenhouse gas emissions from electricity use is to use the EPA eGRID emission factor, which assess all electricity generation within a geographic area.

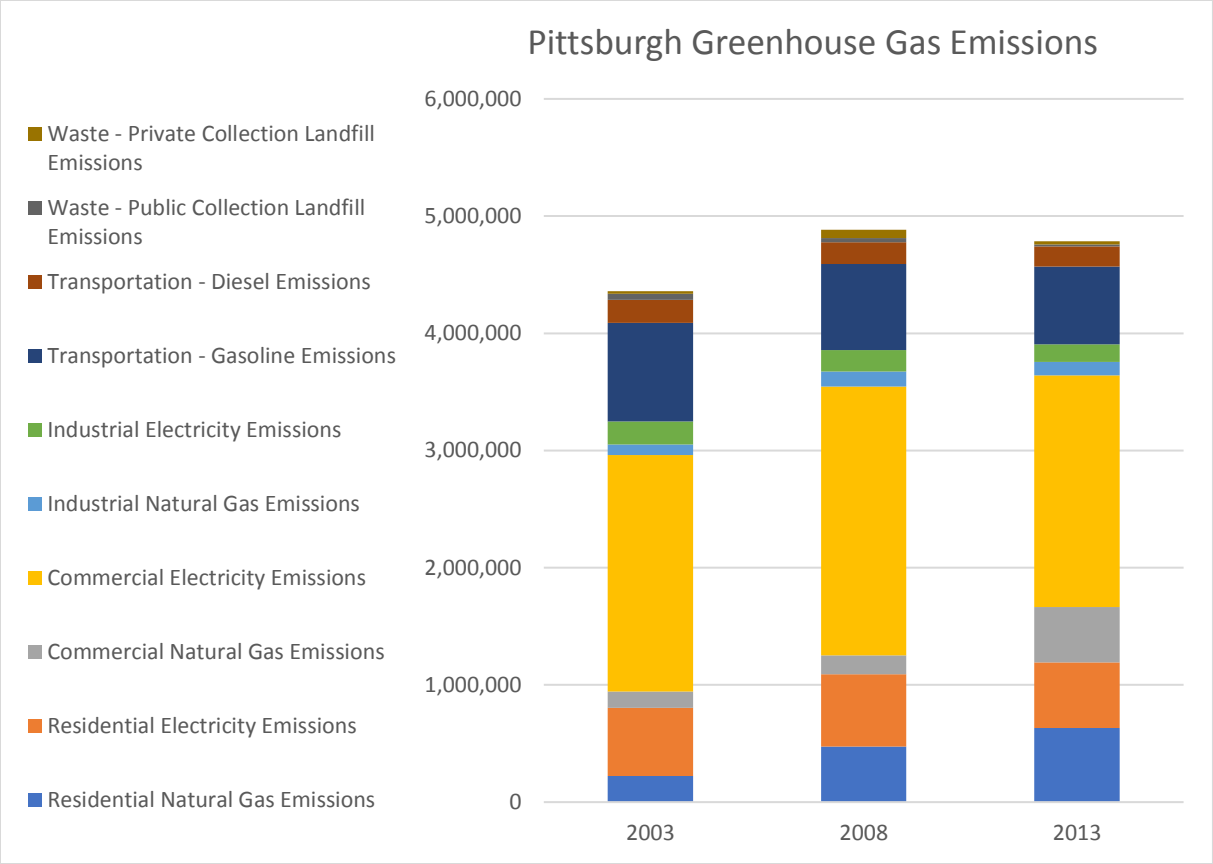


Pittsburgh is located in RFC-W, which also includes electricity generation in Ohio, Illinois and Michigan.

Inventory Year	2003	2008	2013
EPA eGRID Year	2004	2007	2012
CO2 lbs/MWh	1556.39	1151.52	1379.48
CH4 lbs/GWh	20	18.37	17.11
N2O lbs/GWh	24	25.93	21.67
CO2e MT/MWh	0.70911	0.70711	0.62854

Emissions from natural gas are proportional to consumption over time, but electricity has become less carbon intensive since 2004 as more coal fired power plants are replaced by natural gas generation, as a result of which RFC-W has become cleaner over time.

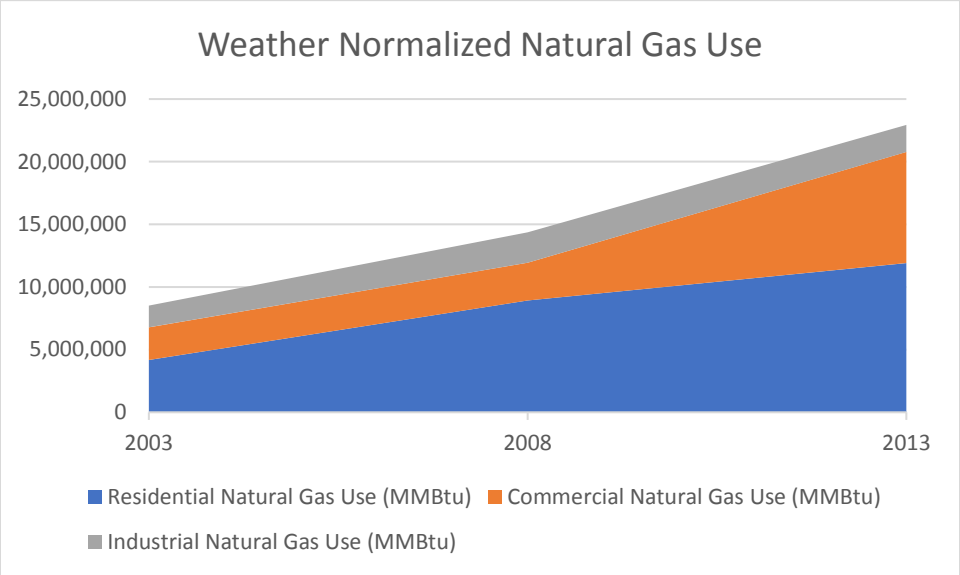
Similarly, as vehicle fuel efficiency improves and engines become cleaner, the emissions per vehicle mile traveled decrease.



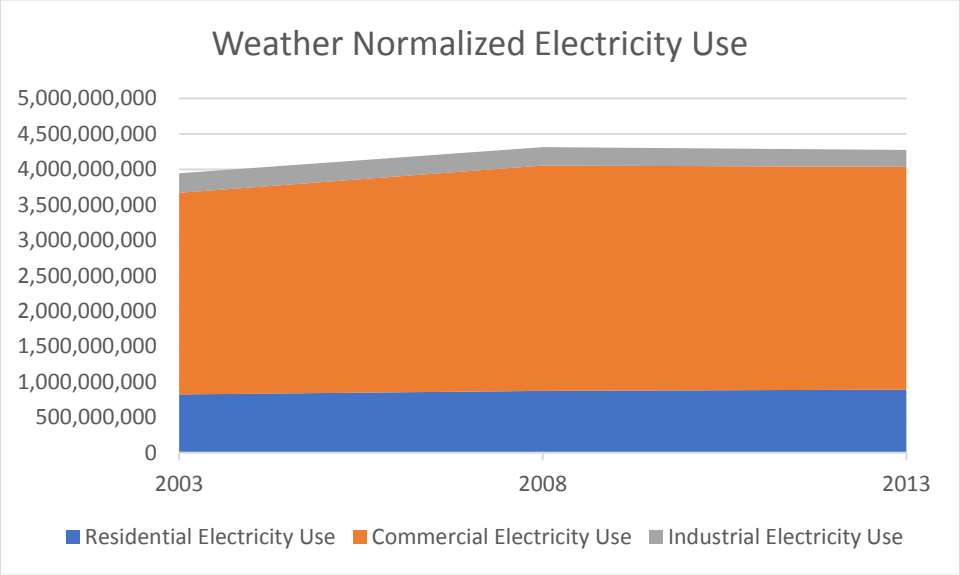
In terms of annual emissions, Pittsburgh saw a 12% increase in emissions from 2003 to 2008, but a decrease of 2% from 2008 to 2013.It is difficult to draw conclusions from Pittsburgh's existing greenhouse gas inventories due to different methods and scopes of consumption data. However, it is clear that Pittsburgh needs to take more ambitious action along with yearly GHG tracking in order to ensure that we are on track for our 2030 goals.

Pittsburgh Sector Based Inventory

Trends in Emission Sources and Activities



Natural gas use in 2003 and 2008 was estimated using assumptions about consumption by sector, whereas natural gas use in 2013 was more accurately provided by zip code, with a sharp increase in use as seen in the graph above. There has not been enough growth in population or buildings to justify a threefold increase in natural gas use, and anecdotal evidence from natural gas providers discredits the reported increase in natural gas use. Issues with data inconsistency undermine the ability to compare the 2003 inventory to 2008 and 2013, even while controlling for external factors such as weather.



In contrast to the natural gas data, electricity consumption provided by Duquesne Light has been fairly consistent, indicating that Pittsburgh needs to undertake much more ambitious energy efficiency measures.

CHAPTER TWO: Energy Generation and Distribution

Goal: 100% Renewable Energy

Energy & Utility Systems Actions: Data

Description	Lead Agency (Partners)
Get reasonable estimates for annual methane leakage volume	Peoples, Columbia
Get reasonable estimates for annual transmission loss for local grid	Duquesne Light
Get annual volume of treated water and non-revenue water for potable water system	PWSA, PA American Water
Get annual volume of wastewater treated, with estimates to indicate percentage of groundwater and stormwater treated	ALCOSAN

Objective #1: Create a 21st Century energy system and support the utilities of the future

Energy & Utility Systems Actions

Description	Lead Agency (Partners)
Achieve Revenue from Volume Decoupling in PA	City of Pittsburgh, Duquesne Light, PA PUC
District Energy Pittsburgh - Develop Pittsburgh Energy Plan	City of Pittsburgh, DOE, University of Pittsburgh Center for Energy

Objective #2: Reduce natural gas fugitive emissions by 50% below 2013 levels by 2030

Natural Gas Actions

Description	Lead Agency (Partners)
Long Term Infrastructure Improvement Plan - replace 3,000 miles of uncoated pipe with plastic pipe to reduce leaks, on both Peoples lines and customer lines $70m/year in Pittsburgh	Peoples Natural Gas
Leak Detection - both walking lines and using sensors on vehicles	Peoples Natural Gas, CMU
Infrastructure replacement projects in Pittsburgh - $1.2 million in Arlington	Columbia Gas

Objective #3: Reduce line loss from electricity by 50% by 2030

Electricity Actions

Description	Lead Agency (Partners)
Electric Grid Optimization - $100m to upgrade grid infrastructure and install smart meters for all customers for the next 5 years	Duquesne Light
Woods Run Microgrid Pilot - install a microgrid at training facility	Duquesne Light

Objective #4: Reduce sewer volume by 50% below 2013 levels by 2030

Sewer Volume Reduction Actions

Description	Lead Agency (Partners)
Pass local graywater and rainwater use legislation to facilitate irrigation/toilet flushing with graywater and rainwater	City of Pittsburgh, ACHD
Finalize Expansion Plan and repair trunk lines to reduce groundwater infiltration and replace pumps with newer energy efficient equipment	ALCOSAN
Implement a stormwater fee to improve green infrastructure and prevent stormwater from entering the combined sewer	City of Pittsburgh/PWSA

Objective #5: Improve the efficiency and effectiveness of public street lighting and traffic signals

Public Lighting Actions

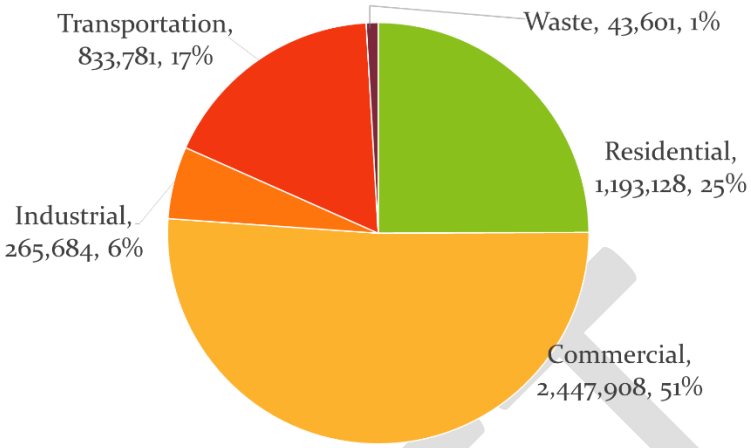
Description	Lead Agency (Partners)
LED Streetlights - need to ensure public health benefits and energy saving	City of Pittsburgh, CMU
SurTrac - synchronize traffic signals to ensure smooth traffic movement, bus prioritization, after hours freight prioritization, etc	City of Pittsburgh, CMU

Objective #6: Install 200MW of renewable energy in Pittsburgh by 2030 and convert 25% of Pittsburgh customers to local renewable energy

Local Renewable Energy Actions

Description	Lead Agency (Partners)
Renewable Resource Authority to enable community choice aggregation & power purchase agreements	City of Pittsburgh
Support Duquesne Light with PUC to install local renewables to meet AEPS standards for POLR customers	City of Pittsburgh, Duquesne Light

Greenhouse Gas Emissions from Electricity



Emissions from the built environment dominate Pittsburgh's emission with 99% of emissions coming from energy use. Pittsburgh is served by Duquesne Light Company (DLC), which is an investor-owned electricity distribution company. Duquesne Light does not generate electricity, and Pittsburgh does not have a municipal utility. Within the Duquesne Light service territory, nearly 70% of electrical generation is nuclear or hydroelectric, but given greenhouse gas inventory protocols, Pittsburgh has to calculate its emissions from electricity using the EPA eGRID emission factors for RFC-West (RFC-W), which includes coal generation in West Virginia, Ohio and Indiana.

Generators within the Duquesne Light Company Service Territory

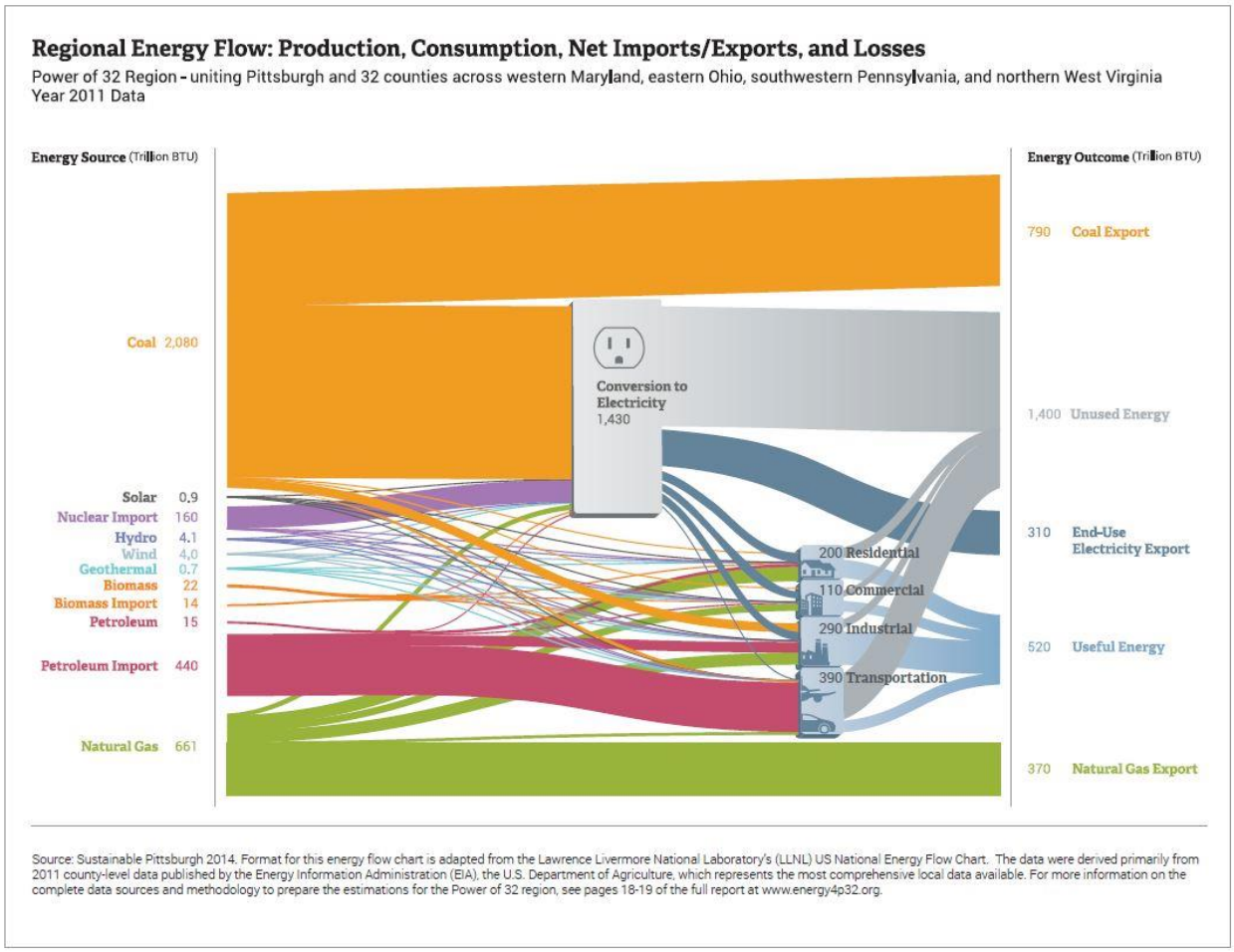
Generator	GenerationType	Output (MW)	Percent (%)
Beaver Valley	Nuclear	1831	69.46
Brunot Island	Natural Gas (Peaker)	220	8.34
Cheswick	Coal	578	21.93
Patterson	Hydroelectric	2	0.27
Townsend	Hydroelectric	5	
	Total MW	2636	

EPA eGRID Emission Factors Year 2004 and Year 2012 Comparison

	EPA eGRID Y2004 RFC-W	EPA eGRID Y2012 RFC-W
CO2 lbs/MWh	1556.39	1379.48
CH4 lbs/GWh	20	17.11
N2O lbs/GWh	24	21.67

The grid has gotten cleaner over the years, which has reduced overall electricity emissions. The eGRID emission methodology does not allow for nuances such as emissions from peak electricity loads or customers who purchase renewable energy certificates. Ideally, it would be possible to track electricity emissions based on time-of-use and the generation sources chosen by the utility to meet demand. This would help identify opportunities to level out demand and avoid firing natural gas at “peakers” which are generators that turn on when the grid needs additional supply. It would also be helpful to consider the amount of power that is available at night, which generators are creating that power, and to project the impact of overnight electric vehicle charging. Currently, we assume that generation at night is largely produced from coal-fired power plants, and the stimulus to bring on additional generation is unknown. It would be helpful to know at what time the DLC service territory is a net exporter or net importer of energy, and where that energy is flowing.

Greenhouse Gas Emissions from Transmission Loss & Inefficiency



Significant amounts of energy are wasted due to inefficiencies in production and delivery. As shown in the Sanki Diagram, nearly 63% of the energy in the Power of 32 Region (32 counties in southwestern Pennsylvania, eastern Ohio, western Maryland and northern West Virginia) is wasted. This is largely due to waste heat in the energy generation process, especially in the conversion of coal to electricity. Duquesne Light is part of the Eastern Grid, where an estimated 9.17% of electricity is lost in transmission. At peak load times, the amount of electricity lost as heat can be 50% higher. Energy that is exported out of the region and the use of petroleum for transportation also contribute to energy waste.

Due to a lack of data, Pittsburgh's previous inventories have not been able to account for the emissions related to natural gas leaks, electricity transmission loss, and energy that is lost while being used to treat water. However, recent studies show that transmission loss accounts for about 9% of the region's energy consumption. For each kilowatt hour used in Pittsburgh, 0.0582 kWh is lost in transmission due to inefficiencies in the RFC-W grid. These transmission loss emissions comprise 3% of Pittsburgh's community emission profile. The electricity grid is not the only source of line loss. From July 2015 to June 2016, Peoples Natural Gas repaired 1035 leaks.

Methane Mapping Project

One essential first step in reducing energy emissions is to reduce wasted energy. This can be done by reducing line loss and improving existing grid infrastructure. People's Gas worked with Google Earth Outreach, Carnegie Mellon University, and the Environmental Defense Fund to improve the tracking of methane leaks across People's infrastructure. Google Map vehicles equipped with sensors that could more effectively and efficiently detect methane leaks created a map of leaks throughout the City. Nearly 50% of the pipes in Pittsburgh are more than 50 years old and many are constructed of materials that are prone to cracking. There were 201 leaks identified during the study period, many in older pipes. These leaks do not typically have immediate risk implications but they can have a serious impact on climate. Since it has a warming potential more than 80 times greater than Carbon Dioxide, reducing the natural gas leaking from these pipes can create major greenhouse gas reductions. Any gas that escapes in transmission is also lost revenue, so reducing leaks also reduces profit loss.

The methane mapping pilot was one step in a larger, 20-year pipeline replacement plan. Over the next 20 years People's will invest $100 million a year in infrastructure upgrades with 60% of that capital being focused within the City of Pittsburgh. Throughout this process, People's is also working with Carnegie Mellon University to create a risk ranking of pipe infrastructure. These rankings take into account pipe age, material, and leak history in order to prioritize areas for upgrades.

Pittsburgh Decarbonization and Electrification Strategy

Pittsburgh needs a four-pronged strategy that (1) reduces demand for energy, (2) creates efficient district energy systems, (3) installs local renewable energy generation systems, and (4) converts systems from combustion to electrification.

District Energy

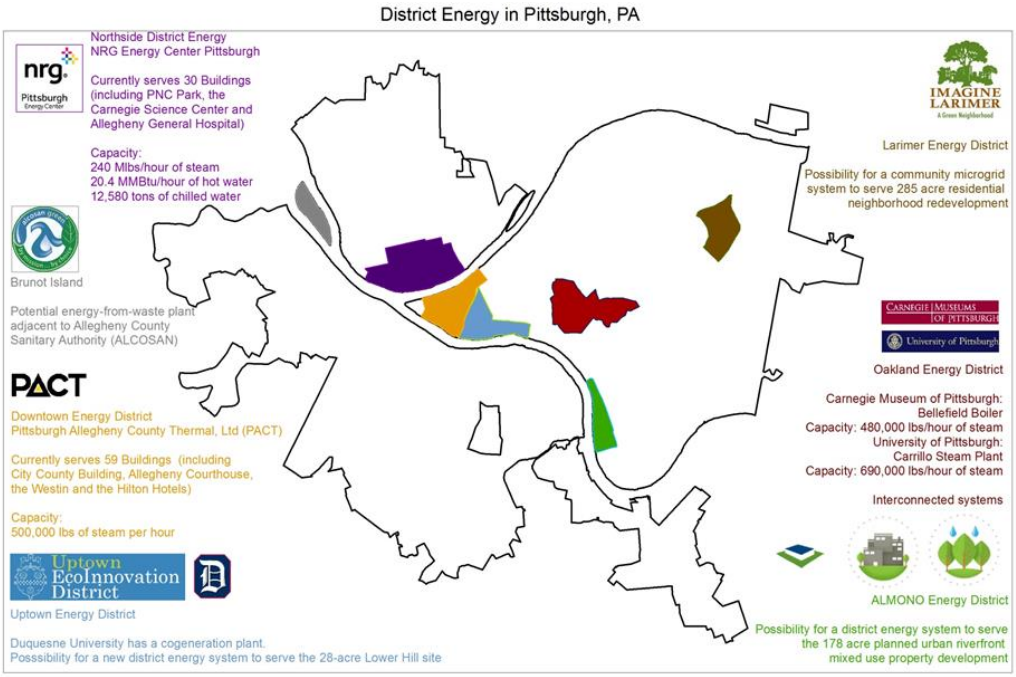
Municipalities across the nation face issues with deteriorating energy infrastructure. It has been shown that up to 60 percent of the energy that moves along aging gas and electric lines can be lost during transmission.[1] The City of Pittsburgh, in partnership with the Department of Energy, the National Energy Technology Lab, Duquesne Light, and the University of Pittsburgh Center for Energy, is currently developing a 21st century energy infrastructure plan to address these issues. The plan calls for the expansion and optimization of district scale energy systems, such as microgrids, thermal loops, combined heat and power systems and other innovative technologies.

Most cities rely on energy provided by power plants far outside of the city boundaries. A district energy system allows a city to develop energy infrastructure on a smaller scale to optimize delivery, create resiliency in the grid system and minimize energy disruption. District scale systems also deliver cleaner and more efficient energy to customers while promoting economic development. A district energy system can provide local, reliable and affordable energy for

urban communities, while also providing economical solutions for commercial and industrial consumers and lowering greenhouse gas (GHG) emissions.
A microgrid is, in many ways, a smaller version of a traditional power grid. It is a discrete energy system with clearly defined electrical boundaries consisting of components for power generation, distribution and demand management. A microgrid can act in parallel with, or independent from, the main power grid. However, microgrids provide a much closer proximity between power generation and usage, resulting in increased efficiency. Microgrids can also take advantage of renewable energy sources such as solar and wind power, geothermal and combined heat and power systems as well as other innovative energy production systems.

District energy resources (DER) are smaller than utility-scale generating systems and are located closer to the customers that they serve. Due to this proximity, there is a reduction in thermal line-losses associated with transmitting electricity over long distances from centralized power plants. The electrical resistance of transmission and distribution lines results in energy being “lost” to heat. These thermal line losses increase as demand on the electrical grid increase. At peak times, line losses are approximately 50% higher, and can approach 8-10% of the power sent through the lines. Locally-sited district energy resources would reduce the need for long-distance transmission and distribution of electricity, Duquesne Light believes that the deployment of microgrids and their associated DER has the ability to significantly reduce the line-losses for electricity generated by DER. If line-losses were reduced by the 8-10% mentioned above, then 8-10% less electricity would need to be generated in order to provide end-users with electricity. Assuming that this 8-10% of electricity was being generated by fossil-fuel power plants, district energy resources have the potential to reduce greenhouse gas emissions. In addition, during peak usage or at times of primary power grid failure, a microgrid can operate independently of the larger grid. If problems arise within the microgrid, it can isolate itself without affecting the larger grid's integrity. Microgrids are also capable of supplying power back to the larger grid during times of grid failure or power outages.

The electrical grid uses AC (alternating current) because large power plants create AC power and transformers need AC power to step up the voltage to send electricity long distances with lower transmission loss. Direct current is not ideal for long transmission but works well for local energy networks, and eliminates the need to convert grid AC power to DC in order to power LED lights, electronics, data and telecommunications. The grid was built in an era of fossil fuel expansion, where having a coal-fired generator on every block was not a desirable situation. However, solar and wind power can be integrated into the fabric of the city with enough regularity to feed a DC grid, and renewable sources already generate DC power. For this reason, District Energy Pittsburgh has proposed two DC microgrids powered by solar photovoltaic electricity; one at the Duquesne Light training facility and one at the Second Avenue parking lot.



Designing systems around the specific energy needs of a neighborhood will allow developers to create systems that take advantage of local resources, infrastructure, and other regional features. While these systems may require more up-front engineering, they can be highly efficient and more cost effective than traditional, off-the-shelf technologies. Pittsburgh already has two steam districts in the downtown triangle, two interconnected university steam systems, and a university cogeneration plant. These systems are all evaluating opportunities for increased efficiency; several opportunities for new district energy systems have been identified.

District-scale energy systems also have a number of notable benefits when compared to the development of multiple stand-alone systems in individual buildings or businesses. A broader customer base will allow for higher utilization rates as well as a broader range of systems available for development. A single point of maintenance (compared to having to go into each commercial and residential building served by the system) will streamline upkeep and repairs, requiring only one system to be monitored for optimal operation. Economies of scale and reduced overhead will decrease the cost of potential upgrades and expansion of a single system compared to many separate systems deployed in different buildings. An example of this is Duquesne University, which has continued to upgrade its combined heat and power (CHP) system, integrating cooling systems and thermal storage. District energy systems within the City of Pittsburgh can provide secure, reliable energy with higher efficiency, lower carbon emissions, and lower capital and operating costs. They will enhance the integration of distributed and renewable energy sources and enable integration of smart grid technology. District energy systems will minimize the City's carbon footprint and greenhouse gas emissions by maximizing clean, locally controlled energy generation.

Pittsburgh is at the leading edge of a global model for the development of municipal energy production to provide area communities and businesses with clean, affordable, efficient energy.

The successful design and deployment of energy districts will enable these systems to be replicated throughout the region. Pittsburgh can become a center for innovation, not just in energy district design, but also in the advanced energy technologies that will sustain those districts.

EcoInnovation District:

The EcoInnovation District is a unique initiative that was developed to address many of the typical challenges faced across Pittsburgh's neighborhoods. It is a plan that combines the goals of EcoDistricts, dedicated to equity and environmental resiliency, with the goals of Innovation Districts that focus on job growth through the establishment of new and innovative businesses. The EcoInnovation District in Pittsburgh is an area "dedicated to sustainability, innovative development practices and inclusive job growth"[1] In other words, it is a community plan that centers on supporting existing residents while increasing job opportunities and protecting the environment.

The EcoInnovation District in Pittsburgh encompasses the Uptown and West Oakland communities. These neighborhoods present both challenges and opportunities. They are located between the thriving Downtown and Oakland areas. However, they have not seen the same level of growth and recovery as these other regions. As the Downtown and Oakland areas experienced significant growth, the Uptown and West Oakland communities have faced divestment and deterioration. In addition, due to their location near transportation corridors, they suffer from problems of air quality, access as well as safety. They also face significant challenges related to housing affordability, storm water runoff and infrastructure issues. However, community organizations in Uptown and West Oakland have encouraged investment while creating opportunities for local residents.[2] As prices rise and space for development falls in the Downtown and Oakland areas, the EcoInnovation District presents an opportunity to develop an environmentally resilient community based on equitable land use, job growth for residents and reliable transportation and infrastructure systems.

Community ownership of this plan is essential and all members of the community were invited to participate in the process. Collaboration and trust among community residents, institutions, businesses, and government is essential in order for successful investment and sustainable growth in the corridor.

The EcoInnovation District reflects a new approach to development that is focused on job growth and economic opportunity, universal access, smart and efficient infrastructure and green building practices. Neighborhoods that are walkable, bikeable, and transit-oriented result in healthier lifestyles for residents, promote greater equity in access, and create a better environment for businesses to succeed.

The EcoInnovation District plan creates a new model for urban growth that is inclusive, innovative, and environmentally sound in all aspects of its development and will serve as a model for deployment into other areas of the City of Pittsburgh.

Western Pennsylvania Energy Consortium

The City of Pittsburgh manages the Western Pennsylvania Energy Consortium (WPEC), a group of 30 local government entities and universities who use reverse auctions to purchase electricity at a lower cost. WPEC acquired 10% non-certified REC in the first auction in 2008, and has increased that percentage by 5% each auction, and currently purchase 35% non-local non certified renewable energy. The City of Pittsburgh has committed to using 100% renewable energy to meet its operational loads by 2030 through both city-owned generation and purchase power agreements that install more renewable energy production locally. In collaboration with the other members of the WPEC, the City of Pittsburgh will design options that allow members to transition to 100% local renewable energy purchase.

Local Renewable Energy

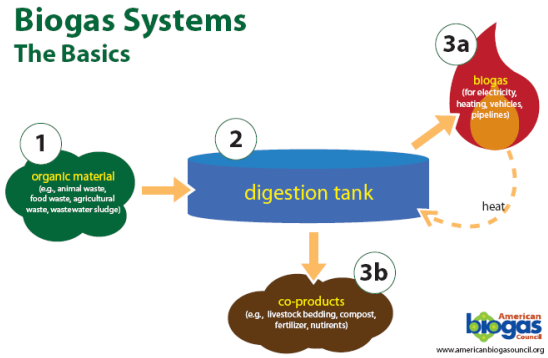
In order to fully realize the benefits of renewable energy, a focus on local generation is needed. Generation of renewable energy in southwestern Pennsylvania can provide a multitude of benefits. Increased availability of local renewable energy will connect large energy consumers with local providers. Deployment of local renewable energy will spur economic growth, create employment opportunities and enhance residents' well-being while improving Pittsburgh's economic competitiveness. (IRENA (2016), 'Renewable Energy Benefits: Measuring The Economics'. IRENA, Abu Dhabi.) As Pittsburgh looks to transition to renewable energy sources, the goal is to install 200MW of new, local renewable energy. Whether solar, wind, or combined heat and power, local generation of renewable energy in southwestern Pennsylvania will provide a myriad of economic, resiliency, and air quality benefits in addition to reduced greenhouse gas emissions.

Anaerobic Digestion –Biogas technology

One potential source of renewable energy is the use of organic waste for energy production. As organic matter decomposes in an oxygen-deprived, anaerobic environment such as a landfill, methane gas is emitted. Methane is a greenhouse gas that is 25 times more potent than carbon dioxide. The breakdown of organic material such as yard and food waste in landfills contributes to GHG emissions. However, organic waste can be collected, and if properly handled, can be used in the production of renewable energy through anaerobic digestion. Anaerobic digestion is a series of natural, biological processes in which microorganisms break down biodegradable material in the absence of oxygen. One of the end products is biogas, which is combusted to generate electricity and heat, or can be processed into renewable natural gas and transportation fuels. [1]

Anaerobic Digester Technology

An Anaerobic Digester (AD) is a closed, built system that coverts organic waste into biogas. Anaerobic digestion systems capture methane and allow that methane to be used in a beneficial way. Anaerobic digestion is being considered for many projects to divert organic materials from landfills and produce low carbon fuels.



CHAPTER THREE: Buildings

Goal: Reduce energy and water consumption by 50%

Buildings Actions: Data

Description	Lead Agency (Partners)
Get monthly/hourly electricity consumption data by sector for each neighborhood (or zip code)	Duquesne Light
Get monthly natural gas consumption data by sector for each neighborhood (or zip code)	Peoples Natural Gas & Columbia Gas
Get monthly potable water use data by sector for each neighborhood (or zip code)	PWSA & PA American Water
Get annual square footage by use type and neighborhood (or zip code)	Allegheny Office of Property Assessments

Objective #1: Reduce energy and water use in existing buildings by 50% by 2030
Existing Building Actions: Policy

Description	Lead Agency (Partners)
Pass state level enabling legislation for residential energy and water disclosure	City of Pittsburgh, GBA & Philadelphia?
Pass Pittsburgh Commercial Building Energy Benchmarking Ordinance	City of Pittsburgh (Energy Benchmarking Working Group)
Create legal framework for Property Assessed Clean Energy program	City of Pittsburgh & Philadelphia?

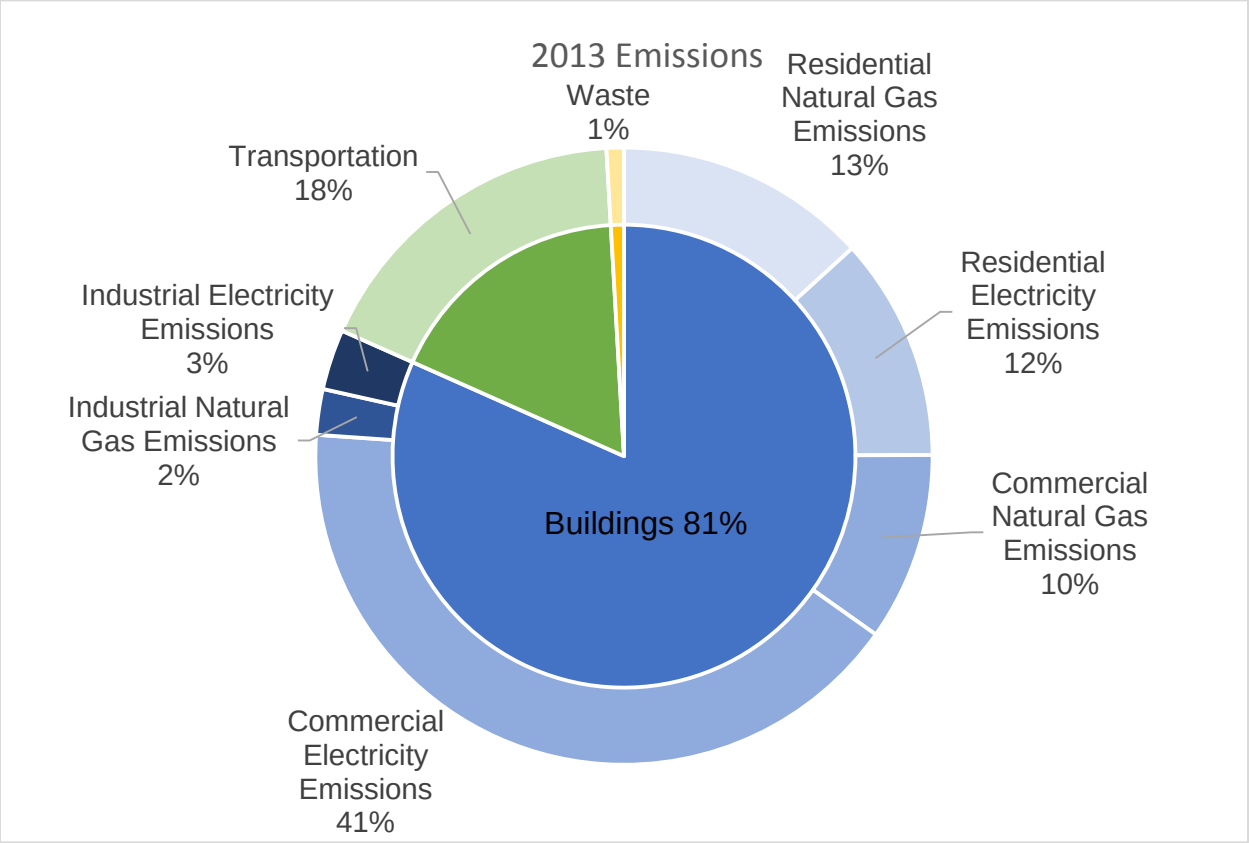
Existing Buildings Actions: Resources

Description	Lead Agency (Partners)
Create a map/matrix of resources for energy efficiency retrofits	CCI/GHHI
Create a revolving loan fund for energy and water efficiency retrofits	ACHD, PWSA, ALCOSAN?
Create a building owner manual and expand first time building owner classes	HACP, CCI, GBA?

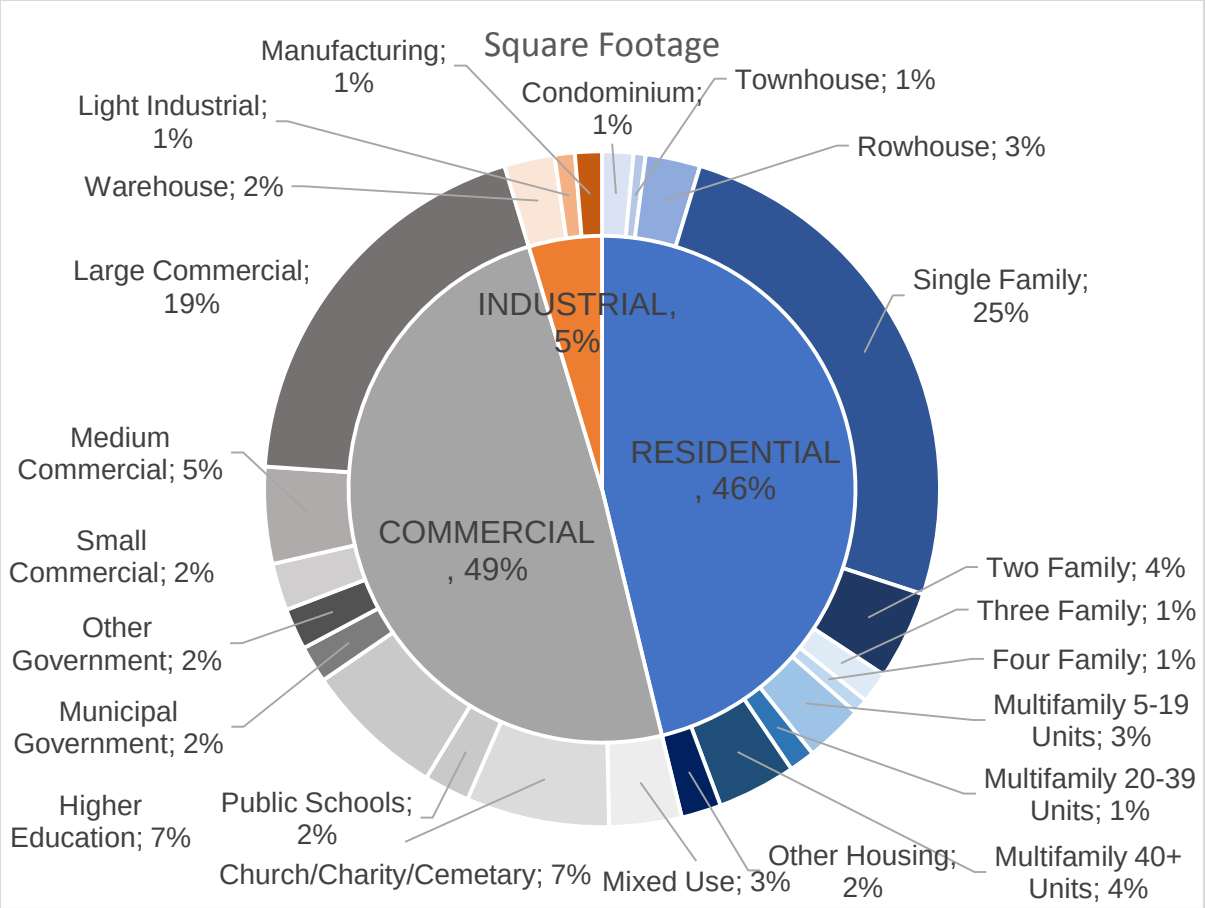
Objective #2: Ensure all new buildings are carbon neutral and location efficient by 2030
New Buildings Actions: Policy

Description	Lead Agency (Partners)
Pass state level enabling legislation for local building code adoption	City of Pittsburgh & Philadelphia?
Adopt Passive House/Climate Smart building energy codes	City of Pittsburgh, GBA
Create a Location Efficiency Overlay and use Transfer of Development Rights to encourage density while protecting open space	City of Pittsburgh, ALT

Based on the 2013 sector based inventory, Pittsburgh's buildings are responsible for 81% of carbon emissions through the consumption of electricity and natural gas.



This large source of CO2 provides many opportunities for deep carbon reductions. Improving energy generation and distribution systems is method to reduce energy related emissions. Improving end use efficiency can also significantly reduce emissions. Energy efficiency improvements are needed in commercial, residential, and industrial buildings and strategies specific to end use type can be deployed.



Energy use intensity measures how much energy a building uses per square foot, which is largely determined by the building use type and age. For example, a manufacturing facility with heavy machinery will use much more energy than a warehouse with only lighting. A newer home should be more efficient than an older home, and thus use less energy per square foot.

It is currently not possible to link energy use back to a specific building or use type, so energy use by sector is divided among the total square footage by sector, which loses some of the nuance. Ideally, in future years it will be possible to link energy use to use type and building size and geographic location to tell a better story of Pittsburgh's energy use.

	2013 Natural Gas MMBtu	2013 Electricity kWh	MMBtu	Square Footage	EUI (kBtu/SF)
Residential Energy Use	11,905,971	890,774,648	14,946,185	200,906,307	74.39
Commercial Energy Use	8,876,464	3,143,404,541	19,604,904	213,664,963	91.76
Industrial Energy Use	2,153,685	240,839,479	2,975,670	20,282,785	146.71

Objective #1: Reduce energy and water use in existing buildings by 50% by 2030

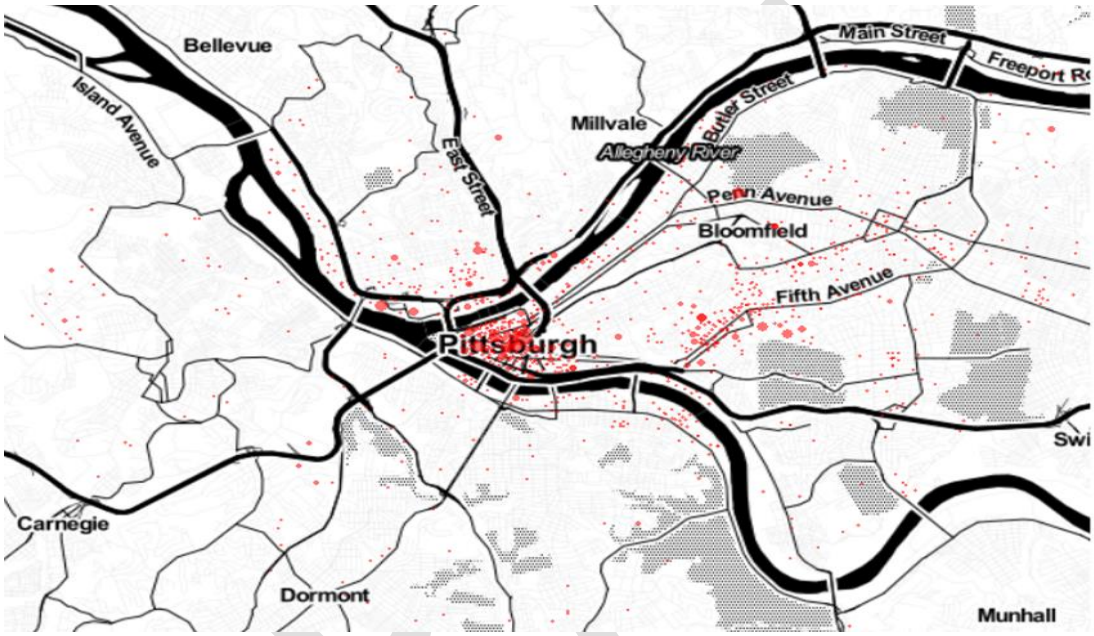
	2013 EUI (kBtu/SF)	2030 EUI (kBtu/SF)
Residential Energy Use	74.39	37.2
Commercial Energy Use	91.76	45.88
Industrial Energy Use	146.71	73.36

	2013	2030
Estimated Water Use (MGD)	70	35
Daily Water Use/Residential Population (gallons/person)	229	115
Daily Water Use/Daytime Population (gallons/person)	153	76
Annual Water Use Intensity (gal/SF)	59	29

Commercial Buildings

Building Benchmarking

In October 2016, the City of Pittsburgh enacted a new Building Benchmarking ordinance. This ordinance requires all nonresidential building 50,000 square feet and greater to report annual water and energy consumption starting in June 2018.



Map of the buildings that are 'covered' by the benchmarking ordinance

As the adage goes, "You can't manage what you can't measure." The first step in making any energy reductions is to get a better understanding of how energy is used. Benchmarking a building will allow the owners and operators as well as possible tenants of the building be able to understand how a building is performing in relation to other buildings of similar size and use type. This information can help inform future decisions and investments. Similar legislation had been implemented in cities across the US with measurable success. In the first year of the legislation, New York City the building benchmarking ordinance resulted in nearly 6% cumulative energy savings. San Francisco saw an 8% energy reduction as a result of similar policy. Pittsburgh hopes to recognize similar savings and begin to carve away at the 51% of emissions that are a result of commercial building operations.

Pittsburgh 2030 District

The building benchmarking ordinance looks to expand upon the energy efficiency improvements already being recognized with in the Pittsburgh 2030 District.

The Pittsburgh 2030 District, a Green Building Alliance strategic initiative, is a collaborative, nationally recognized, local community of high performance buildings in the Downtown, Oakland, and North Shore neighborhoods. It consists of building owners, facility managers, community partners and local resource partners working together to dramatically reduce energy and water consumption, decrease transportation emissions, and improve indoor air quality while increasing competitiveness in the business environment and enhancing returns on investment.

Using performance targets provided by the global Architecture 2030 Challenge, the Pittsburgh 2030 District seeks to demonstrate that high performing buildings are the most profitable buildings in the City.[1] Over 435 commercial buildings in Pittsburgh's 2030 District have committed to reducing energy and water use by 50% below 2003 levels by 2030. The 2030 District also set a goal of reducing transportation emissions by 50% below the 2015 modeled baseline by 2030.

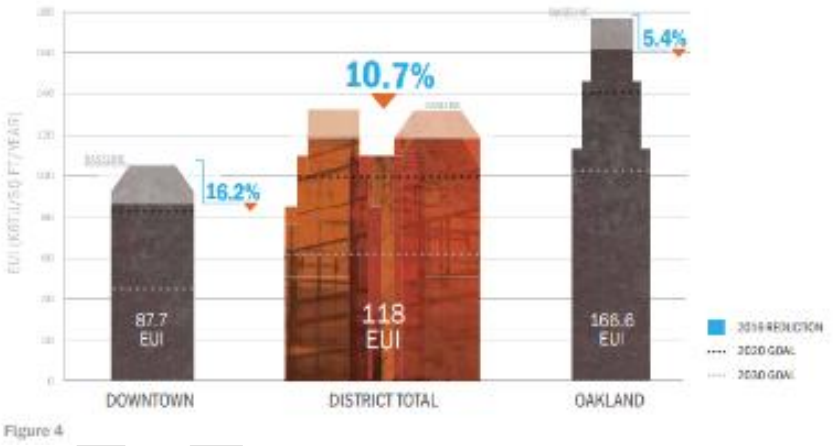


Figure 4

Since 2012, the 2030 District has been able to reduce energy consumption by an average of 10.7% below the baseline. This equates to 2.6 Billion kBTUs, the equivalent of more than 305,000 Tons of CO_2 equivalent, and a savings of $52.3 million dollars.

These collective efforts have established the Pittsburgh 2030 District as an example of a financially viable, sustainable, multi-sector endeavor that maximizes performance and profitability while significantly reducing greenhouse gas emissions. This type of collaborative action will keep Pittsburgh competitive and also represents a major investment in Pittsburgh's future.

Energy Intelligence Network

Through a partnership with Carnegie Mellon University's Center for Building Performance and Diagnostic and the Metro 21 group, the City recently rolled out a building energy use dashboard. This dashboard is part of a larger 'Energy Intelligence Network' (EIN) currently in development.

The Energy Intelligence Network is designed to improve data quality and access in order to better understand and thus reduce the environmental impact of City facilities. Starting in the City County Building, the EIN utilizes a number of monitors to collect and display real time energy consumption data. Real time, granular data about the energy being used by plug loads, lighting, and HVAC systems as well as the total energy being consumed can be used in numerous future projects and decision making processes.

Demand Response

Improved data quality as supplied by initiatives such as the Energy Intelligence Network can improve energy management capabilities. Energy management such as demand response programs can reduce energy costs and emissions and also improve the resiliency of electric grid infrastructure. However, real time data is needed in order to optimize these programs. Demand response allows building operators to reduce or shift energy consumption during periods of peak consumption across the grid. Through a variety of options, individual buildings can impact the demand and supply ratios of electricity in order to help ensure the demand does not exceed the available supply. Additionally, a more level load throughout the day will ensure that the supply is not too great which results in wasted energy.

Currently, if electric companies are unable to manage peak demands for energy, new sources of energy generation must be added to the grid. This often occurs in either 'restarting' coal fired power plants or building new power plants in order to reach the needed output. These plants often are only utilized during peak hours, and there is a negative economic and environmental impact of having to build additional capacity.

Peak load shaving, load shifting and time of use pricing, are a few demand response programs that can help reduce energy costs and prevent grid failures. The highest demand for energy often occurs mid-day in the summer. Commercial buildings are often at their highest occupancy in the middle of the day and this is also when outside temperatures peak. This means more time that air conditioners have to work harder to maintain indoor temperatures and cool the buildings. Several options such as raising air-conditioning temperatures, scheduling energy intensive processes at alternative times or closing an office and allowing employees to work from home can help to reduce energy demand during peak hours.

Demand response programs not only reduce energy consumption, they also save money that would otherwise be spent to build additional capacity.

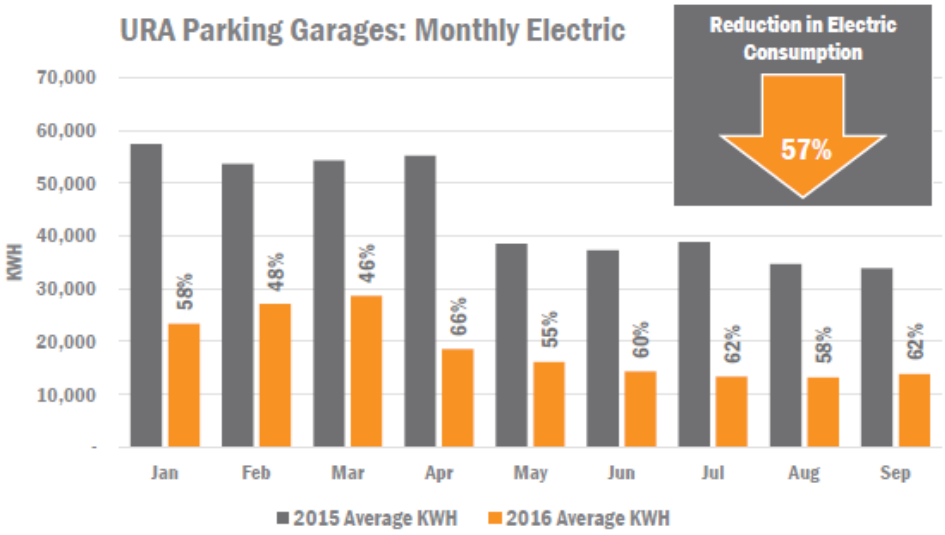
Building Code Updates

Currently, the state of Pennsylvania follows the 2009 International Building Codes (IBC) even though the International Code Council (ICC) instituted updated codes in 2012 and again in 2015. To date, state level legislation has prevented the adoption of the most up to date building codes. Building Codes are put in place to protect the health and well-being of building occupants and ensure that best practices are used in construction and renovations. As codes are updated new technology, techniques, and best practices are incorporated. Writing of the 2009 building codes began in 2006 meaning that technology developed in the past 10 years are not accounted for in Pennsylvania codes. Up to date building codes not only allow designers and builders to be competitive, but they ensure that public health, safety, and environmental considerations are protected. Keeping in line with the current building codes ensures that buildings reach optimum levels of energy efficiency and reduce related greenhouse gas emissions.
In addition to the higher greenhouse gas emissions contributions, Pennsylvanians are also subjected to higher insurance premiums and higher building operating costs due to the lack of compliance with leading standards and improved efficiency. The content of modern building codes included updated technology and standards that allow buildings to be more energy efficiency, cost-effective, and resilient.

With the help of the City of Philadelphia and local stakeholders, Pittsburgh is advocating for adopting up to date building codes in the state of Pennsylvania.

Green Garage Initiative

The Pittsburgh Green Garage Initiative (GGI) is an example of a simple energy efficiency measure that creates a significant impact on energy use. Dramatic energy savings were realized as part of the GGI when the City changed a few building code lines in order to allow for LED lights to be used in parking garages .The GGI has evolved into a collaboration of the Green Building Alliance, the Pittsburgh Parking Authority, the Sports and Exhibition Authority, and the Urban Redevelopment Authority to improve parking garages' energy efficiency and expand electric vehicle charging infrastructure.. A recent study concluded that 6,000 kW of solar photovoltaics could be installed on Pittsburgh Parking Authority garage roofs and at the Second Avenue parking lot.



As part of the garage initiative and energy grant, URA retrofit five local parking structures with extraordinary results. For the first nine months of post-retrofit operations, the Authority averaged a 57% reduction in electricity use. URA's complete retrofit portfolio to date includes five parking garages with a total of 3,051 parking spaces lit by 1,436 new fixtures. As a result of these remarkable results, the Authority is evaluating its entire parking garage portfolio and planning to leverage savings from its initial projects by reinvesting into other facilities via a new sustainability revolving fund.

Pittsburgh Parking Authority is not far behind, having completed a similar First Avenue Garage lighting and control retrofit in August 2016. This enterprise is expected to have comparable extraordinary electricity reductions of 50% to 60%. PPA is now designing similar retrofits on nine additional garages.

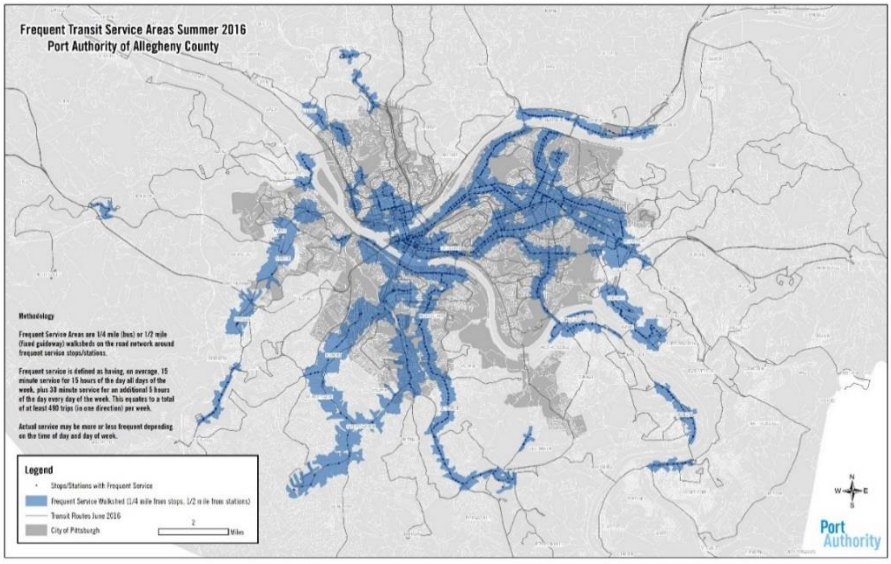
Lighting design were completed on SEA, URA, and PPAP parking garages. Within just one year of completing its resultant retrofits, SEA also experienced a 64% reduction in annual electricity use.

New Construction

Objective #2: Ensure all new buildings are carbon neutral and location efficient by 2030

New Buildings Actions: Policy

Updated building codes will help ensure that all new construction is built to perform at optimum efficiencies. Beyond a building's energy and water use, location has a significant impact on greenhouse gas emissions. If a new building is sited on a green field far away from residential areas and transit, the building decreases carbon sequestration and increases emissions from cars traveling to it. If the building is far from existing infrastructure, there is additional cost and energy loss conveying electricity and natural gas to the site.

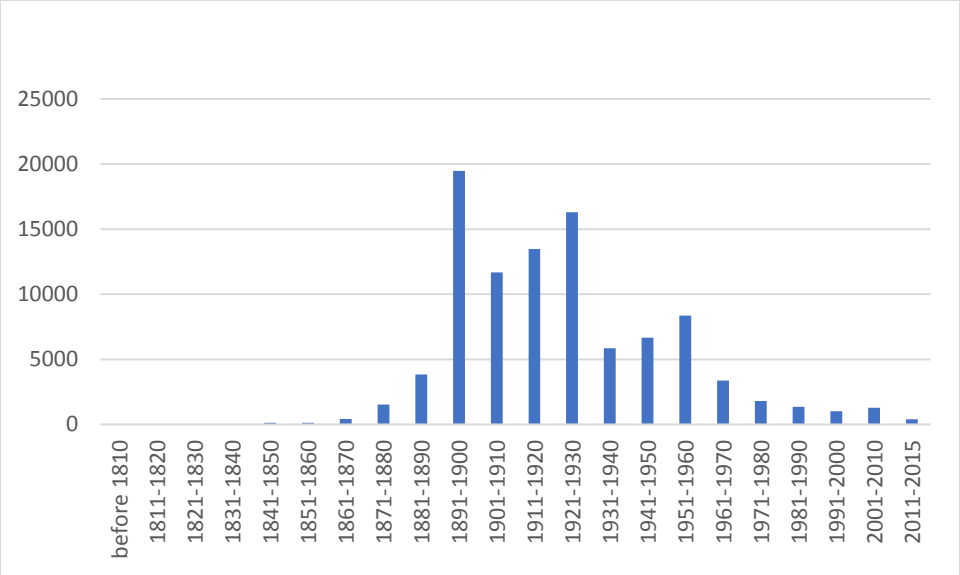


Location Efficiency Map

Pittsburgh defines a location efficiency using overlay map that integrates the walksheds around job centers (1/4 mile), walksheds to frequent service transit (fixed guideways) and protected bikeways to job centers/frequent service transit.

Residential Buildings

With 51% of emissions coming from commercial buildings, it is easy to focus attention solely on commercial energy efficiencies. However, residential efficiency actions also offer opportunities for significant impact. As with commercial buildings, updated building codes will help ensure that energy efficiency is prioritized as new homes are built. However, over seventy percent of existing residential buildings in Pittsburgh were built prior to 1960, many years before energy efficiency standards were integrated into national building codes in the 1970s. While sturdily built, these older homes need renovations to improve efficiency, health and safety.



Residential energy efficiency projects can offer equity benefits in addition to the potential emission reduction benefits. The American Council for an Energy-Efficient Economy (ACEEE) recently ranked Pittsburgh among the top ten cities where energy burdens, the ratio of utility bills to annual household income, were found to be greatest for low-income households. Nationally, the average energy burden for American households is approximately 4%. However, low income households' in Pittsburgh experience an energy burdens upwards of 15%.

In commercial buildings, electricity reduction offers the greatest opportunity for energy savings. In residential buildings, natural gas efficiency generates the maximum impact. Heating-related natural gas usage constitutes up to 56% of all natural gas usage in the City, 38% of all non-transportation energy usage, and up to 25% of the non-transportation related greenhouse gas emissions in the City. The residential sector is of particular interest, as up to 68% of gas usage in that sector is heating-related, amounting to an estimated 17% of energy use for the City (not including transportation sector emissions). Especially with the aging housing stock, which often lacks insulation or other heat saving updates, a significant amount of heat-related energy is 'lost' or wasted.

There have been a number of initiatives targeting residential improvements however, the ReEnergize Pittsburgh Coalition identified key barriers to increasing residential energy efficiency in Pittsburgh including;

1) Lack of homeowner education and awareness around energy efficiency programs and home performance issues
2) Difficulty connecting homeowners with available programs
3) Homeowner misconceptions about the value and ease of energy efficiency project implementation
4) Uncertainty around demand for and ability to sustain a skilled workforce

ReEnergize Pittsburgh Coalition also identified key strategies for improving residential efficiencies that include; improving consumer education resources, monetizing the value of home energy investments, integrating regional organizations and planning efforts, and identifying financing options and opportunities (Solving the Residential Home Energy Efficiency Challenge).

Green and Healthy Homes

In July 2017, Pittsburgh became the 19th United States city to join the Green and Healthy Homes Initiatives (GHHI). The Baltimore based organization utilize 8 key elements to help create healthier, more energy efficient homes. These whole-house strategies address issues from lead-based paint contamination, to poor indoor air quality, to energy efficiency in order to reduce housing costs specifically in low income households. These actions can help alleviate costs due to not only high energy burdens but also the socio-economic costs of related issues such as lead poisoning, asthma, lost labor force productivity, and high residence turn-over rates. In the United States, nearly six million households are exposed to 'unhealthy homes.' Through education, hazard remediation, advocacy, and efficiency services, Green and Healthy Homes is striving to improve the living conditions in those households.

Residential Energy Labeling and Green Listings

The new building benchmarking ordinance mandates transparency in the commercial building sector, however, similar transparency does not always exist at the residential level. The US Department of Energy offers a Home Energy Score program that aims at improving residential energy efficiency. Similar to vehicle fuel efficiency, the Home Energy Score provides useful energy use and efficiency information to homeowners and buyers. The scoring process also provides homeowners with suggested energy efficiency projects or updates for the home (https://betterbuildingssolutioncenter.energy.gov/home-energy-score).

In addition to promoting Home Energy Scoring, allowing for 'green' information to be included in multi-listing databases will also help improve residential energy efficiency.

Green information such as, solar panels, high-efficiency HVAC, insulation levels, or Home Energy Scores, are not currently included in multi-listing databases. However, this information could have a significant impact on appraisal values and accounting for the true value of these items

Home energy scores, green listings, and point of sale energy audits can help improve transparency in the home buying process. Increasing the information available to potential homeowners can allow those individuals make informed decisions and, as with the commercial energy benchmarking ordinance, begin to prioritize energy efficiency in residential reality.

Act 129

Utility-managed energy saving initiatives, such as Act 129 in Pennsylvania, represent a significant portion of available efficiency programs available for homeowners and renters. While these programs have a number of applications and benefits, they are often underutilized. Act 129 is legislation which requires Electric Distribution Companies (EDCs), such as Duquesne Light, to reduce electricity consumption. Improving education and access to Act 129 benefits can help significantly reduce residential energy use in cost-effective way.

Industrial Buildings and Activity

Pittsburgh has made great progress from the time when it was referred to as 'Hell with the lid off.' For much of the 20th century, the improved air quality standards and downturn of the steel industry in Pittsburgh resulted in significant emissions reductions. Whereas most emission previously were a result of the steel production and related industries, industry currently accounts for only 5% of the greenhouse gas emissions in Pittsburgh.

While the 5% emissions calculation accounts for things such as water treatment and sanitation, there is little data about privately-operated industrial activity. Greenhouse gas emission from energy use at industrial sites often only account for a portion of the environmental impact. Onsite activity can have additional air quality and environmental health implications. In order to better account for the true environmental impact of industry in the city, a concise database is needed. Those working in industrial sectors can best identify key areas for improvement as well as identify impediments to action. With improved information, key stakeholders can be brought to the table and further action can be taken.

CHAPTER FOUR: Transportation and Land Use

Goal: Reduce on-road transportation emission by 50%

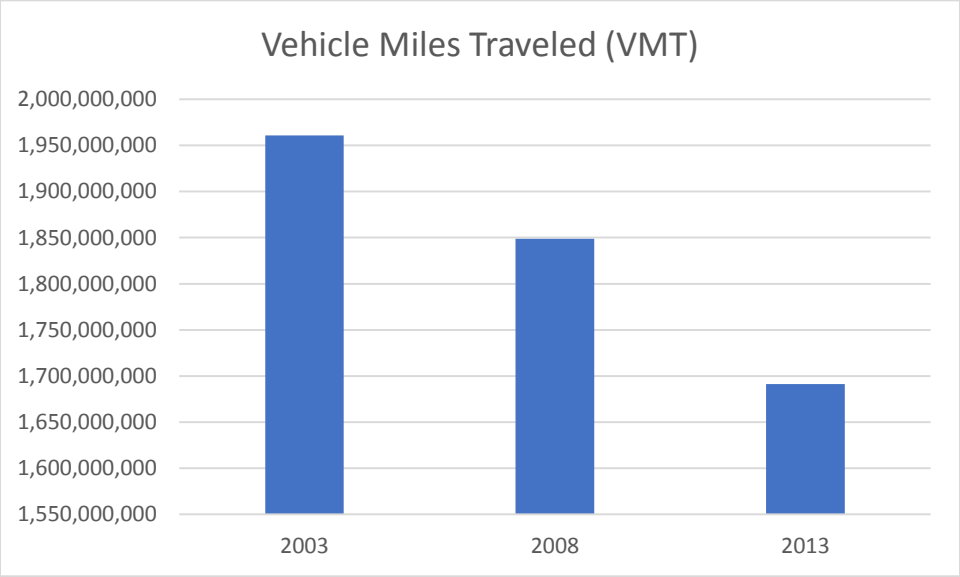
VMT Reduction Actions

Description	Lead Agency (Partners)	Timeline	GHG Impact
2030 District - Transportation	Green Building Alliance	Ongoing	
Green Workplace Challenge (Telecommute, Carpool); CommuteInfo, Pittsburghers for Public Transit	Sustainable Pittsburgh, SPC	Ongoing	
Comprehensive Plan	City of Pittsburgh	Ongoing	
Complete Streets Ordinance	City of Pittsburgh	Ongoing	

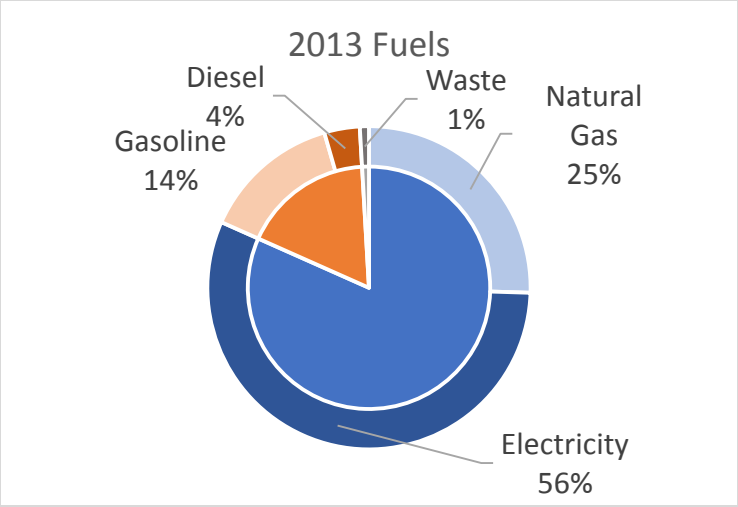
Mode Shift Actions

Description	Lead Agency (Partners)	Timeline	GHG Impact
City Accelerator: Develop system to finance and maintain 700 public stairways	City of Pittsburgh, City Accelerator	Ongoing	
Survey pedestrian infrastructure to prioritize improvement	DPW? CMU?	?	
Pittsburgh Bike Plan	Department of City Planning	Underway	
Enforce Traffic Safety, Passing and Parking laws	Pittsburgh Police, PPA	?	
Eliminate Parking Minimums	Department of City Planning	Short Term	
Improve transit rider experience - simplified payment system, more ConnectCard machines that actually give cards, better bus stops and signage	PAAC (operations), City of Pittsburgh (bus stop design)	Underway	

Transportation sources of greenhouse gas emissions in Pittsburgh include on-road vehicles such as passenger cars, mass transit, freight trucks, and off-road vehicles, such as construction vehicles, boats and trains. Since 2003, emissions from on-road vehicles have been tracked in Pittsburgh and the City is following the national trend in decreased vehicle miles traveled (VMT). Since 2004, total VMT in the U.S. has declined slowly. In 2012, total VMT reached the lowest level since 1996 (State Smart Transportation Initiative, 2013).



The decrease in VMT and increase in average fuel efficiency of vehicles has resulted in a decrease in transportation-related greenhouse gas emissions between 2003 and 2013; however, these emissions still account for 18% of Pittsburgh's overall GHG emissions. In order to achieve Pittsburgh's 2030 goals and carbon neutrality, several actions will be required. The increasingly stringent US EPA vehicle emission and fuel economy standards will help reduce on-road transportation emissions. Achieving target reduction will also require actions that reduce vehicle miles traveled on Pittsburgh roads, shift modes away from single occupancy motor vehicles, and shift away from relying on fossil fuels. In addition, equitable access to public transit and alternate modes of transportation is essential to ensure that all residents in the City of Pittsburgh are able to access essential resources such as major job centers, social and human services, grocery stores, recreational centers, schools, and medical facilities.



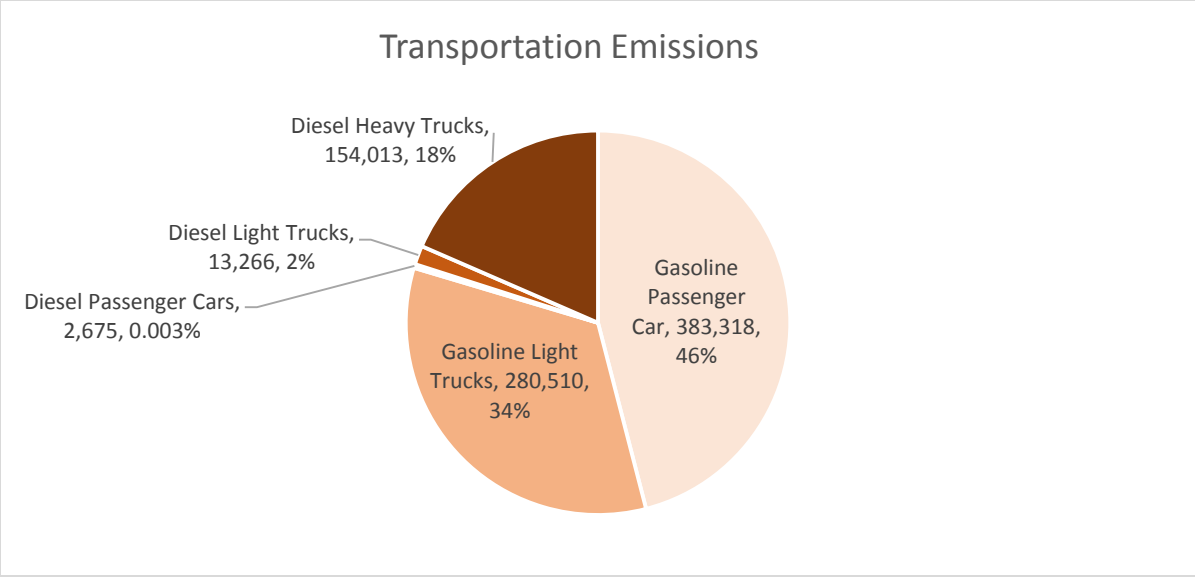
2013 Source based greenhouse gas emission breakdown

Greenhouse Gases from Transportation

It is important to have accurate measurements of GHG emissions from various modes of transportation. Emissions from the use of electricity and natural gas are able to be calculated from aggregate consumption information for specific geographic areas that can be collected from utility monopolies. However, for gasoline and diesel fuel, the location of fuel sales and the location at which emissions are produced are not necessarily the same. Therefore, total fuel sales within a boundary are not used to calculate transportation emissions. Instead, vehicle miles traveled and emissions per mile are used.

An estimated 18% of Pittsburgh's greenhouse gas emissions come from the tailpipes of vehicles traveling on roads within Pittsburgh city limits. However, there are significant data challenges that require assumptions within this calculation. In order to estimate annual vehicle miles traveled in the city boundary, the Southwestern Pennsylvania Commission (SPC), the Pittsburgh region's local Metropolitan Planning Organization, used a transportation model to provide the weekday total vehicle miles traveled (VMT) on all Pittsburgh roads. This number was then multiplied by 300 to account for ½ VMT on Saturdays and ¼ VMT on Sundays. A local breakdown of vehicle types was unavailable, so the national average road composition was used, along with average emission factors for each vehicle type. This model only considers gasoline and diesel vehicles, and does not account for emissions from idling vehicles.

To improve the inventory in the future, the model should simulate the entire year of VMT and include emissions from idling. The model should also use the local vehicle composition from DMV registrations, which will allow for emission factors based on vehicle make, model, and year, rather than relying on national averages.



2013 Sector based profile for transportation related emission

Based on the modeling done by SPC and Carnegie Mellon Universities, emissions were categorized by vehicle and fuel type. Of the 833,000 tons of CO_2 emissions from transportation, 80% are created by gasoline powered vehicles. In order to reach the 2030 Goal of 50% reduction in transportation-related emissions, significant reductions in vehicle miles traveled (VMT) by gasoline powered vehicles must be attained.

Goal: Reduce emissions from on-road transportation by 50% below 2013 levels by 2030.

Objective #1: Reduce Vehicle Miles Traveled per capita by 50% below 2013 levels by 2030.

As vehicle fuel efficiencies improve, transportation-related emissions per vehicle will decrease. However, if Pittsburgh's population increases and the number of jobs within the city increases as expected, the demand for transportation will increase along with increased transportation emissions. To counteract the increased population, the per capita VMT must be reduced. By shifting away from single occupancy vehicles, vehicle miles traveled (VMT) within the city can be drastically reduced. This will help reduce emissions, improve air quality, reduce infrastructure maintenance costs and reduce congestion throughout the City of Pittsburgh.

Year	Total Annual Vehicle Miles Traveled on Pittsburgh Roads	Residential Population	Outgoing Commuters	Incoming Commuters	Net Commuters	Total Daytime Population	Annual VMT/ Daytime Population
2003	1,960,663,200	334,563	43,839	182,030	138,191	472,754	4,147
2008	1,848,654,000	312,119	39,721	190,339	150,618	446,606	4,139
2013	1,691,400,000	306,062	42,929	193,106	150,177	456,239	3,707
2030		318,342					1,854

The best way to reduce VMT is to increase the percentage of trips made by other modes of transportation. Increasing the use of public transit, shared rides, or non-motor vehicle trips will reduce the trips taken in single occupancy vehicles, the largest contributor to transportation related emissions.

Tracking Commuter Mode Shift Split through Census Data

Trend in commuter mode share, City of Pittsburgh commuters

	2010	2011	2012	2013	2014	% Difference between 2010 to 2014
Drive Alone	53.6%	53.5%	53.8%	54.8%	55.5%	+1.9%
Carpool	10.2%	10.2%	10.3%	10.1%	9.9%	-0.3%
Public Transit	19.5%	19.0%	18.8%	17.5%	16.9%	-2.6%
Walk	11.8%	11.3%	11.3%	11.2%	10.9%	-0.9%
Bike	1.2%	1.3%	1.3%	1.7%	1.8%	+0.6%
Taxi, Motorcycle or Other	0.7%	1.0%	1.1%	1.1%	1.2%	+0.5%
Work at Home	3.1%	3.7%	3.4%	3.6%	3.8%	+0.7%

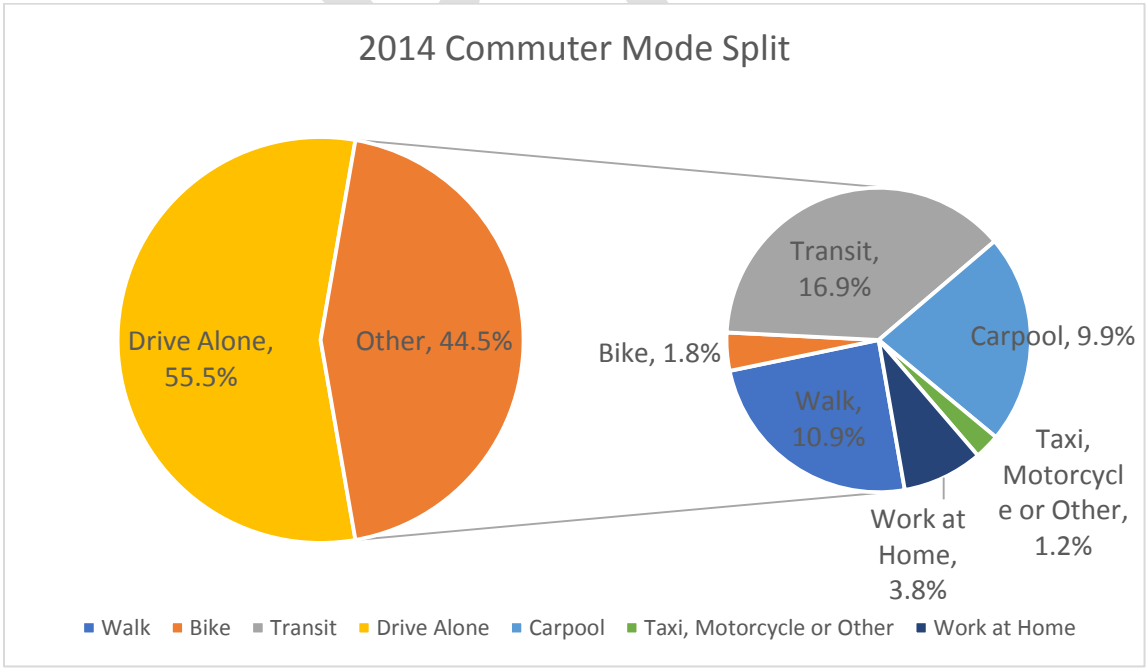
In recent years, commuter trends in Pittsburgh have shifted towards single occupancy motor vehicle trips and away from carpooling, public transportation and walking. An area in which there has been a positive mode shift is in vehicle free commutes, including bicycling, walking and telecommuting. These mode figures correspond with the 2013 greenhouse gas inventory and are not reflective of current commuter mode splits. In future years, as annual GHG inventories are conducted, mode shift trends will also be analyzed to increase the accuracy of commuter mode split data. It should be noted that the Census only gathers information about commuter trips.

Setting 2030 Mode Shift Goals

In 2008, the Pittsburgh Climate Initiative (PCI) was founded, following the adoption of the first iteration of the Pittsburgh Climate Action Plan by the City of Pittsburgh. PCI's collaborative platform of nonprofit, local government, business, and institutional organizations provides a strong basis for action.

Reconvening the PCI group in 2015, the Office of Sustainability assumed more of a leadership role and formed various subcommittee groups to address each of the chapters of the plan – including the transportation subcommittee – with the goal of identifying chapter leads and determining how to implement the priority action items. Pittsburgh Community Reinvestment Group was identified as the transportation chapter lead and has led efforts around determining realistic city-wide mode shift goals, identified in the table below:

Mode	2014 Commuter Mode Split	Objective	2030 Commuter Mode Split Goal
Walk	10.9% (+/- 0.6)	50% increase	16.4%
Bike	1.8% (+/-0.2)	100% increase	3.6%
Public Transit	16.9% (+/- 0.7)	100% increase	33.8%
Single Occupancy Vehicle (Drove Alone)	55.5% (+/-0.9)	50% decrease	27.75%



2014 mode split for commuter trips in Pittsburgh

In the Southwestern Pennsylvania Commission's 2015 travel model, it is estimated that approximately 29% of all trips were commuter trips, 35% of car-based trips were commuter-based, and around 49% of transit trips were commuter trips. Transit trips were only 9.31% of commuter trips and about 4% of non-work trips. Better data for non-commute trips is needed in order to get a more accurate mode split analysis. Assessments such as the Green Building Alliance, Make My Trip Count survey can help provide this data in the future.

Transportation in Pittsburgh

Pittsburgh strives to be the city that pioneers transportation GHG reduction via an aggressive mode shift strategy. By weaving together a cohesive network of public transit, bike and pedestrian infrastructure, car sharing and TNC services, Pittsburgh will become a city in which single occupancy auto ownership is not required for a high-quality lifestyle. Planning for transit-oriented development and mixed use, walkable neighborhoods will reduce the miles people must travel to meet their needs and will deter personal vehicle ownership. It has the added benefit of significantly reducing household transportation costs, incorporating mobility and housing equity goals into Pittsburgh's climate goals.

City's Efforts: Comprehensive Plan Priorities

With the creation of the Department of Mobility and Infrastructure, The City of Pittsburgh is developing its first Comprehensive Plan, which will include a transportation component and complete streets guidelines, prioritizing pedestrian, cyclist, public transit and carpool trips over single occupancy motor vehicles. While the City aims to reduce reliance on personal auto ownership,, there are also efforts in place to also increase the viability of electric vehicles and replace internal combustion engines that negatively impact Pittsburgh's air quality and cause adverse health effects. The plan will also include a streetlight overhaul converting sodium bulbs to LEDs, designed to improve visibility and safety for all users of the road.

Increasing Mode Shift

There are various transportation demand management (TDM) strategies and actions that can impact mode shift from personal autos. These include having employers and landlords offer universal transit passes, car/bike share subscriptions, telecommute and flexible work schedules, road and parking pricing, and road space allocation to promote bike lanes and transit-only lanes. In order to decrease the percentage of commuters driving alone, there must be other viable and easily accessible choices available to replace or supplement driving. .

Increasing the percentage of public transit trips requires capital outlay to accommodate increased demand with more frequent routes, additional busses and drivers, and bus facility space available. The Port Authority is currently working to identify the latent demand of people who could potentially take transit but currently are not. Another reconfiguration of the system, to update reforms enacted in 2009-11 should be explored as well.

Commuting by bike has shown a steady increase in the past few years and is expected to continue to grow with the creation of new bike infrastructure, including the expansion of total miles of protected bike lanes and bike repair stations. However, there are still deterrents to the choice of a bicycle as one's primary mode of transit, such as winter weather and unsafe traffic conditions.

Increasing the percentage of commuters walking to work is difficult without strategic land use changes designed to create more walkable and complete neighborhoods. Within the Buildings Chapter of this plan, there is a recommendation for a location efficiency overlay that has the potential to improve the percentage of commuters that choose to walk, bike or take transit to work. Overall, to see real changes in mode shift, a general shift in development patterns and land use designation – specifically around zoning – is required in order to have a real impact across the City of Pittsburgh. As the city continues to transition and begins attracting more people to the region, it is important to emphasize that all new development projects and re-development efforts are focused on creating a multimodal environment.

Designing and Implementing Transit Streets

Strategically designing streets to balance transit operations, car volumes, and pedestrians/cyclists is vital for people to easily and efficiently access destinations, across any city. In particular, many cities have re-focused their efforts to design transit streets in economic centers to address "growth in these areas, mode shift, carbon neutrality, and economic development."[3]

In Pittsburgh, the Downtown area (also known as the Golden Triangle) is much more compact than many CBDs[4]. Because Pittsburgh's light rail system extends predominantly south, buses are the most prominent feature of transit in Allegheny County. On weekdays, assuming walking is viable, about 45% of residents and about 58% of job sites in the county are within a 5-10 minute walk to transit[5]. However, one of the biggest hurdles Pittsburgh residents face is the difficulty in citing housing in close proximity to accessible modes of transit and job centers.. Despite having many high frequency transit corridors in the city – including Penn Avenue, Butler Street, and Centre Avenue – accessing these frequent service corridors can be difficult. The City should consider implementing a location efficiency policy, such as establishing priority development areas, for all new multi-unit developments and commercial developments within the city limits to create a targeted investment strategy.

[3] http://www.seattle.gov/transportation/docs/tmp/briefingbook/SEATTLE%20TMP%207%20BP%20-%20p%20-%20Center%20City%20Circulation.pdf, 2.
[4] The Golden Triangle is a total of 0.64 square miles or 410 acres. For comparison purposes, Portland's Center City area is 1.00 square miles or 640 acres.
[5] Port Authority Annual Service Report, 2016. Port Authority defines "walkable access to transit" as being within a 5 minute walk to a bus stop (1/4 mile) or a 10 minute walk to a light rail station (1/2 mile). In addition, the walkshed does not take topography into account, skewing how realistic a ¼ mile or ½ mile walk in areas across the city.

Generally, transit streets offer a way to efficiently integrate on-street transit vehicle facilities, service-enhancing stops and stations, pedestrian and bicycle infrastructure, and general traffic lanes in a variety of street sizes and types. Additionally, transit streets offer a way to design streets through the combination of several elements to form a vibrant streetscape with transit as its spine.[6] NACTO breaks down street environments into three distinct categories to distinguish unique challenges that each environment will experience: neighborhood, corridor, and downtown transit streets. When creating these street environments, several key elements should be considered for implementation: service design, capital facilities development, wayfinding, and placemaking[7].

Best practices for transforming high-activity corridors into attractive transit streets:

- Active retail frontage
- Expansive sidewalks (15-30 feet)
- Continuous and themed lighting schemes
- Pedestrian buffers such as trees and landscaping
- Space for café seating
- Coordinated public art program
- Curb extensions and pedestrian crossing features
- Level boarding features
- Enhanced bus shelters and stop amenities
- Wayfinding signage

Cities such as Denver, Minneapolis, and San Francisco can act as case studies for successful implementation of transit oriented development.

Bus Rapid Transit

Allegheny County, the City of Pittsburgh, Port Authority of Allegheny County, and the Urban Redevelopment Authority of Pittsburgh have proposed a Bus Rapid Transit (BRT) system that connects Downtown Pittsburgh with Uptown, Oakland, and Wilkinsburg, and includes branches to Squirrel Hill and Highland Park.

This route is projected to link more than 30,000 people across 24 neighborhoods via rapid, frequent, and more reliable transit service that's as fast and comfortable as light rail, but could be built much sooner and at a fraction of the cost.[6] In addition to enhancing public transit, this project has the potential to unlock development and contribute to neighborhood growth and link residents to job centers, educational opportunities, medical services, and cultural attractions.[7]

Land Use and Transit Oriented Development

Local Economic Revitalization Tax Assistance (LERTA) and Abatement Strategies

[6] https://nacto.org/publication/transit-street-design-guide/transit-streets/
[7] http://www.seattle.gov/transportation/docs/tmp/briefingbook/SEATTLE%20TMP%207%20BP%20-%20p%20-%20Center%20City%20Circulation.pdf, 3.

LERTA is a PA tax abatement program that was created to improve the economic and business climate of certain residential and commercial districts with declining populations, blighted, vacant properties and a dwindling tax base by lessening the tax burden and encouraging new development. The program targets Downtown, the Strip District, and the North Shore.

Differentiating LERTA and Tax Abatement Programs[8]

There are several different types of tax abatement or assistance programs depending on the type of property involved. Residential LERTA applies to rental residential and hotel properties that occupy former commercial or industrial sites located within four neighborhoods in and around downtown. Residential Enhanced LERTA specifically applies to "residential separately assessed units[9]" located within the same four neighborhoods as the Residential LERTA. Commercial LERTA applies to commercial use buildings in the City of Pittsburgh. In addition, there are targeted growth zones in which City of Pittsburgh and School District taxes can be abated. Another abatement program, Act 42 Enhanced Residential Abatement, was established in 2007 to allow for residential improvements and construction in defined neighborhoods.

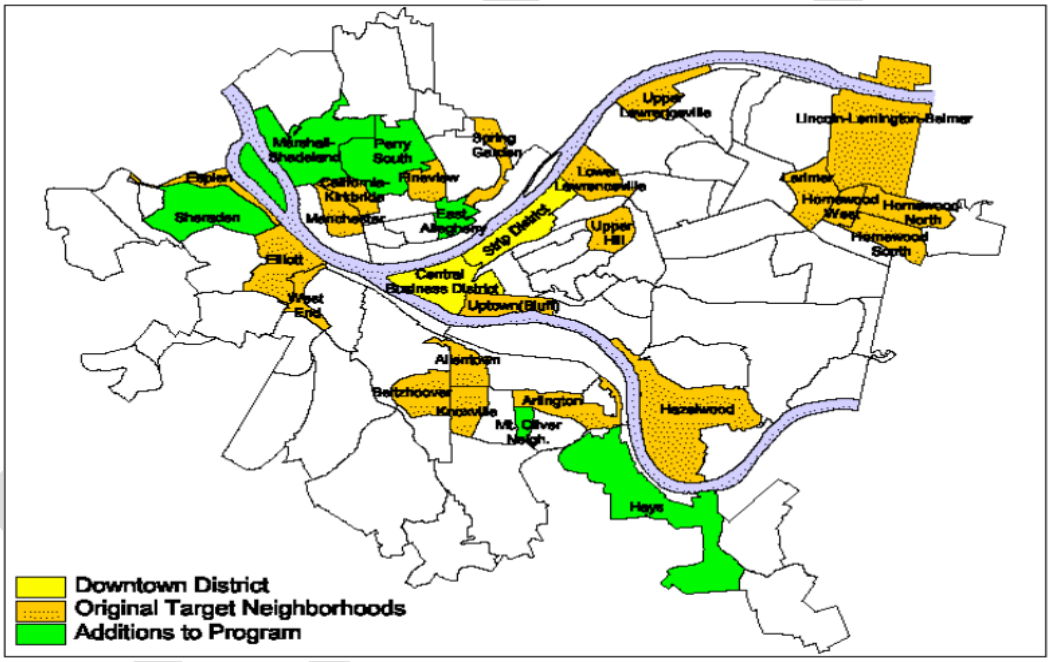


Figure 1, Pittsburgh's Targeted Growth Zones, 29 total neighborhoods (URA)

Making the Case for Location Efficiency through Tax Abatements

There is a common misconception that property tax abatements are only available for new homeowners rather than for homeowners' repair or rehabilitation projects. Real estate property

[6] https://www.itdp.org/library/standards-and-guides/the-bus-rapid-transit-standard/what-is-brt/
[7] http://www.post-gazette.com/news/transportation/2017/05/31/Pittsburgh-transportation-bus-rapid-transit-project/stories/201705310254
[8] http://landuselaw.wustl.edu/Articles/Pittsburgh%20Tax%20Abatement%20Report.pdf
[9] This specific phrase is used to differentiate single family units from condos. Initially, this program was geared towards condo development.

tax abatements can greatly improve the quality of the existing housing stock by making renovation financially feasible for property owners.[10] Additionally, property tax abatements can allow a wider range of socioeconomic groups to maintain rents at affordable levels. For developers interested in building affordable housing units, tax abatements are a tool that can be used to spur the development of affordable housing.

The Local Economic Revitalization Tax Assistance (LERTA) is a Pennsylvania tax abatement program that was created to improve the economic and business climate of certain residential and commercial districts with declining populations, blighted, vacant properties and a dwindling tax base by lessening the tax burden and encouraging new development. The City of Pittsburgh currently offers various types of tax abatement assistance programs depending on the type of property involved, including the Residential LERTA, the Residential Enhanced LERTA, the Commercial LERTA, and the Act 42 Enhanced Residential Abatement.

Too often in southwestern Pennsylvania, affordable housing developments are designed using traditional suburban methods, contributing to urban sprawl. Consideration must be given to the essential overlap between reliable access to transportation, housing, and job centers. Ensuring a balance of jobs and housing on a regional scale can achieve important smart growth objectives. It supports choice and opportunity by promoting efficient and sustainable land development, incorporating redevelopment patterns that optimize prior infrastructure investments. By consuming less land, more area is available for agriculture, open space, natural systems, and rural lifestyles[11]. Ultimately, by ensuring this balance of transportation, housing, and job centers, the smart growth model ensures location efficiency by reducing the likelihood of long commute times, mitigating traffic congestion, and creating more opportunities for alternative means of travel[12].

Cities across the country are finding creative ways to provide abatement opportunities for low-income families, fund improvement projects, and encourage affordable development through a smart growth model. As the LERTA program is set to expire at the end of 2017, there are many successful approaches to reforming LERTA in order to create a tool that can positively benefit many more individuals and neighborhoods across the City of Pittsburgh.

Additional Tools for Funding Location Efficient Affordable Housing

Other tools exist, such as Tax Increment Financing (TIF), to provide incentive for economic development in areas where a high number of vacant or distressed parcels exist. TIF is a tool that has already been utilized in Pittsburgh[13], and there are approximately 20 sites across Pittsburgh that currently utilizes TIF.

[10] http://www.mitod.org/propertytaxabatementforrenovation.php?tabShow=open%20all
[11] https://www.planning.org/policy/guides/adopted/smartgrowth.htm
[12] https://www.epa.gov/sites/production/files/documents/affordable_housing.pdf, 27.
[13] https://todline.blogs.pace.edu/features-2/

Aside from TIF and tax abatement options, there are many other possible solutions that have not yet been utilized in the Pittsburgh region, including Developer Impact Fees, Inclusionary Zoning/Housing, Special Improvement Districts, and District Improvement Funds. Currently, Downtown and Oakland both have Business Improvement Districts (BID) in place, where the Downtown BID has existed since 1996 and incurred around $959K (accounts for 64% of total expenses) to "clean and safe" expenses, as of 2011.[14] However, neighborhood residents have come together to petition for Neighborhood Improvement Districts (NID), including in East Liberty, which suggests that there is a need for more ways to generate revenue for a given neighborhood or provide assistance to support the creation of new amenities that will benefit the community as a whole.

Location Efficiency within 2011 and 2015 Enterprise Green Communities Criteria

The Pennsylvania Housing Finance Agency (PHFA) 2015 Qualified Application Plan (QAP) states that "all new construction and rehabilitation developments must meet the mandatory measures outlined in the 2011 Enterprise Green Communities Criteria, or any subsequent updates." A comparison of the 2011 and the updated 2015 Enterprise criteria can provide insight on the importance of proximity to public transportation within location efficiency. The "Location + Neighborhood Fabric" category has the largest impact on location efficiency within both the 2011 and 2015 versions.

Mandatory	Optional
1. Sensitive Site Protection 2. Connections to Existing Development and Infrastructure 3. Compact Development 4. Proximity to Services 5. Preservation of and Access to Open Space for Rural/Tribal/Small towns	1. Optional Compact Development 2. Preservation of and Access to Open Space 3. Access to Public Transportation 4. Improving Connectivity to Surrounding Communities 5. Passive Solar Heating and cooling 6. Brownfield Site or Adaptive Reuse Building 7. Access to Fresh, Local Foods 8. LEED for Neighborhood Development Certification

One change to the 2015 version is the new optional criterion of "Local Economic Development and Community Wealth Creation." The category's overall description is "Locating a project within an existing neighborhood and in close proximity to infrastructure, *transportation and services* encourages more resource-efficient development of land, reduces development costs, conserves energy, and adds to the vitality of the overall community." This guidance specifies that new construction projects **must** either earn optional points under "Access to Public Transportation" (**8** or **10** points), or earn 8 optional points through the following criteria within "Location + Neighborhood Fabric."

- Preservation of and Access to Open Space (**6** points maximum)
- Improving Connectivity to the Community (**2-8** points)

[14] http://www.alleghenyinstitute.org/tag/nid/

- Access to Fresh, Local Foods (**6** points)
- LEED for Neighborhood Development Certification (**4** points)
- Local Economic Development and Community Wealth Creation (**6** points maximum)

While the Enterprise Criteria provides a good basis for dealing with transit related issues, there are still gaps that the QAP needs to fill in. There are no mandatory transportation/accessibility criteria for rehab developments other than "Proximity to Services." These criteria are very broad and do not eliminate the need for proximity to public transit.

Parking Codes and Reform

Parking regulations can contribute to transportation efficiency by allowing flexibility in addressing vehicle parking and access issues. The City of Pittsburgh has strategies in place to solve parking issues and enhance a safe and efficient transportation system. Current development codes are consistent with environmental goals and are designed to ensure that access will not adversely affect nearby land uses and surrounding neighborhoods. In addition to a minimum requirement, Pittsburgh code establishes a maximum limit of car parking spaces. Parking reform can be a disincentive to driving by limiting parking spaces, enforcing metering and removing the requirement for minimum parking at buildings.

The City of Pittsburgh promotes bicycle commuting in order to lessen car-related congestion by requiring the provision of adequate and safe facilities for the storage of bicycles. The Code also allows for a reduction in required automobile parking spaces when bicycle parking is accommodated and defines minimum bike parking requirements for most new development. The code specifically lists that 60% of bike parking for multifamily dwelling developments must be protected parking in order to replace a portion of car parking requirements.[16]

Transit stops can also be incorporated into new development in order to satisfy current standards. Up to 20% of the required parking spaces can be eliminated, provided that certain conditions are met. Transit stops must be clearly identified and open to the public, designed as an integral part of the development project, with direct access to the station or a covered waiting area. They must be well-lit with seating for a minimum of twenty persons. The transit stop must also be maintained by the developer for the life of the project. Additionally, clearly defining Transit Oriented Development (TOD) in the Code would help to limit the various interpretations of what "direct access" to a stop means and would offer an opportunity to develop a TOD overlay

Other cities such as Cleveland, Indianapolis and Philadelphia have successfully developed parking codes that promote alternatives to car transportation. They require a minimum number of bike spaces for new development and may allow up to 10% of parking requirements to be met by bike parking spaces. Developers may also reduce the number of required parking spaces if they include electric-car charging stations, car sharing spots, or other "green" amenities. Parking requirements may also be reduced by 10, 30 or even 50% if development is

in close proximity to transit systems. Defining what “close proximity” means within the Code is essential for developers to abide by.

Objective #2: Fuel Shift: Vehicle Electrification

Municipal Electric Vehicle Conversion Strategy

Pittsburgh has set the complementary goals of (1) operating a 100% fossil fuel free fleet and (2) using 100% renewable energy, either through purchase or generation, by 2030. In order to achieve these goals, we have identified the following hierarchy of strategies and scalable pilot projects:

Downsize the fleet

The City of Pittsburgh has had a vehicle replacement policy that requires departments to retire a vehicle before purchasing a replacement, unless the department can demonstrate the need for additional vehicles. However, there are 122 sedans, 35 SUVs and 123 pickup trucks that average fewer than 8,000 miles per year, which indicates opportunities reduce the size of the fleet. The City of Pittsburgh is committed to working with each department to determine the necessity of each vehicle and exploring alternatives such as Zipcar on demand car sharing.

Downsize Vehicle Types

Beyond selling off underused vehicles, the City of Pittsburgh plans to identify the necessary vehicle specifications and minimum performance standards for all vehicle uses in the fleet to ensure that each department is well equipped to perform services, using electric vehicles and fuel efficient models wherever possible.

Procurement and Operations

The Equipment Leasing Authority (ELA) and the Office of Management (OMB) maintain a 5-year vehicle acquisition plan that is updated annually. The plan identifies vehicles to retire and aims for a six year turnover of sedans and a 10 year turnover of trucks. The ELA established a Green Vehicles Ordinance in 2008 to prioritize purchasing vehicles with high fuel efficiencies and alternative fuels. The fleet currently includes 7 gas-electric hybrid vehicles, 5 CNG trucks, and 24 diesel refuse trucks outfitted with biodiesel tanks.

ELA has drafted a 3-year Electric Vehicle Acquisition Plan that allocates $5 million dollars to purchase 10 electric motorcycles, 81 electric sedans, 14 electric medium SUVs and 107 level 2 charging stations from 2017 to 2019. Electric vehicles will be rotated into the fleet as conventional vehicles are retired and as technology improves.

The City was recently awarded $250,000 in funding from the Alternative Fuels Incentive Grant Program (AFIG) run by the Pennsylvania Department of Environmental Protection. Of these funds, $80,000 funds will be used to help purchase 10 Nissan Leaf EVs to begin the conversion

of the Bureau of Permits, Licensing, and Inspection's (PLI) fleet to fossil fuel free vehicles. The PLI vehicles are ideal candidates for electrification due to their low daily mileage and non-emergency usage.

Purchase and Install Renewable Energy

Given the state of the grid, Pittsburgh recognizes the need to purchase or install renewable energy to cover the projected demand for electric vehicle charging. The City of Pittsburgh already purchases 35% renewable energy through the Western Pennsylvania Energy Consortium, a power purchasing agreement with almost thirty local governments and schools. However, these non-certified Renewable Energy Credits (RECs) are not local and will not displace local coal-fired power. Where possible, the City of Pittsburgh plans to install carbon free charging infrastructure for EV chargers. $170,000 of AFIG funding will go towards the installation of this charging infrastructures. As a starter, Pittsburgh is looking to install portable, solar powered charging stations. These stations will allow EVs to be charged without having to tie into the grid. Additionally, these stations can be deployed throughout the city in emergency situations, blackouts or interruptions in electricity supply which will improve the overall resiliency of Pittsburgh and its residents. The first charging stations will charge the DPLI fleet at night and then will be open to the public during the day.

Private Fleet Conversion

Pittsburgh envisions a transportation system where personal vehicle ownership becomes obsolete. Personal trips will be made by public transit, car share, ride share, bike, or walking. However, we realize that private fleets are necessary, and will continue to operate. As the City moves towards a fossil fuel free fleet, facilitating the conversion of private fleets will also be a priority. Shuttle buses used by universities, hospitals, and other large campuses can easily be converted with existing technology.

Local Government

The City plans to establish the Pittsburgh Electrification Partnership with the local Clean Cities chapter, local electric utility Duquesne Light, local government fleets and taxi, hospital, university, corporate and rental car fleets.

The Pittsburgh Region Clean Cities (PRCC) chapter has installed charging infrastructure from the Pittsburgh International Airport to the city along the Energy 376 corridor. The City of Pittsburgh helped connect the PRCC with the Pittsburgh Parking Authority (PPA) that operates 35 parking enforcement sedans. The PRCC collaborated with the PPA to use a an additional AFIG grant funding to install 13 level two chargers in the PPA 1st Avenue garage that will serve the public during the day and will charge the PPA's electric sedans at night.

Port Authority

In addition to the City of Pittsburgh fleet, electrification of the Port Authority of Allegheny County, whose fleet of over 700 diesel public transit buses have a significant impact on local air quality, is a top priority. Electrifying the public bus fleet will improve rider experience, reduce vehicle lifetime costs and increase the visibility of electric vehicles.

Public Electric Vehicle Infrastructure

The Pittsburgh Parking Authority (PPA) operates 10 parking garages and one large surface lot, on Second Avenue, in Downtown Pittsburgh. There are currently 15 level-2 electric vehicle chargers in PPA garages. Downtown Pittsburgh is Pennsylvania's second largest commercial district, but has only a dozen charging stations out of 23,000 parking spaces. As of last count, there are 64 charging stations in Allegheny County. As commercial and municipal fleets move towards electric vehicles, available charging infrastructure will continue to expand. Improved access to charging stations and increased visibility of electric vehicles will help drive the integration of EVs into individual households.

Resilient EV Charging Hubs

Pittsburgh neighborhoods typically lack driveways and garages, making home charging prohibitive for many city residents. Neighborhood charging stations would not only insure access to localized charging infrastructure, but these neighborhood stations would be operated with off-grid solar generation and battery backup, providing a resilient hub for residents to gather and charge devices or vehicles in times of grid failure. The kiosk can also serve other two-way communication purposes, such as a base to distribute weather advisories or similar information in times of emergency.

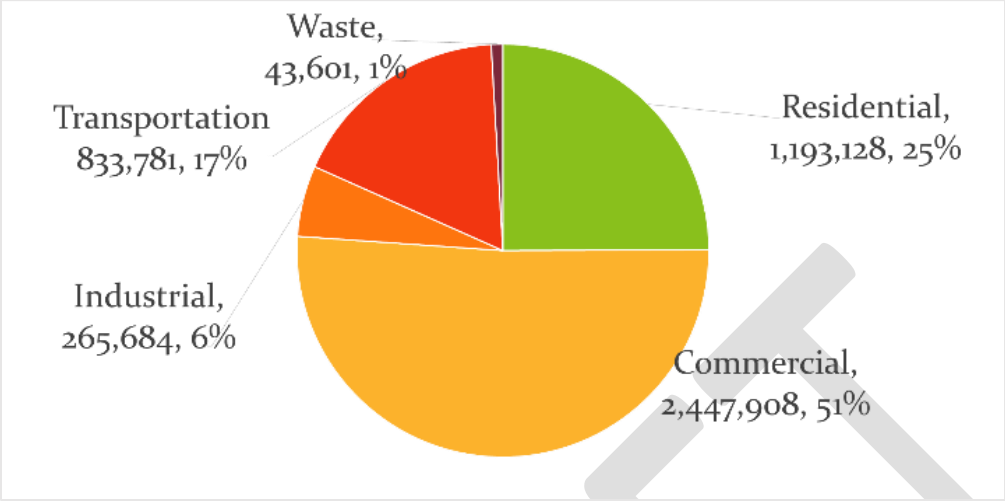
As an EPA air quality nonattainment zone, vehicle electrification comes with the very important co-benefit of improving local air quality by reducing tailpipe emissions. Using the Resilient EV Charging Hubs as a reporting station for idling or other air quality violations would enable residents to make the connection between the carbon reduction benefits of electrification and their direct health. The Hubs could also be utilized to improve the ease of commuting via less carbon intensive transit modes, as a place to purchase bus tickets, post City transit option maps, and connect people to car, van and bike pools. The kiosks can also provide space for advertising to offset the cost of energy and maintenance.

Objective #3: Reduce freight emissions by 25% by 2030

In addition to municipal and private vehicle emissions, it is important to address freight-related emissions within the City of Pittsburgh. Conversion to alternative fuel cannot be required, but it is critical to enforce existing laws and policies concerning freight deliveries, idling laws, truck routes and loading zones. Loading and unloading can be incentivized during off-peak hours. In addition, improved signage around loading zones will encourage compliance. Designated loading zones can be designed to take advantage of existing transit lanes and plans can be developed for efficient coordination of freight deliveries.

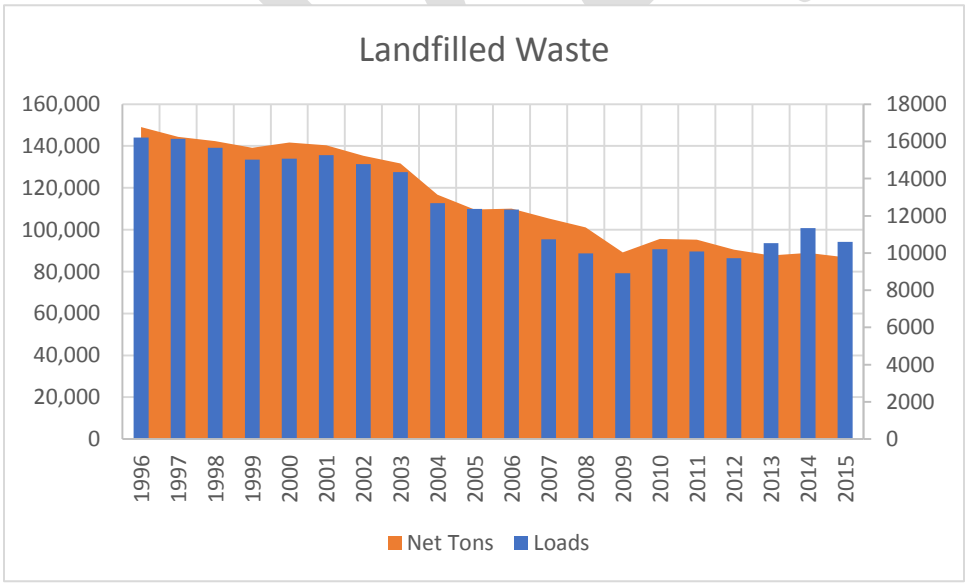
In addition to land-based freight, the impact of boat traffic around the City will need to be considered. Conversion of boat engines to natural gas should be encouraged.

CHAPTER FIVE: Waste and Resource Recovery



2013 Sector Based Emissions

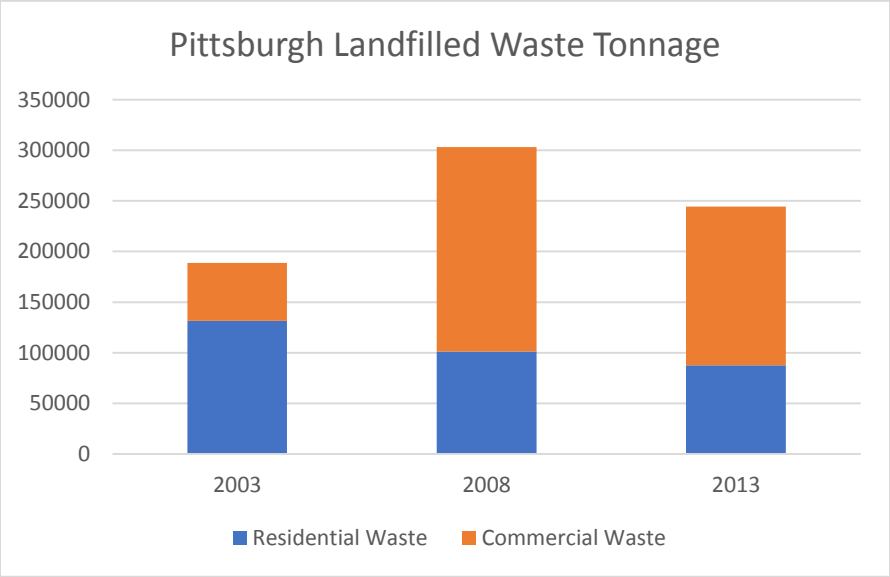
Based on 2013 data, waste-related emissions only accounted for 1% of the City's total emissions. However, the sector-based inventory methodology, used to develop Pittsburgh's greenhouse gas inventory, only reflects a very small portion of the greenhouse gases that are emitted as a consequence of consumption and waste habits. The sector-based inventory measures only the methane that escaping from landfills, rather than taking into account all sources.



The City of Pittsburgh Department of Public Works - Environmental Services (DPW ES) only collects waste and recycling from residential buildings with four or less units. Therefore, the waste data collected by DPW-ES only accounts for a portion of the total waste being generated in Pittsburgh. Over the years, the scope of service of DPWES has changed, so though total

volume and loads of waste hauled to landfill have decreased, this does not necessarily mean that the average Pittsburgh household is producing less waste.

Commercial buildings, including multi-unit residential buildings, individually contract with private waste haulers. Approximately 50 local private waste haulers operate within city limits. Due to the number of buildings that fall within this category it is difficult to gather data about privately collected waste. Solid waste volumes are reported to the state by county of origin so it is possible to estimate Pittsburgh's waste volumes based on the Allegheny County profile. In 2013, Allegheny County landfilled 888,646.2 tons of municipal solid waste, or the equivalent of 4 pounds per person per day. Given Pittsburgh's 2013 residential population of 306,062, the city generated an estimated 221,675 tons of solid waste. Of that estimate, 87,710 tons were collected by DPW ES, leaving 133,965 for private collection.



Based on the available data, waste in Pittsburgh has increased between 2003 and 2013. Specifically, there was a noteworthy increase in privately hauled waste. By 2030, Pittsburg has a goal of diverting 100% of waste from landfills. Because the goal is to reach zero waste, the baseline data is not as important for waste as in other sectors.

Consumption based inventory

The most efficient way to reduce waste is to reduce consumption. Reducing consumption completely removes materials from the waste stream. Additionally, reduced consumption will help mitigate emissions from the creation, transportation, and distribution of materials and products. Before significant consumption changes can begin, a better understanding of consumption trends and practices is needed. With a better understanding of consumption patterns, steps can be taken to reduce the associated environmental impact.

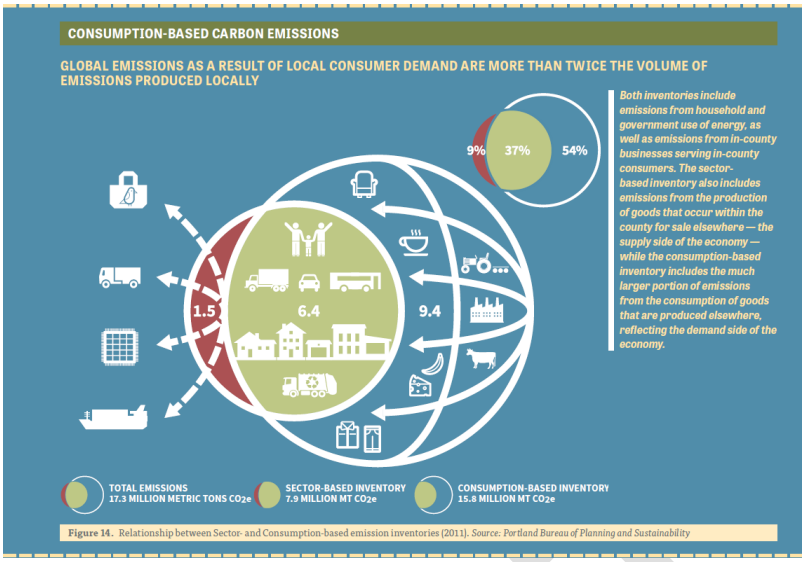


Figure 14. Relationship between Sector- and Consumption-based emission inventories (2011). *Source: Portland Bureau of Planning and Sustainability*

The sector-based greenhouse gas inventory uses the national average waste characterization to determine waste composition and therefore the amount of methane that is released as the waste decomposes. Both landfills that receive Pittsburgh waste have methane capture-in-place systems. However, some gas still escapes into the atmosphere. This methane release is only 1% of Pittsburgh's total greenhouse gas emissions. However, the greenhouse gas implications of Pittsburgh's consumption and waste are much larger. The emissions from the manufacturing, utilization and transportation of products that ultimately end up in the landfill are not easily accounted for in the sector based inventory.

Portland and Multnomah County in Oregon use a consumption-based inventory to track greenhouse gases that are burned outside of their boundaries in the production and transportation of products to satisfy demand within their boundaries. This inventory concluded that 54% of emissions are due to consumption. When comparing the sector-based inventory and the consumption-based inventory, emissions increased from 7.9 million MT CO2e to 17.3 MT CO2e respectively.

Waste Characterization Study

Improved data will help to inform decisions and track progress towards a zero waste goal. In order to get a better understanding of Pittsburgh's waste streams, a waste characterization study is needed. A characterization study of the waste that is collected by the City and private hauling companies will help to quantify what is currently being taken to the landfill, what is being recycled, and what recyclables are not being diverted from landfills.

Building on the waste characterization study, a long-term waste tracking system is needed. The characterization study sets the baseline but a measurement system is needed to track progress towards the 2030 goal. In order to track success and encourage citizen ownership of the 2030 landfill diversion goal, data collection and reporting needs to begin as soon as possible. In addition, studies show that active measurement and tracking of recycling information increases participation. To ease administrative efforts and costs, data should be reported quarterly and the results should be provided in the City newsletter and on the City website.

The US EPA produced a report based on 2013 national municipal solid waste and found that after diversion for compost and recycling, landfill volume had the following composition, here applied to the total estimated landfill waste generated within Pittsburgh.

	2013 EPA US Discard Composition	Pittsburgh Volume (tons)
Paper & Paperboard	15.10%	33,472.99
Yard Trimmings	8.10%	17,955.71
Metals	9.10%	20,172.46
Glass	5%	11,083.77
Plastics	17.70%	39,236.55
Wood	8%	17,734.03
Food	21.10%	46,773.51
Rubber, leather & Textiles	11.60%	25,714.35
Other	4.30%	9,532.04

The EPA also produces the Waste Reduction Model (WARM) to help estimate greenhouse gas reductions from solid waste management practices. If the City of Pittsburgh were to recycle all the paper, metals, glass and plastics and compost all food waste and yard trimmings, it would result in 260,078 MT CO2e avoided, rather than 34,733 MT CO2e emitted.

Zero Waste Plan

In partnership with the 100 Resilient Cities, the City of Pittsburgh worked with R20 to develop a 'Roadmap to Zero Waste". The roadmap outlines a 13-year strategy for achieving zero waste by the year 2030.

Implementing a Zero Waste System

The first step to implementing any zero waste strategy is to create a public private partnership (P3). A public private partnership maximizes social and environmental goals such as pollution prevention, resource conservation and local job creation while ensuring that the public benefit from the Zero Waste system is as essential as private revenue.

The public private partnership would likely have a board of directors and an advisory council. Members would include, but not be limited to, City Staff, government agencies, Allegheny County and State officials, ALCOSAN, the Pennsylvania Resources Council (PRC), as well as other stakeholders such as waste haulers and recyclers. In addition, universities, not-for-profits, corporations (e.g. Alcoa, Calgon Carbon, etc.) and Foundations (e.g. Heinz, Carnegie Mellon, etc.) would play a critical role in any P3. These stakeholders may differ in their motives, but they can unite in the vision to enhance Pittsburgh’s reputation as a national and global leader in

sustainable innovation. They can help to solve complex societal challenges in order to protect human health and the environment while doing so in an economically viable way.

The public private partnership would also oversee the creation of a Zero Waste Strategic Plan (ZWSP). The Road Map to Zero Waste and the Climate Action Plan provide a framework from which a ZWSP can be created. The Zero Waste Strategic Plan will serve as a long-term strategic document that emphasizes the sustainable management of waste to achieve the maximum efficiency of resources. In addition, it will systematically outline the goals and how they are to be achieved on a step-by-step basis. The ZWSP will include topics such as

- A strategic focus on actions that can be taken to achieve zero waste
- Revenue potential of recycling as compared to the cost of recycling and the cost of landfills
- Materials to be included in a recycling program and those to be excluded due to relative values
- The financial or regulatory instruments that will best drive the desired behavior and therefore maximize beneficial results

The ZWSP will guide the development and implementation of an overall solid waste program by establishing specific actions to be taken and setting criteria for decision making. The ZWSP must be a truly integrated approach, therefore ensuring that all parts of the plan and all of the goals are working in concert and not against one another. In addition to municipal solid waste (MSW), the ZWSP will include the management of special industrial wastes, household hazardous wastes, electronic wastes, construction and demolition (C&D) wastes, and organic wastes.

Reporting Requirements

The ZWSP will require that private haulers, institutions, and specific categories of commercial businesses submit a quarterly landfill tonnage report to the City. It will also require that all commercial businesses and institutions report their recycling tonnage) to the City's Recycling Division on a quarterly basis instead of the current quarterly or yearly basis.

Education and Information

The ZWSP will improve education and information by updating the Environmental Services Website and Informational Materials. The City's recycling/reuse website, when properly designed, can easily become the basis of a sound Zero Waste program. The website name could even be associated with a marketing campaign that allows people to easily remember which website to access when they want to know how to responsibly dispose of an item. The website should be easy to read and navigate and all-inclusive for the entire Zero Waste system. It needs to be updated regularly in order to maintain accuracy and should be designed to provide useful feedback to the City.

Materials Recovery Map

A Materials Recovery Map will be created to include the location of drop-off sites and facilities for the recovery of non-traditional items such as electronics, sharps (needles), cell phones, TVs,

etc. It will also include a decision option tree – Reduce, Reuse/Donate, Drop-off Sites, and Curbside recycling including full instructions, links to websites and drop-off locations.

Current/Proposed Systems

Under the current system, the City provides trash, recycling, and yard waste collection service only to single-family homes and multi-unit buildings with five units or less. There is no food waste collection program and no bins are provided by the City for trash or recycling.

Under the system proposed by the ZWSP, each route and neighborhood will be evaluated to determine the feasibility of using automated cart tipping for waste collection. Where appropriate, automated collection bins and dual-compartment trucks will be used. This will allow one driver to support both the trash and recycling route service at the same time. The new trucks will be fueled by bio-gas since City garbage trucks at 3 miles per gallon of fuel are the largest contributors to air pollution in the City vehicle fleet. Traditional rear-loading trucks could be used for routes where automated trucks are not feasible. They would also continue to be used for yard waste pickups, for special pickups such as Christmas trees, and for collection of construction and demolition waste from various City projects. Unneeded trucks will be sold. It is also recommended that there be an increase in collection frequency for recycling to once-per-week. The frequency of recyclables collection must at least equal to that of trash collection in order to encourage recycling.

Potential Benefits of the Proposed System

Bin distribution will improve aesthetics by providing uniform, lidded carts, with limited or no bags outside of the bins. Automated trucks will increase the number of households serviced per route while decreasing the number of employees needed per route. They will improve employee working conditions, reduce worker's compensation claims, reduce employee absence due to injuries, increase employee longevity and broaden the potential employee pool because they will not have to lift as much. Dual compartment trucks will require fewer trucks and less labor while decreasing road wear and tear and reducing fuel consumption and the associated pollution.

The ZWSP will support universal recycling for all businesses as well as for multi-family units with more than 5 units. The City will support businesses in their recycling efforts through education and their commitment to the Zero Waste program. Private haulers servicing the large multi-family unit buildings and businesses will also be encouraged to charge less per volume for recycling than for trash collection.

2015 Northside Bin Initiative

The Northside Bin Initiative is a pilot project in which approximately 1100 recycling containers were distributed to residents served by a single recycling route in the Northside area of Pittsburgh. It was developed to test the impact of converting the collection system from bagged set-outs to provided bins. During the course of the project, data was gathered in order to analyze the impact of the City's proposed new approach for recycle collection. These

considerations included: impact to the City's vehicle fleet, staff time, routing, finances, changes to recycling participation rates, material quality and contamination levels, and resident feedback. The primary objectives of this pilot program were to:

- Decrease blue plastic bag contamination at the Materials Recovery Facility (MRF)
- Determine baseline recycling participation data
- Increase resident awareness of recycling
- Increase tonnage of materials recycled
- Measure & track changes in pre/post bin distribution participation & weight
- Measure & track impact to City and route operations
- Educate as many residents in person as possible about recycling and the bin project

The information gathered through this pilot project will assist in the City's plan to expand the bin recycling system citywide. The pilot project will serve as building block for the City of Pittsburgh's "Roadmap to Zero Waste" in the pursuit of a more circular economy. The next phase of implementation will expand the bin initiative from a neighborhood level to a citywide scale that will encompass about 115,200 households. Expanding the project will cost an estimated $2,923,400 to cover bin purchase, distribution, and education citywide. The pilot project was funded by the ALCOA Foundation with support from the City of Pittsburgh and the Pennsylvania Resources Council. Continued funding for the expansion of this project is proposed for the 2018 City of Pittsburgh capital budget, and the City is seeking further grant opportunities.

Benefits of the Northside Bin Initiative

CO2 Reduction: The main goal of this project was to increase the City's diversion rate and reduce waste going to the landfill. More than 44,000 tons of CO_2 equivalents can be attributed to the waste collected by the City of Pittsburgh Department of Public Works. Although this is only about 1% of the City's total greenhouse gas inventory, it is an area in which deep cuts can easily be made. An additional 154,000 tons of CO_2 equivalent are due to the use of diesel heavy trucks, such as refuse vehicles. By increasing diversion rates and reducing waste being dumped at landfills, emissions can be reduced from both the 'waste' and the 'transportation' sectors of Pittsburgh's Greenhouse Gas Inventory.

Economic co-benefits: Increased recycling will reduce the cost of waste hauling by reducing the number of trips to the landfills. This will save money through reduced tipping fees, reduced operational and fuel costs, and an increase in the lifespan of refuse vehicles.
RFID tags added to the bins will allow the City to collect better data about household participation and diversion rates. State of the art garbage bin sensor technology will alert the City's Department of Public Works when public garbage bins need to be emptied. This will allow DPW crews to strategically plan collections, resulting in improved efficiency and the elimination of unnecessary trips to cans that are not full.

Environmental co-benefits: Reduction in the volume of waste traveling to landfills and improved quality of materials being processed at the MRF will improve the system's efficiency and resource recovery. Improved waste practices will also help to reduce the amount of 'illegal dumping' that occurs in the City.

Health co-benefits: Improved data will allow optimization and reduction of routes that refuse vehicles take to the local landfill. This will reduce vehicle emissions and improve the local air quality.

Social co-benefits: Using a bin system will help to reduce recycling clutter, keeping sidewalks clear for pedestrians and bicyclists, and improving neighborhood aesthetics. Resident outreach and education will increase participation and the quantity of material recycled.

The bin distribution, educational components, and data collection developed through the Northside Bin Initiative will help to advance the City's Zero Waste goal.

Supporting Policies

It is essential that enforcement be a part of any effective Zero Waste plan. Requirements for recycling are currently in place, but they are not being enforced. The ZWSP will mandate that businesses have a recycling program and mandate that recycling be available to all multi-unit housing residents serviced by private haulers. The current source separation mandate will be enforced to encourage support of the recycling program. Education and technical assistance will be provided for multi-family unit residents and for businesses in order to enforce participation in recycling and composting programs and reach recovery rates above 70%.

Drop-off Sites

Drop-off sites will primarily be used for tires, excess yard waste, scrap metal and for residents with an excess of "traditional" recyclables that will not fit in the recycling bin.
In order to improve these sites, recommendations are to ensure that all bins at each site are clearly labeled, to extend the hours of the manned sites to include weekly Saturday hours in order to improve accessibility for residents with day jobs. It is also recommended that they coordinate with a textile-clothing vendor for clothing drop-off bins and ensure that all recyclables collected at the drop-off sites are, in fact, being recycled (e.g. cardboard collected on weekends). The sites could also consider adding other hard-to-recycle materials to the list of acceptable materials at the manned sites.

Purchase Deposit on Beverage Bottles

Incorporating a purchase deposit on beverage bottles will produce a cleaner recycling stream for processing and aid in reducing the City's litter problem (especially at events).
It also provides a financial incentive to recycle.

Recycling Participation in Schools

The ZWSP would require the education of the City's children on how our waste and resources are managed. Under the current system, recycling program participation is left up to the principal of each school resulting in a wide variety of results.

Yard Waste

It is recommended that the residential yard waste collection service be expanded. Current options for City residents include two designated, curb-side, yard waste collection days each year. City residents can also choose to bring their yard waste to one of three manned drop-off sites. These sites also take larger branches, shrubs and Christmas trees, but the drop-off hours are limited to Monday-Friday from 8:00 a.m. to 2:00 p.m. In addition, residents are allowed to set out yard waste on their designated garbage collection day. Any yard waste collected on these days is transported with the garbage to the landfill

Food Waste

Another goal of the ZWSP is to facilitate the development of a food waste treatment system. It would prohibit food waste from large volume commercial and industrial generators of food waste entering the landfill. In order to meet that goal, the City will work with the state and the county to promote growth of the infrastructure of facilities to handle food waste. Potential options include the construction of a City-owned compost facility for food waste and landscaping green waste, or enhancement of the County POTW treatment (ALCOSAN) system to include an anaerobic digester. The City could also encourage private sector investment in newer/larger compost systems or encourage private sector investment in anaerobic digesters. They could also work with local farmers with existing manure digesters to upgrade their systems to include food waste. In order to reach Zero Waste, a food waste ordinance must be part of a systematic, long-term plan. Commercial businesses that generate more than a set amount of waste per week will be required to recycle organics. When fully operational for commercial businesses, the plan will add single-family households, multi-family housing units and smaller businesses. The plan could also require that new or renovated multi-family housing buildings have adequate handling systems for trash, recyclable and compostable materials collection.

Anaerobic Digestion

Although only 1% of GHG emissions are derived from organic material in landfills, it would be more efficient to eliminate that component by removing all organic waste from the landfills. To effectively reduce the carbon footprint of waste, it is important to divert as much material as possible. Pre-sorting organic waste before it reaches the landfill would prevent methane release and allow the material to be used to create energy.

Organic matter, including food and yard waste, occupies approximately 21 percent of landfill space.[15] Anaerobic biodigestion technology can be used to create biogas and prevent the

[15] https://www3.epa.gov/region9/waste/features/foodtoenergy/food-waste.html

[2] http://www.calrecycle.ca.gov/Publications/Detail.aspx?PublicationID=1275

release of methane. Organic materials can be separated from the municipal solid waste (MSW) stream and processed in an anaerobic digester to produce biogas. Organic waste that can be broken down by anaerobic digesters includes food and yard waste, fats, oils, and greases, industrial food waste, biosolids from sewage sludge, waste water, and animal manures. All anaerobic digestion systems adhere to the same basic principles, no matter what organic material is being processed.

Anaerobic digestion also produces digestate, a nutrient-rich material that is left over following the anaerobic process. Technology exists to separate the digestate into solid and liquid components that have multiple potential uses. The solid component can be composted or heat-processed into fertilizer pellets. It can also be used for animal bedding or converted into other products such as flower pots. The liquid component of digestate can be directly applied to land as a fertilizer or soil amendment. Land application of digestate can improve overall soil health.

Benefits of Anaerobic Digestion

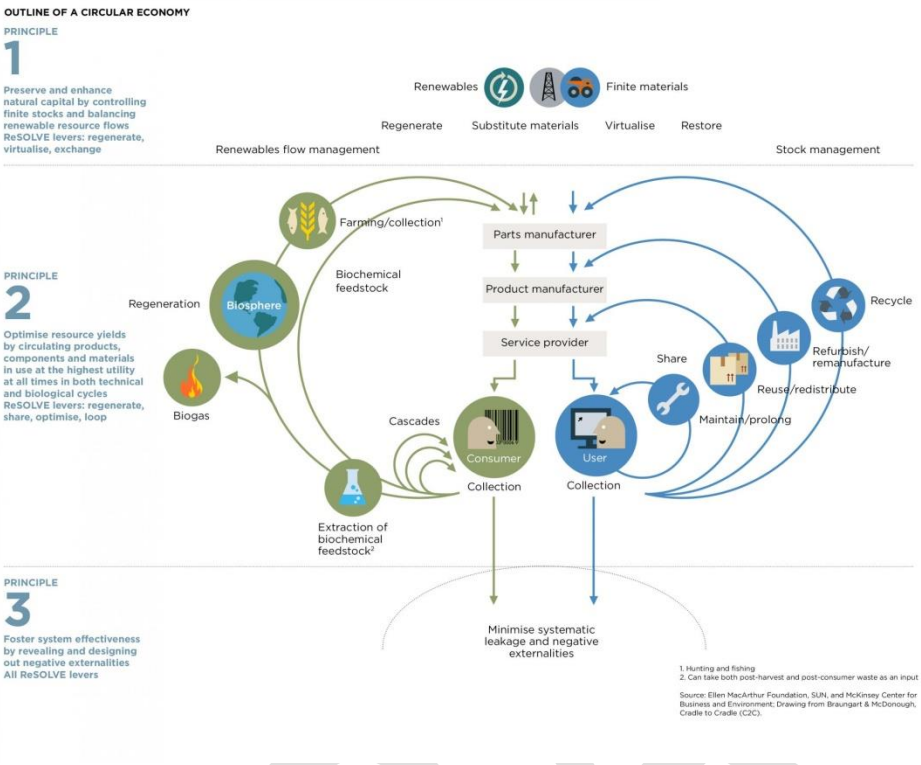
There are multiple benefits to the use of Anaerobic Digestion technology. Organic waste can be diverted from landfills. This will reduce GHG emissions that occur when organic materials decay in landfills, releasing methane and carbon dioxide into the atmosphere. It is also a method to create clean, renewable energy that can be used in a multitude of systems. The by-products of energy creation can improve soil health by increasing organic matter content; reducing the need to apply chemical fertilizers and pesticides, reducing soil erosion and nutrient runoff, increasing water retention, reducing the need for irrigation and alleviating soil compaction. For further information about the importance of soil health in GHG reduction, see Chapter 7 on the Urban Ecosystem.

Circular Economy

Beyond greenhouse gas emissions, the way we use and dispose of products, is a significant concern. We are rapidly depleting the world's natural resources at a rate much faster than they can be replenished. Vast quantities of energy are consumed in the extraction of raw materials in order to manufacture products that are then discarded, creating the need to extract even more resources. Our goal is to transition to a closed loop system, or circular economy, in which materials are regenerated, recovered and restored in order to create is zero waste.

The concept of a circular economy is in contrast to our current industrial model that relies on a "take, make and dispose" process. Our current, linear economic model is based on the consumption of large quantities of inexpensive materials and energy that are finite in nature. A circular economy is based on renewable energy sources and relies on innovation to redefine products and services in order to design out waste and minimize negative impact. A circular economy is a continuous cycle that has both technical and biological components. In the biological cycle, resources are used and regenerated through natural processes. In the technical cycle, materials are designed to be recovered and restored with the highest quality

retention through minimal use of renewable energy. (Ellen Macarthur Foundation, Towards a Circular Economy: Business Rationale for an Accelerated Transition, November 2015)



CHAPTER SIX: Food and Agriculture

Category	Action	Actor	Impact
Prevent Food Waste			
	Promote tray-less dining	City; nonprofits; businesses; universities	30% post-consumer food waste reduction; reduced water and detergent use
	Promote smaller dining plates	City; nonprofits; businesses; universities	Possible 16% less food taken
	Serve lunch after recess	Schools	32% decrease in food waste; 54% increase in fruit and vegetable intake
	Ensure lunch is at least 30 minutes long	Schools	37% decrease in food waste
	Promote ugly fruits and vegetables	City; nonprofits; businesses; institutions; schools	
	Increase cooking education	Schools; nonprofits	Potentially reduce kitchen food waste by 47%
Donate Food			
	Promote food recovery	City; nonprofits; businesses; schools	
	Increase awareness of garden donation programs	City; nonprofits; schools	
Compost Food Waste			
	Pilot a community composting program for gardens	City; nonprofits; businesses; community groups	Soil remediation and storm water management
	Eliminate market incentives for food waste sent to landfills	State government	
Capture Biogas			
	Improve biogas generator efficiency	State; businesses	Reduce air pollution and methane emissions; reduce energy demand
Change Eating Habits			
	Support research and education around local, organic, and heritage crops—in particular, SARE and OREI	Federal, State and Local government; universities; foundations; nonprofits; farmers; citizen scientists	Increase consumption and demand for local food; reduce demand for high-emission imported food; increase food security by creating new climate-resilient crops

	Promote eating of multiple small meals per day	City; nonprofits; businesses; universities; schools; community groups	Caloric intake and body mass reduction potentially decreases emissions by 8MMTCO2e
	Reduce beef consumption by 30% to meet USDA recommended dietary guidelines	Individuals	Reduce need to increase cow production locally to meet demand and future production losses as a result of increased temperatures
Make Strengthening the Local Food System a City Priority			
	Adopt a City-wide definition of “local” food	City	Create a standard for baseline research and target-setting of future goals
	Develop an Office of Food Initiatives and hire a manager	City	Facilitate conversation and action in the local food system
	Create a local food and urban agriculture website	City	Improve access to information
	Develop a regional food plan	City; nonprofits; businesses; universities; schools; community groups	
Build Demand for Local Food			
	Increase institutional purchases of local foods	City; institutions; universities; schools	
	Create a vegetable prescription program	Hospitals, clinics, insurance providers	
	Promote sustainable Pittsburgh restaurants, farmers’ markets, community gardens, healthy corner stores, and food pantries on City food website	City	
	Support local food buyer-seller networking events	City; nonprofits; businesses; foundations	
Increase Supply of Local Food			
	Promote climate-resilient, small-scale, organic production methods such as silvopasture and alley cropping	City; businesses; universities; nonprofit organizations; farmers	Reduce emissions associated with fertilizer, large herds, manure lagoons, and indoor cooling systems; increase carbon

			sequestration potential of farms; improve the local economy; reduce nutrient runoff
	Increase the number of gardens, urban farms, and peri-urban farms	City; foundations; nonprofits; community organizations; individuals	Educate the public on gardening/farming and overall food production; improve food access and food security; improve air quality and community pride; increase carbon sequestration and reduce storm water runoff; increase property values; reduce emissions associated with transport and synthetic fertilizers and pesticides; increase diversity of employment opportunities
	Encourage institutions to grow gardens	City; nonprofits; institutions	Reduce emissions associated with transport and synthetic fertilizers and pesticides
	Support alternative growing platforms such as hydroponics, aquaponics, and green rooftops	City; foundations; businesses; nonprofits; schools; institutions	Closed nutrient systems reduce emissions associated with irrigation and fertilizer; green rooftops and gardens reduce emissions from heating and cooling
Increase small farm profitability			
	Continued support of 2012 Healthy School Food requirements	City; schools	Increase vegetable consumption by 16%; increase fruit demand by 23%
	Create food hubs	City; nonprofits; businesses	Reduce transportation emissions
	Create a cottage food law	City; County; State	Increase demand for local products; increase employment

The third edition of Pittsburgh's Climate Action Plan comes during a pivotal time for the City. This edition also marks the first inclusion of a chapter entirely devoted to food. The addition of this chapter is due to the growing awareness of agriculture's impact on climate. For purposes of this chapter, the agriculture sector is divided into two topics: the local food system, and food

waste, which were identified as topics to focus on for the greatest reduction of emissions in the City of Pittsburgh. Since this is a first for a food chapter, this edition is an overview of the issue and contains first steps the City and its partners should take to mitigate the effects of agriculture on climate and support the ongoing commitment to a resilient Pittsburgh.

Quantifying greenhouse gas emissions attributed to the agriculture sector is challenging because the sector is broad and encompasses activity in sectors outside agriculture. Nationally, the agriculture sector accounted for 8.8 percent of total greenhouse gas (GHG) emissions in 2013.[16] Comparatively, GHG emissions within the agriculture sector in Pennsylvania accounted for 7.12 million metric tons of CO_2, or 2.62 percent, of total GHG emissions in the same year.[17] The Pennsylvania Greenhouse Gas Emission Inventory divides the agriculture sector into three contributing factors: **enteric fermentation** from livestock digestion, agricultural **soil management** from fertilizer application, and **manure management** from the livestock, and each factor contributed approximately 48.47 percent, 34.13 percent, and 17.29 percent respectively.[18] (See *Figure 1*)

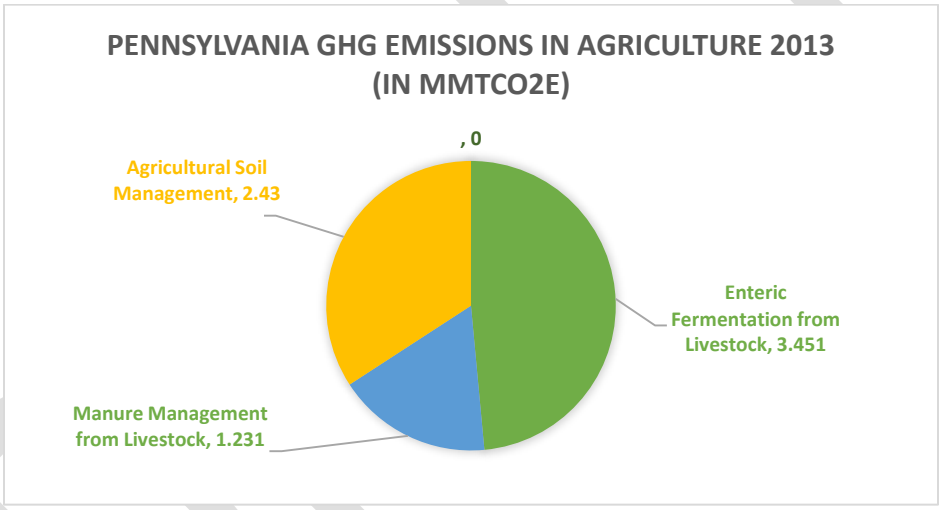


Figure 1

It should be mentioned that GHG emission calculations on both the national and state level are not complete accounts of the agriculture sector and food system in its entirety. Other attributable sources of GHG emissions in the sector include energy to operate tractors and vehicles used in food transportation, or food production machinery. According to data from the Consultative Group on International Agricultural Research:

[16] https://www.epa.gov/sites/production/files/2016-03/documents/us-ghg-inventory-2015-main-text.pdf
[17] http://files.dep.state.pa.us/Air/AirQuality/AQPortalFiles/Advisory%20Committees/CCAC/Docs/Inventory-2016_1-18-17_(final).pdf
[18] Id.

The global food system, from fertilizer manufacture to food storage and packaging, is responsible for up to one-third of all human-caused greenhouse-gas emissions…[19]

What can Pittsburgh do?

While there isn't a lot that we can do to directly affect the three main contributing factors to GHG emissions, we can indirectly reduce our food-related emissions by putting more effort into **supporting the regional food system** and better **managing our food waste**.

Local Food System

What exactly is "local" food? There is no definitive answer, but many agree a 150 mile radius from the City or any other designated location is appropriate. The USDA adopted a 400 mile radius, whereas others choose to eat only foods in season and source food from as close to home as possible.[20] Pittsburgh food distributors and organizations, including Parkhurst, Paragon Foods, Giant Eagle, Sustainable Pittsburgh, and the Pittsburgh Public School system promote a 150 mile radius for food to be considered locally sourced. (See *Figure 2*) In practice, farmers tend to travel even less based on formal and informal interviews with farmers who, at most, travel 135 miles to the City. An increase in demand and sales opportunities may encourage farmers to drive a bit further, so while "local" in regards to food does not have a concrete definition, 150 miles or less is ideal for the City of Pittsburgh.

[19] http://www.nature.com/news/one-third-of-our-greenhouse-gas-emissions-come-from-agriculture-1.11708

[20] https://www.ers.usda.gov/webdocs/publications/46393/7054_err97_1_.pdf?v=42265

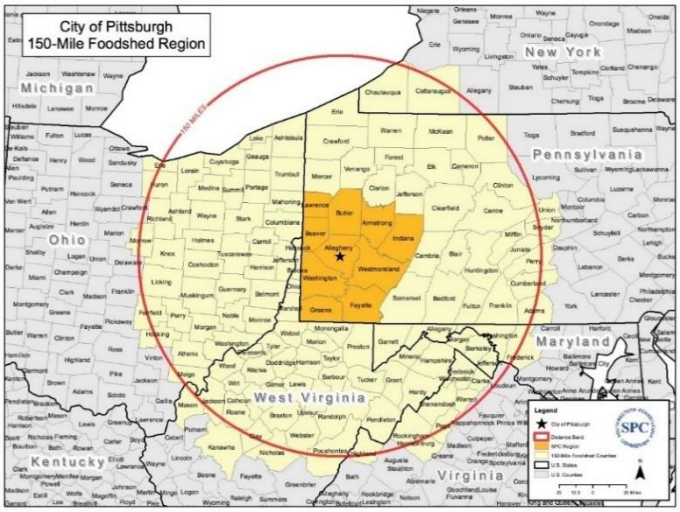


Figure 2

Increasing and promoting local food production serves a number of purposes. First, there is an opportunity for new food business and job development. A report published by the Southwestern Pennsylvania Commission (SPC) analyzing the local food supply chain in the region used economic models and found "if economic activity in the supply chain can be increased by 10%, the region would add $4 billion in business activity and 33,000 new jobs."[21] Second, consuming produce from more local, small and medium size farms reduces City residents' contribution to the larger, more commercial farms that truly impact climate and GHG emissions levels from heavy fertilizer use and emissions from transportation.

To increase food sourced within the Southwestern Pennsylvania region, the City and its partners should engage in federal programs such as *Local Foods, Local Places*, that assist in local food system development. Local Foods, Local Places is a collaboration between seven federal sponsors – the USDA, the EPA, the Center for Disease Control and Prevention (CDC), the Department of Transportation (DOT), the Department of Housing and Urban Development (HUD), the Appalachian Regional Commission, and the Delta Regional Authority. The program "helps cities and towns across the country protect the environment and human health by engaging with local partners to reinvest in existing neighborhoods as they develop local food systems."[22] The City of Pittsburgh should submit a proposal for consideration as a partner community.

The aforementioned SPC report found overall, the number of farms in the surrounding ten counties has decreased, but the average size, in acres, of each farm increased. Between 2007 and 2012, the value of agricultural products also increased, leading to a record high in 2012 of

[21] http://www.spcregion.org/pdf/food/Local%20Food%20Report_Full%20Report.pdf
[22] https://www.epa.gov/smartgrowth/local-foods-local-places#main-content

agriculture sales in the region.[23] Consequently, one of the more significant steps the City of Pittsburgh can take to reduce its carbon footprint, and strengthen the local economy, is to encourage small and medium farm growth and food production. There are vacant lots in the City that residents may utilize for urban agriculture purposes, but developing and maintaining partnerships on the county and regional level will be most beneficial to foster local food production.

Power of the Institution

Increase institutional purchase of local foods. Development and promotion of a local food system cannot be an individual endeavor; all sectors need to be involved in order to have a prosperous food system. The City should lead by offering local produce and products in government buildings, public institutions, and City schools. One initiative the City has underway is a **Community Supported Agriculture** (CSA) program for City employees. A CSA allows participants to buy a share of a local farmer's harvest. The share is purchased upfront at the beginning of the season to help farmers pay for seeds and labor. Participants then receive a weekly or biweekly box of produce, which is dropped off at a central location for pickup. The Department of City Planning is the host site for two farms for the 2017 season. CSA programs are not new, but encouraging City employee participation is one step in supporting the local food economy and setting an example for other city residents and businesses.

The Pittsburgh Public School District (PPS) also actively seeks to increase its number of food contracts with local farmers and producers. According to the most recent Farm to School Census Report published by the USDA, PPS devoted approximately 24 percent of its almost $7 million food budget to local foods during the 2013-2014 school year. The school system's current local produce supplier works with farms within 100 miles of the City, and its milk is supplied from farms within 70 miles of the City.[24]
Organizations throughout the City have partnered with PPS to promote healthy, local meal options, and the Pittsburgh Food Policy Council assists the district through advocacy, grant writing, and community education and outreach to increase the number of freshly prepared meals using local products. Common Threads and Community Kitchen have also joined PPS to offer cooking classes to students after school. There are 54 schools in the district – 6 schools have gardens and 10 schools have a salad bar. PPS stated in the USDA report that it would like to increase the percentage of locally sourced produce, and increasing the number of school gardens is just one avenue in which to accomplish this objective.

To further promote the purchase of local produce and food products, the City could implement a local food procurement policy. These policies are designed to give preference to local farmers and producers that may otherwise be overshadowed by large corporations. The policy would be applicable to any contract public institutions and government entities may have that involves the purchase of food. States like Vermont and New Hampshire and cities including New York and

[23] http://www.spcregion.org/pdf/food/Local%20Food%20Report_Full%20Report.pdf
[24] http://www.monteverdes.com/index.php/about-us/distribution-map ; http://turnerdairy.net/

Los Angeles have enacted local food procurement policies and may be models for the City through the proposal, drafting, and enactment process.

Encourage institutions to grow gardens. Growing fruit and vegetable gardens in schools and other institutions throughout the City serves two purposes. First, produce may be harvested and used in school and workplace lunches, thereby increasing local produce consumption and decreasing the City's carbon footprint. And second, the gardens serve as an educational tool and encourage individuals to make fresher, better food choices for healthier lifestyles in an era of rising rates of obesity.

In their mission to assist schools expand garden education, Grow Pittsburgh developed a CORE-aligned garden education program for schools and added 9,400 square feet of growing space in the City through 15 garden installations in public and charter schools. The program has engaged more than 6,000 students and teachers while educating them in food growth and production. In 2017, Grow Pittsburgh aspires to install 13 additional school gardens, culminating in approximately 27,000 square feet of edible schoolyards.

Large institutions like hospitality and dining service groups that serve corporations, event venues, and more are also key stakeholders in gardens. The David Lawrence Convention Center, operated by Levy Restaurants, has three outdoor spaces, and their North Terrace holds 27 rooftop garden boxes. Fresh produce is grown and picked daily to use for food service at the convention center. The outdoor space also hosts a variety of pollinator plants and a Monarch Waystation with milkweed habitats as part of the convention center's sustainability plan.[25] Parkhurst Dining, another large corporation in Pittsburgh, has an extensive client portfolio, including Google, Reed Smith, Bayer Corporation, the Pittsburgh Steelers, and Chatham University. At each of these locations, there is a rooftop or urban garden of some sort, providing produce, herbs, and honey direct to the businesses in which they are located.[26]

Hospitals are also key players in sourcing locally grown foods, some even from their own facilities. University of Pittsburgh Medical Center (UPMC) at Magee Women's Hospital recently implemented food production and gardening classes in their Japanese garden as a component of the wellness program. Approximately 2,000 pounds of fresh vegetables harvested from the garden are used in patient meals and the hospital's cafeteria annually.[27]

Growing produce on rooftops in Pittsburgh is an effective way to not only support the local food system but also reduce emissions from transporting food across Pennsylvania and the country. The City may support urban gardens through cross-sector collaboration with zoning, finance, permits, licenses, and inspections to make rooftop gardens more widely accessible.

[25] http://www.greenfirst.info/outdoor/outdoor-spaces.php

[26] http://www.parkhurstdining.com/sustainability/farmsource

[27] Email interview with Chris Vitsas, Director of Food and Nutrition at Magee-Women's Hospital of UPMC.

Food Hubs & Cottage Food Laws

Expand food hubs. A **food hub** is a business or organization that collects produce from farms in the region and creates channels in which the produce can easily be distributed. Food hubs offer small and medium farmers and producers the capacity to sell to the local market, and it is done in one accessible location. The concept minimizes emissions from the trucks, planes, and ships used in food transportation. Penn's Corner and Three Rivers Grown, both located in Pittsburgh, are considered food hubs and strive to lessen the barriers farmers encounter when entering the local market.

Adopt a cottage food law in Allegheny County. Food preservation techniques, such as canning, fermentation, and dehydrating, as well as **value-added food products**, are beneficial to many – imperfect produce is not wasted and farmers and small business owners have an additional source of income or even a new career. Selling a variety of products produced with local produce and ingredients that may otherwise go unused is vital to increase profit margins for farmers and producers. The Pennsylvania Food Safety Act regulates the sale of value-added products produced in residential kitchens and designates residential kitchens as limited food establishments for purposes of the Act.[28]

Due to local regulations administered by the Allegheny County Health Department, all value-added food products produced for sale must be made in a commercial kitchen. The local regulations therefore prevent residents and small business owners from producing value-added products in their homes and impart additional barriers on individuals seeking new business ventures. A report published by the Harvard Food Law and Policy Clinic discusses the nuances of a cottage food law and how to navigate the different components of the law.[29] The City should work with the county to remove or modify any barriers in small-scale food production so small food businesses have the opportunity to grow without the burden of installing an expensive commercial kitchen. Alternatively, the City could pledge a certain amount of permanent space to develop commercial kitchens for community use.

Permitting food production in residential kitchens can have tremendous economic benefits. California enacted the California Homemade Food Act in 2012, and it went into effect in January 2013. Within a year, over 1,200 local food businesses opened their doors, generating income and supporting local food production. Similarly, Pittsburgh could have a more robust local food economy while also combating food waste by allowing food production in residential homes or providing easy access to commercial kitchens. There is a wide range of cottage food laws, and some states regulate more heavily than others, but it is one more avenue in which imperfect food can be salvaged and local producers can share their products.

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28 http://www.agriculture.pa.gov/Protect/FoodSafety/Processing%20Wholesale%20and%20Distribution/Pages/Limited-Food-Establishment-.aspx

29 http://www.chlpi.org/wp-content/uploads/2013/12/FINAL_Cottage-Food-Laws-Report_2013.pdf

Urban Gardens

Increase the number of gardens—particularly in areas with high food insecurity rates. There are a good number of organizations and individuals working in the City developing community and private gardens, but there are other manners in which residents can cultivate land. For example, the City created the Adopt-A-Lot program in November 2015 which allows City residents to obtain leases and licenses for vacant, City-owned land to grow produce, flowers, or install rain gardens. Residents have to renew leases and licenses with the City each year, and the land may revert back to the City with reasonable notice, but the program provides an opportunity for urban agriculture at little to no cost to residents who may otherwise not have convenient access to fresh produce.

Support the Urban Agriculture Act. On September 28, 2016, Michigan Senator Debbie Stabenow introduced a comprehensive urban agriculture bill to the United States Senate. The Urban Agriculture Act establishes an Office of Urban Agriculture within the USDA and provides funding for a number of programs committed to urban food systems, expanding community gardening, and rooftop agriculture. The Office will develop pilot programs for municipal composting and other food waste reduction strategies and strengthen the connection between healthy food consumption, the environment, and health.[30] The City has the ability to lobby for this bill to better serve the community and further develop urban agriculture in the City. Organizations and individuals throughout Pittsburgh can also show their approval of the bill. For example, the Pittsburgh Food Policy Council has already sent its support to Washington, and other organizations committed to the City, the food system, and the community can also get involved.

Food Waste

If food waste were a country, it would be the third largest producer of greenhouse gases in the world, after China and the U.S. [31]

As a nation, the United States spends "$218 billion a year, or 1.3% of GDP, growing, processing, transporting, and disposing of food that is never eaten."[32] Specifically, **wasted food** consumes 21 percent of all fresh water, 19 percent of all fertilizer, 18 percent of cropland, and 21percent of landfill volume. In addition, the production of fertilizer uses energy and fossil fuel. If we reduce the amount of food wasted, we save water, reduce fossil fuel consumption, and reduce methane from landfills. As a bonus, the land that isn't needed for food production can be converted into forests, which would help to sequester carbon.

The Environmental Protection Agency (EPA) estimates that 40 percent of food is wasted, and the United States itself plays a significant role in perpetual waste by not responding to changing patterns of food consumption. Data collected and published annually by the United States Department of Agriculture (USDA) follows food consumption trends; in 1976, beef consumption

[30] https://www.congress.gov/bill/114th-congress/senate-bill/3420
[31] http://www.nationalgeographic.com/magazine/2016/03/global-food-waste-statistics/
[32] https://www.refed.com/?sort=economic-value-per-ton

peaked, and Americans consumed 91.5 pounds per person of beef that year. More recently, beef consumption per person fell to approximately 52.3 pounds in 2012.[33] This may in part be due to the revival of historical campaigns like "Meatless Monday," which not only bring attention to health implications of beef consumption, but also environmental ones. In 2015, human activity produced 10 percent of methane in the United States. Of that 10 percent, enteric fermentation and manure management, both from livestock, accounted for 35 percent of methane emissions.[34] Furthermore, 47 percent of soy and 60 percent of corn produced nationally is used for animal feed, and both crops have a large impact on climate due to the nature of their commercial production.[35] In response to decreased consumption, the meat industry reduced its environmental impact by improving efficiency and producing more meat with fewer animals, but given the current consumption trends, the industry continues to overproduce products and contribute significantly to greenhouse gases.

The City of Pittsburgh acknowledges the pressing issue of food waste and has made a number of commitments to reduce the amount of food that is wasted. In September 2016, the City signed the Biophilic Cities Commitment which is a promise to protect, restore, and grow the City's urban ecosystems. Mayor William Peduto also signed the Milan Urban Food Policy Pact (MUFPP) in April 2016. MUFPP is a network of 144 cities from around the world dedicated to developing sustainable and socially just food systems.[36] The City will uphold its commitment to go beyond the 50 percent reduction in food waste proposed by the EPA and aim to be a leader in sustainability by 2030. Furthermore, the Mayor signed an executive order in June 2017 to reaffirm the City's commitment to the Paris Agreement.[37] One particular 2030 objective that falls within this chapter is the City Wide Zero Waste Initiative because food waste is a large contributing factor to the City's waste production (see Chapter 5 for more information on the City Wide Zero Waste Initiative).

There are a number of strategies the City may implement to reduce food waste, thereby reducing local emissions that contribute to the larger greenhouse gas issue in the region and country. To combat food waste, the EPA developed a Food Recovery Hierarchy, which prioritizes actions and guides entities in addressing food waste. The below strategies are categorized based on a loose model of the EPA's Food Recovery Hierarchy.[38] This model in turn addresses the City's Zero Waste Initiative to divert 100 percent of materials from landfills.

[33] http://earth-policy.org/data_highlights/2012/highlights25 (pulled from data spreadsheet the Earth Policy Institute used to generate graphs); https://www.ers.usda.gov/data-products/food-availability-per-capita-data-system/ (looking at red meat, poultry, and fish food availability data spreadsheet)
[34] https://www.epa.gov/ghgemissions/overview-greenhouse-gases#methane
[35] http://www.sustainabletable.org/260/animal-feed
[36] http://www.milanurbanfoodpolicypact.org/wp-content/uploads/2016/06/Milan-Urban-Food-Policy-Pact-EN.pdf
[37] http://apps.pittsburghpa.gov/mayorpeduto/Climate_exec_order_06.02.17_(1).pdf
[38] https://www.epa.gov/sustainable-management-food/food-recovery-hierarchy

Prevention

Promote tray-less dining. Dining trays in large, buffet-style establishments promote overconsumption and taking more food that will eventually go to waste. A number of universities found removing dining trays reduces post-consumer food waste; the University of Massachusetts removed trays from their dining halls in 2009, and post-consumer food waste decreased 30 percent.[39] Locally, the University of Pittsburgh eliminated trays from their dining facilities in 2009 and conserved thousands of gallons of water and large quantities of dish detergent as a result.[40] Tray-less dining in universities and large institutions can significantly decrease food waste, and organizations and networks like the Pittsburgh Council on Higher Education, a network of ten local colleges and universities, may commit to removing trays from dining establishments and actively find new ways to reduce food waste on campus.

Support "ugly" fruits and vegetables. A recent trend splashed across headlines is **"ugly" produce**, or produce that is imperfect in appearance and is unmarketable. Notwithstanding their ugly aesthetics, the produce is completely edible and just as nutritious as "perfect" produce. Pittsburgh organizations, namely 412 Food Rescue, promote ugly produce to combat food waste and recently developed a partnership with Penn's Corner Farm Alliance to begin an UglyCSA program. Supporting programs that salvage "ugly" produce will further reduce waste from food that is aesthetically flawed, but perfect to eat.

Donation

Promote food recovery for all institutions and events. Historically, the Greater Pittsburgh Community Food Bank receives most corporate food donations from grocery stores and stadiums. However, the Food Bank and other food pantries lack the capacity and flexibility to accept fresh produce and other perishables, despite increasing acceptance rates in recent years. Perishable foods need to be delivered quickly to mitigate spoilage and waste, and without a team of volunteers, these products tend to perish. Organizations like 412 Food Rescue are integral to food recovery, especially perishable foods. Established in 2015, 412 Food Rescue is a Pittsburgh organization that utilizes volunteer "heroes" to "rescue" food from donors and deliver to other organizations that redistribute food directly to those in the community that need it most. Since its inception, the organization has rescued nearly 1,600,000 pounds of food and served over 1,300,000 meals, reducing local emissions by over 855,000 pounds.[41] In April 2017, the City partnered with 412 Food Rescue during Inclusive Innovation Week for the Food Recovery Challenge. By week's end, residents recovered and redistributed over 27,000 pounds of food to communities.[42] It is important to support food recovery organizations because food waste, and ultimately GHG emissions, will decline.

Engaging the large number of colleges and universities in Pittsburgh is vital to food recovery. At the University of Pittsburgh, students launched a food recovery program in fall 2014. They

[39] http://www.refed.com/solutions/trayless-dining
[40] https://www.pc.pitt.edu/dining/sustainability.php
[41] https://412foodrescue.org/
[42] http://pittsburghpa.gov/innovation-performance/innovationroadmap/events.html

collected and delivered more than 4,000 pounds of food to local entities. In May 2016, Pitt became Food Recovery Certified by the Food Recovery Network, a student movement committed to fighting food waste and hunger, and they recovered over 9,300 pounds of food in 2016.[43] Urging other institutions of higher education as well as City schools to join the Food Recovery Network will further promote the reduction of food waste and resultant emissions. The City could also adopt an incentive program for other institutions to promote food recovery. Additionally, the City could sponsor food recovery and waste challenges throughout the year. The EPA and USDA have toolkits for food recovery and waste challenges that the City of Pittsburgh, local schools, and corporations can utilize.[44]

Home garden donation program awareness. Working in partnership with the Greater Pittsburgh Community Food Bank, home gardeners are able to donate surplus food at a number of locations throughout the City each day, and the Food Bank Community Harvest program ensures produce is provided to families in need.[45] The City can support this program by providing information on how to donate produce and work with local organizations in donation marketing.

Composting

Pilot a community composting program. Small, community level composting initiatives are ideal for the City and its residents and should be supported through the development of a composting ordinance. Community composting, rather than municipal, is more economically feasible, reduces emissions from transporting compost long distances, and better suited for environmental regulation compliance. Compost not only makes use of food waste that may otherwise end up in the landfill, but there are also a number of ecological benefits such as dilution of toxins in soil and improved storm water retention. For more information on composting, see Chapter 5 on Waste.

Office of Food Initiatives

In order for Pittsburgh to successfully address these issues associated with food and climate change, an individual is needed to lead the conversation. To that end, an Office of Food Initiatives is needed. This office will act as a liaison between residents, the City, and the network of stakeholders comprising the Pittsburgh **food system** to facilitate conversation and action in the local food climate. This office shall designate a manager to represent the City in an official capacity at meetings and conferences pertaining to food, to oversee the implementation of food-related policy recommendations, coordinate efforts related to food policy with the Resilience Team and other necessary departments, communicate with other food policy advisors and managers throughout the country, and maintain a centralized resource for food-related information for City residents.

[43] https://www.pc.pitt.edu/dining/sustainability.php
[44] https://www.usda.gov/oce/foodwaste/Challenge/index.htm; https://www.epa.gov/sustainable-management-food/food-recovery-challenge-frc
[45] https://www.pittsburghfoodbank.org/community-harvest-2/

With the development of an office dedicated to food initiatives in the City, a local and regional food plan should be created to direct the City on sustainable food initiatives. This chapter focused on a few of those initial steps, but a food system plan will further transform Pittsburgh into a more sustainable and resilient community that fosters and promotes a strengthened local economy and diverse food climate.

Conclusion

The City of Pittsburgh is in a unique position to set the stage for local food production and waste reduction through innovative technology and regional practices. It will take a strong commitment from stakeholders across all sectors, including the government, colleges and universities, entrepreneurs, and large corporations, but together there is the opportunity to develop a sustainable, resilient, healthy, and just local food system.

CHAPTER SEVEN: Urban Forest, Natural Systems and Carbon Sequestration

Goal: Increase sequestration by 100% by 2030

Strategies:

Based on current information, efforts can be made to improve the urban environment and its ability to reduce GHG, specifically CO2.

- Restore soil by increasing organic matter, reducing compaction
- Halt tree canopy loss due to development
- Minimize loss of trees due to pests and disease
- Encourage sound management practice to limit soil disturbance
- Support efficient water use and manage storm water, limit erosion
- Support sustainability in park design, development, maintenance, and management;
- Allocate adequate resources to sustain the public open space system
- Recover vacant spaces and brownfields for vegetation or urban agriculture
- Establish/continue public education efforts

Objectives:

- Increase tree canopy to 60% (from 42% now) by 2030
- Plant 780,000 trees by 2030; 17,700 trees planted annually with 50% natural regeneration
- Forestland protection: 100 acres a year actively protected by 2030
- Habitat conversion from lawn/concrete to urban forest
- Improve urban soil conditions through the use of compost and biomass material
- Increase biodiversity at all levels of the urban environment
- Species diversification/invasive species removal
- Wetland restoration
- Development and design guidelines for greenways

Challenges:

- Climate change will increase invasive pest species & population
- Need better data
- Green space not functional
- Local regulatory conflict
- Conflict with utilities
- Local energy/development in competition with green space
- Development pressure from building industry & current practices

- Lack of species balance, e.g.deer overpopulation causing destruction of vegetation
- Need more funding/financial structures for green space
- Green space = viewed as loss of tax revenue
- Lack of information - what do we need to teach average resident?
- Difficulty of working across sectors - landscape architecture vs landscape ecology
- Need common priorities
- Anti-ecological habits & misinformation
- City staff limitations
- Policies, process & enforcements
- Legacy contaminants - soil quality
- Extreme weather events, challenge for vegetation, ecology, geology

Introduction

Urban areas have unique challenges and opportunities with regard to climate change. Many cities are growing, both in area and in population. They cover only 2-3% of the earth's surface, but hold more than 50% of the world's population and have been estimated to produce around 75% of the total global anthropogenic carbon dioxide emissions ((Grimm et al., 2008; IPCC, 2007; IEA, 2008). One estimate suggested that during the growing season, urban landscapes emitted up to 71% of fossil fuel carbon dioxide ($FFCO_2$) (Decina et al, 2016). However, urban areas have also been shown to store more carbon per area than surrounding regions. This creates potential to impact the City's CO2 levels

In Pittsburgh, we have an opportunity to protect and manage our ecosystems by lowering our greenhouse gas emissions, specifically CO2 and CH4, through the assessment, protection, management, and improvement of the city's urban ecosystems (vegetation, soil, and water).

Pittsburgh leads major US cities in urban tree canopy coverage with 42% of the city sheltered by trees. Almost 40,000 street trees help Pittsburgh avert around 3,265 metric tons of CO2e through shading and cooling. The Pittsburgh urban forest sequesters 13,900 metric tons of CO2e, but this considers only the carbon stored in the trees, which does not account for the carbon stored in soil. In order to develop the best practices for GHG reduction, carbon sequestration must be accurately calculated. Only then can the City and partners act to increase carbon sequestration and storage.

Background: Vegetation, Soil, Water

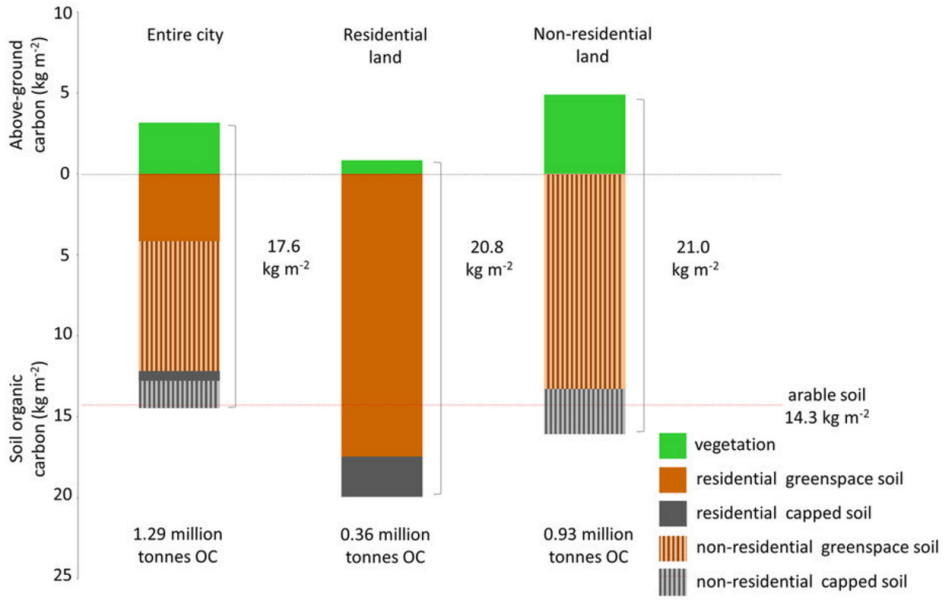
Many cities are developing policies to promote urban vegetation in order to reduce their net greenhouse gas emissions. Urban centers are diverse areas with significant potential both to reduce carbon emissions and to increase carbon sequestration and storage. Carbon sequestration is the process of incorporating atmospheric carbon into plants, soil, and water. Terrestrial sequestration uses plants to capture CO2 from the atmosphere and store it as carbon in plants and soil. Geologic sequestration allows carbon to be deposited into long-term storage in geologic zones deep underground. Urban areas have both carbon sources and sinks. A source is any process or activity through which greenhouse gas is released into the atmosphere. A sink is an area of storage for this carbon. Carbon sinks in the carbon cycle include the atmosphere, vegetation, bodies of water, and soil (NASA 2016).
Research has been done over the years looking at ways CO2 can be sequestered via vegetation and soil. However, the potential for urban vegetation to remove CO2 from the atmosphere has not been well-documented. Assessments usually consider only the carbon accumulated by trees and do not take into consideration the effects of soil respiration or the emissions associated with the management of green spaces. Soil respiration is the amount of gas that is released to the atmosphere from a given area of soil and in a given time interval. In soil, living organisms interact with non-living materials, with microorganisms and bacteria driving decomposition and mineralization processes. Soil respiration is dependent on the microclimate within soil that integrates the combined effects of its temperature, water content and aeration conditions in addition to its organic matter characteristics and the presence of organisms. It has been found that vegetation may either act to sequester carbon or as a source of CO2 emission, depending on the species and its characteristics as well as the amount and conditions of pervious surfaces for soil respiration. (Velasco et al 2016) In order to development an effective plan for management of urban ecosystems in Pittsburgh, more information is needed about the carbon sources and sinks within the city.

Urbanization is widely presumed to degrade ecosystems, but research studies are now challenging these assumptions. Urban ecosystems are able to store considerable amounts of carbon in their vegetation and soils, even under impervious surfaces. The majority of sequestered carbon (82%) was held in soils, with 13% under impervious surfaces, and 18% stored in vegetation. (Edmonson et al 2012) Carbon is the main component of soil organic matter and helps give soil its water-retention capacity, its structure, and its fertility. There is more carbon stored in soil than in the atmosphere and all biomass combined. There are 2,500 billion tons of carbon in soil, compared with 800 billion tons in the atmosphere and 560 billion tons in plant and animal life. Increasing carbon sequestration in the soil is an important component of any city plan to reduce overall GHG levels.

Urban areas have been found to be carbon dense as compared to less urban, more agricultural and forested areas. This has been found for both above ground and below ground carbon. Urban forest stands also had significantly higher organic carbon densities than suburban and rural forest stands. (Vasenev et al 2013; Pouyat et al 2002)

Figure 3: Organic carbon storage density across the entire city (including the area covered by buildings), and in residential and non-residential land (excluding the area covered by buildings).

From: Organic carbon hidden in urban ecosystems



(Ryan and Law, 2005)

Biophilic Cities

Biophilia is a term used to describe the extent to which humans are hard-wired to need connection with nature and other forms of life. Biophilic design is a growing field that recognizes and implements the need for biophilic workplaces, gardens and natural light in hospitals, and for homes that utilize daylight, ventilation, plants, and greenery. Creative and effective means for incorporating nature on a city scale is becoming increasingly important as the world's human population becomes more urban. Biophilic cities are abundant in nature, provide residents opportunities to be outside and enjoy nature, are multisensory environments, place importance on education in biodiversity, and are globally responsible cities that recognize the importance of actions to limit the impact of resource use on nature.

The City of Pittsburgh partnered with Phipps Conservatory and Botanical Gardens to apply to the Biophilic Cities Network and was formally inducted into the global network on September 16, 2016. The City's main biophilic endeavors have focused on improvements to water and air quality, and to increasing city residents' engagement with the natural world. The City will create partnerships to enhance biodiversity, increase the tree canopy, install green infrastructure, daylight streams, and plan EcoInnovation districts. Pittsburgh will measure success in these areas through tree canopy coverage over time, extent of biodiversity, participation in monthly Biophilic meet-ups, percent of city budget devoted to nature conservation, restoration, and education, among other indicators.

Urban Soil Rehabilitation

Urban soils have unique characteristics that create unique challenges. About one-third of urban carbon emissions result from changes in land use, such as the replacement of vegetated surfaces with developed or industrial land (Denman et al., 2007).
Soil disturbance due to typical land development practices reduce the organic matter and carbon stored in the soil and increase the carbon emitted from the soil into the atmosphere during construction processes even when the topsoil is replaced. (Yujuan Chen et al, 2013)
Land management practices for urban agriculture, landscaped areas and lawns can also increase emissions. In addition, urban soils often exhibit altered physical, chemical, and biological characteristics in comparison to local non-urbanized soils. They can be contaminated by pollutants due to anthropogenic activities or degraded due to the influence of past land use on soil properties. These unique attributes can promote non-native invasive vegetation and can create novel soil types that cause difficulties for the ecological restoration of urban soils. (Kumar & Hundal, 2015; Mitchell A. Pavao-Zuckerman, The Nature of Urban Soils and Their Role in Ecological Restoration in Cities)
Both the loss and gain of carbon in soil depend heavily on the pattern of interaction between plants, microbes, and the soil itself.

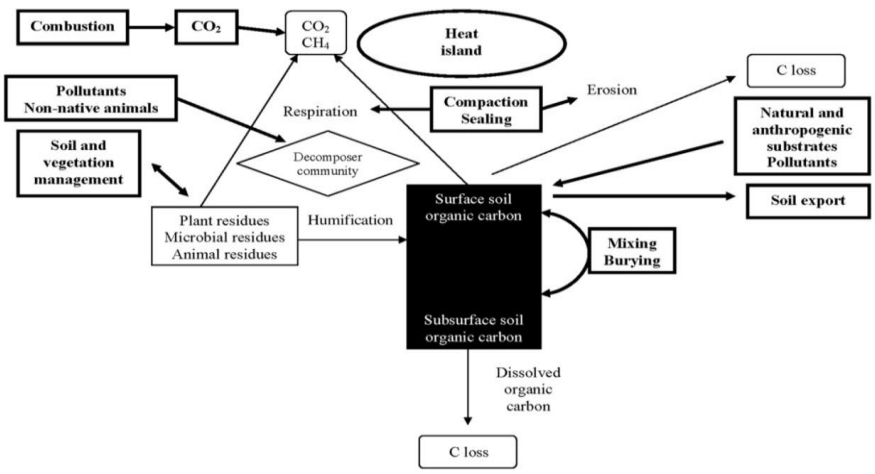


Fig. 1. Soil organic carbon dynamics and main effects of urbanization in bold (modified from Lal, 2004).

"Biogeochemical cycles in urban ecosystems are altered by human activities. Biological, chemical and physical properties of soil are changed; non-native plant and animal species and pollutants also affect the cycles. The atmospheric climate y be affected by the urban heat island and pollution island effect. However, urban soils also have the potential to store large amounts of soil organic carbon (SOC) and contribute to mitigation of increases in atmospheric CO2. This will improve retention of nutrients and water, and promote soil fertility.(Lorenz and Lal, 2009)

Improvement of urban soils is crucial to improving overall ecosystem function. Urban soil quality can be improved by using local resources such as composts and biosolids to restore soil and improve carbon sequestration. It has been shown that soil biodiversity has a positive impact on soil carbon sequestration. Ecosystems with high biodiversity sequester more carbon in the soil and living organisms than those with reduced biodiversity. (Lal, R, 2004) Methods to reduce compaction of the subsoil also have potential to increase soil carbon storage below the surface. Soil rehabilitation can mitigate the risks from pollutants and improve the soil quality. It has been shown to have the potential to increase carbon storage both above ground and in below ground communities. (Yujuan Chen et al, 2013; Kumar & Hundal, 2015)

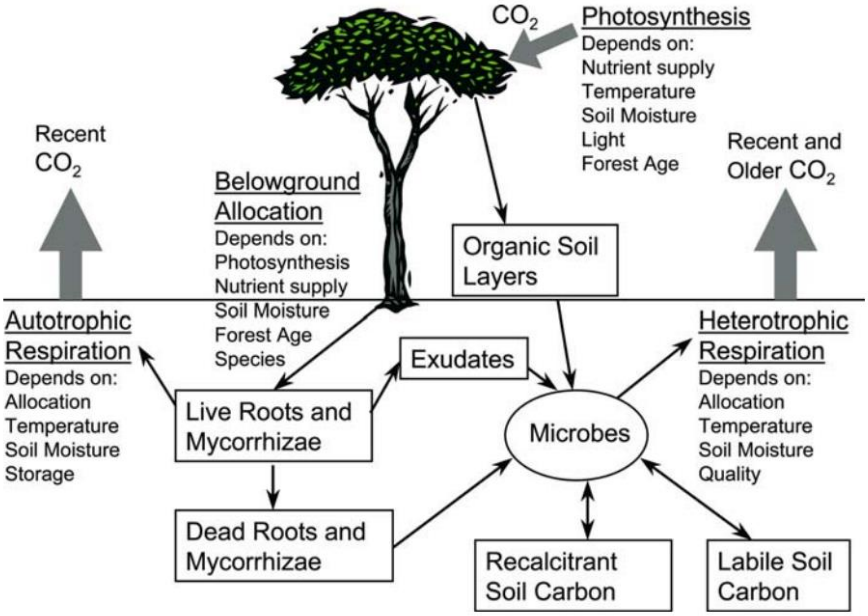


Figure 1. Conceptual model of the components and responses of CO_2 efflux from soil. Both the autotrophic and heterotrophic components of soil respiration are strongly controlled by substrate availability – phloem transport of carbohydrate supply for root and mycorrhizal respiration, and dead organic material for microbial respiration.

Ryan and Law 2005

Vegetation

Urban vegetation can take many forms including urban forests, urban agriculture, public and private landscaping, grasses, green spaces and vacant areas. Different types of vegetation can affect the ability of an area to increase carbon sequestration and/or reduce carbon emissions. Urban vegetation can also provide important ecosystem services beyond carbon sequestration, including decreased storm water runoff (Xiao & McPherson, 2002), reduction of airborne particulates (Nowak et al., 2006), reduction in seasonal heating/cooling demands (McPherson et al., 2005), reduction of the urban heat island through evaporative cooling (Huang et al., 2011), and providing recreational spaces and aesthetic value (Millward & Sabir, 2011).

Urban forests have the greatest potential to contribute to the overall reduction of GHG. Trees act as a sink for CO2 by fixing carbon during photosynthesis and storing excess carbon as biomass. (Nowak, D. 2002) Soils are also able to absorb carbon through the roots of the plants. Mature trees tend to extract and store more CO2 and have a greater leaf area to trap airborne pollutants, cast shade, and intercept or slow rainfall run-off (Brack 2002) Carbon dioxide in the atmosphere is incorporated as fixed carbon into the roots, trunk, branches, and leaves of trees, with roughly fifty percent of tree carbon storage occurring in the woody biomass (EPA 2007). Mature trees can store approximately 1,000 times more carbon dioxide than saplings (Nowak 2001). This difference highlights the importance of maintaining large tracts of healthy, mature forest, which will be much more useful in establishing carbon sinks than planting saplings. The

type of trees in the urban forest is also important. Different species of trees will absorb different amounts of carbon dioxide (ICLEI 2006).

Greenways Plan

The “Greenways for Pittsburgh” program was established in 1980 in order to protect steeply sloped hillsides that were unsuitable for building and to consolidate and preserve this land. The Pittsburgh City Council defined the term “greenway” as a permanent, passive open space that benefits the adjacent neighborhoods and the general public. As of today, there are 12 designated greenways in the City, totaling 605 acres of protected land. Emerald View Park contains 61.5 of those acres, and three neighborhood parks contain a combined total of 8.9 acres. Currently, 14% of Pittsburgh’s public open space is designated as greenways. Twenty-one additional potential greenways would add over 450 acres to the system. As a point of reference, the City’s largest park, Frick Park, is 644 acres in size.

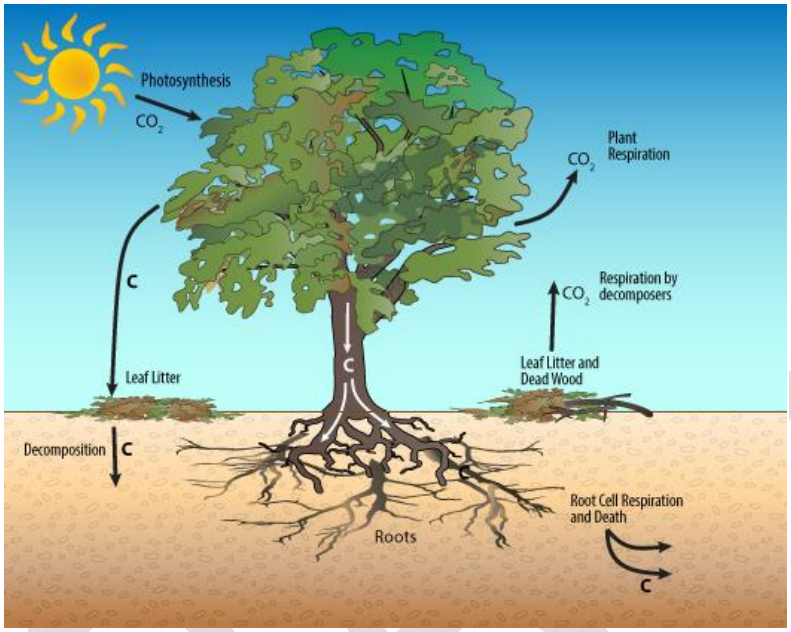
The Greenways for Pittsburgh program faces many obstacles to its success. Economic constraints have limited the time and staff available to maintain these open spaces, and defined methods for maintaining these areas must be developed. In addition, these areas are vulnerable to destructive actions such as overuse by motorized vehicles, dumping of refuse and possible unlawful activity. Greenways are also threatened by natural elements such as pests, disease and invasive species. Resources and methods to deal with all of these issues are needed. Residents of the City have indicated a desire for more greenways as well as improved access to and protection of existing natural areas that are not designated as greenways.

In July 2013, the City adopted the Open Space Plan. One recommendation that came from the plan was “Greenways for Pittsburgh 2.0”, an update of the Greenways for Pittsburgh project. The intent of Greenways 2.0 was to expand and enhance the City’s greenways, improve connectivity of open spaces, and to develop a network of hiking/biking trails. A second recommendation of the Open Space Plan was the development of a Natural Resources Manager. The Greenways for Pittsburgh 2.0 Resource Guide will be released in 2017. The Resource Guide is a how-to manual for citizens who are interested in becoming stewards of one of the City’s greenways. The Guide explains the Greenway Program and provides useful information for stewards of existing greenways or those interested in designating a new greenway. A second recommendation of the Open Space Plan was the development of a Natural Resources Manager. The role of this position would be to oversee the management and conservation of the City’s natural resources to meet the public desire for quality, accessible, connected open spaces while striving for the highest level of sustainability.

Shade Tree Commission

Shade trees play a vital role in the City’s green spaces and they are an essential element of a healthy urban ecosystem. In April, 2017 Mayor William Peduto issued an Executive Order calling for new methods to protect the City’s trees. A Task Force on Tree Protection was created in order centralize all of the City’s tree policies and to build on the work being done by the Pittsburgh Shade Tree Commission and the Public Works Forestry Division. Included in the Order is the requirement for an inventory of the City’s street trees and urban forest as well as a 10-year plan for maintenance, implementation and a streamlined process for disbursements

from the PSTC dedicated funds. The Task Force will develop a tree policy manual and all Pittsburgh departments, agencies and contractors will adhere to those policies and will be held accountable to the Mayor for upholding the tree protection standards. The policies and standards established by the Task Force on Tree Protection will allow for ongoing maintenance, protection and sustainability of the City's vital tree canopy.



Oldfield et al.

Urban forests in Pittsburgh have been found to provide an annual benefit of roughly $38,335 ($1.14 per tree) in carbon storage and avoidance. Carbon storage amounts to a net 4.4 million pounds each year, which accounts for an estimated annual value of $14,400. As a result of the cooling and wind break benefits trees provide, the amount of carbon released into the environment was reduced by 7.3 million pounds, valued at $23,967.
In addition to acting as carbon reservoirs, urban forests also affect the soil. It has been found that urban forest soils emitted the least CO2 as compared to lawns and landscaped cover. (Decina et al 2016). Conversely, the success of tree-planting projects in cities is also dependent on healthy soil. Healthy soils are critical for vigorous tree growth, so soil restoration, site preparation and management improves the traits of urban soils that are critical for success of any urban forestation projects. The preparation of urban soils for tree planting will improve the health of urban soils and therefore improve the entire urban environment. (Oldfield, Emily E. et al) In the City of Pittsburgh, 60% of private landscaping is residential. The greatest potential for urban forest occurs on residential land, but it is also the area of highest risk of removal of trees. Homeowners must be educated about the effects of their individual decisions on the urban ecosystem.

Urban green-spaces and parks can also contribute to carbon sequestration. Urban park soils can act as a carbon sink. The type of land-cover within a park determines the effectiveness of each area. Wetland soils had the highest levels of stored carbon, although their effectiveness may be limited by the release of methane gases into the atmosphere. After urban forests, lawns and bare soils were less effective, but can still influence the carbon budget of urban parks. Turf grass is a major vegetation type in the urban environment; however, plants linked with fruiting and mushroom-type fungi have been found to store 70 percent more carbon per unit of nitrogen in the soil. In addition, management practices related to turf grass, such as species selection, irrigation, and mowing will also affect carbon release and storage. (Yaling Qian et al 2015) Therefore, understanding the land-use history and the choosing the correct type of land-cover in park planning can substantially impact the effectiveness of carbon sequestration. (Bae & Ryu, 2015)

Due to the decline of industrial manufacturing, many urban centers have experienced population declines that have resulted in large areas of vacant land. Since vacant lots have a limited capacity for carbon sequestration, urban agriculture may be an appropriate land use for these spaces. However, degraded soils are common. Soil amendments such as compost and urban yard waste can significantly improve soil quality and increase crop yields for urban agriculture, thereby improving potential carbon storage in these areas. (Beniston et al 2015)

Water

Sound management of the urban ecosystem will take into account the possible effects on groundwater as well as local waterways. Proper maintenance of soils and vegetation will help to manage stormwater run-off and prevent erosion. Erosion causes not only the loss of soil, but also carries organic carbon into the waterways, impacting the health of aquatic habitats. In addition, reduction of GHG will reduce the presence of acid rain and its effects on the environment.

Carbon stored in organic matter gives soil its water-retention capacity. Soil with a higher organic carbon level will help prevent run-off and maintain healthy vegetation while requiring less maintenance and fewer resources. Soil water content and temperature directly affect the production and/or consumption of greenhouse gases. Increased water in the soil helps to increase microorganism and root activity in the soil and allow more carbon to be sequestered. (Smith et al 2003)

Ground and surface water are directly impacted by the condition of the soils in the area. Healthy soils not only help to sequester carbon but also filter pollutants, reduce runoff, control erosion and protect the water supply. (NASA 2016) Improving degraded soils with compost and biosolids will improve the soil ecosystem with minimal impact to surface water. (Basta et al 2016) Likewise, improving the efficiency of water use can reduce soil disturbance and therefore reduce the release of carbon into the atmosphere.

In order to develop a comprehensive, effective plan for reducing GHG through management of the urban ecosystem, all of the individual factors that affect carbon sequestration and release

must be monitored. In this way, the net carbon sink resulting from the combined effects of multiple factors can be determined. All areas, including the urban forest, parks, residential and commercial parcels, greenways, hillsides, wetlands, water and vacant lots must be analyzed.

Education and outreach are needed to build an understanding of the importance of sustaining, protecting and improving the urban environment. Public education is necessary for citizens to understand the impact of the urban environment on GHG levels. Resource allocation is also needed in order to support efforts to manage the urban ecosystem. Cooperation between public and private sectors and innovative approaches to the various challenges are essential for success.

Protecting and improving the urban ecosystem in the City of Pittsburgh will provide many benefits to its residents, businesses and communities beyond reducing the impact of climate change. Natural ecosystems can not only provide climate benefits, but also make our city healthier and more livable. Creating a resilient urban ecosystem will benefit the environment and property owners as well as local and regional communities and economies. A successful process will respect and enhance the relationship between nature and the built environment.

Natural areas provide environmental benefits such as improved air and water quality, a reduction in resource use and greater connectivity for wildlife. They can also create overall improvements in public health and quality of life for the City's residents. Restoring and maintaining green spaces and the health of the city's rivers and streams provides healthy opportunities for recreation and transportation. A healthy urban forest helps to decrease energy requirements while mitigating the effects of climate change. Reclamation of vacant spaces may help address food deserts within the City by providing a fertile environment for local agriculture. (Kumar & Hundal, 2015)

A healthy, dynamic urban environment provides aesthetic value and brings economic benefits to the City while increasing community pride and identity and preserving Pittsburgh's scenic and historic resources.